DRAFT

Environmental Assessment

Fire Island Community Short-Term Storm Protection

Fire Island, Suffolk County, NY

Lead Agency: National Park Service
Fire Island National Seashore
120 Laurel Street
Patchogue, NY 11772
(631) 687-4750
Contact: Michael Bilecki, Chief, Natural Resource Management

Prepared By: Land Use Ecological Services, Inc.
Coastal Planning & Engineering, Inc.
Fire Island National Seashore

Date of Preparation: April 8, 2008
Revised July 2, 2008
Revised July 25, 2008

Summary

A short-term beach nourishment project is proposed by several communities on Fire Island to protect homes and infrastructure, enhance recreation areas, and sustain emergency services on Fire Island. Nourishment is designed to temporarily stabilize and maintain Fire Island community conditions until the finalization of the U.S. Army Corps of Engineers (USACOE) Fire Island Inlet to Montauk Point (FIMP) study.

The National Park Service (NPS)/Fire Island National Seashore (FIIS) must issue Special Use Permits before projects may be undertaken within the boundaries of FIIS, which includes Fire Island communities. Prior to issuance of a Special Use Permit, FIIS must comply with the National Environmental Policy Act (NEPA), Director's Order 12, Director's Order 53 (Special Park Use permits), National Park Service Management Policies, and other relevant statutes and regulations. This Environmental Assessment (EA) was prepared in accordance with guidelines set forth under NEPA and the NPS Director's Order 12 (DO 12), NEPA guidelines.

Chapter 1 provides an outline of the relevant laws and regulations governing this project, describes the purpose and need for projects proposed by the Fire Island developed communities for short-term storm protection, and lists the history of storm protection projects that have been completed over the years. The developed communities encompass approximately 6 miles of the 32-mile long barrier island (Figure 1). Projects are intended to provide protection to community structures and infrastructure from storm damage and flooding, provide adequate beach width for safe vehicle passage during all tidal cycles, and enhance or provide recreational use of the beaches. In addition, projects may enhance habitat for shorebirds and vegetation.

Chapter 2 provides a discussion of all alternatives presented. Alternatives considered in this EA include no action, beach scraping, beach nourishment, and a combination of beach scraping and beach nourishment. There are four beach nourishment alternatives discussed in this EA: (1) 2003 permitted construction parameters, (2) modified construction parameters, including combination template and tapers on Federal property, (3) modified construction parameters, including combination template but no tapers on Federal property, and (4) 2008 dune crest line, no tapers on Federal property. For all beach nourishment alternatives described in this EA, there are four reaches defined: (1) Western Fire Island reach (Saltaire, Fair Harbor, Dunewood, Lonelyville), (2) Central Fire Island reach (Fire Island Summer Club, Corneille Estates, Ocean Beach, Seaview, Ocean Bay Park), (3) Fire Island Pines, and (4) Davis Park. Alternatives considered but rejected include trucking/barging sand from an upland source, retreat/relocation of dwellings and infrastructure, groin construction and/or removal, construction of bulkheads, breakwaters or seawalls, installation of geotubes, installation of sand bags, and flood proofing.

Chapter 3 of this EA discusses in detail the potential resources that may be affected by alternatives, including geology, water quality, terrestrial ecology, aquatic ecology, transportation, community services, socioeconomics, and cultural resources. Proposed alternatives have the potential to impact the coastal geological framework, including beach, dune, and borrow area sediments. Proposed alternatives also have the potential to impact terrestrial species that inhabit the beach and dune, including piping plover and seabeach amaranth. Beach nourishment has the potential to impact marine species inhabiting both the sand placement areas and the borrow areas, including marine mammals and sea turtles.

Detailed analysis on potential impacts of each alternative is provided within Chapter 4 of this EA. Analysis of potential impacts of beach scraping and beach nourishment is based on the framework(s) developed for each in the 2003 EA prepared by NPS/FIIS for short-term

community storm protection (NPS, 2003), Federal and state permit conditions for the 2003 beach nourishment project, and on monitoring data collected for four (4) years following implementation of the 2003 project.

Following the analysis of potential impacts of alternatives on resources, Chapter 5 discusses the environmentally preferred alternative as required by NEPA. Chapter 6 outlines the consultation and coordination undertaken as part of the proposed communities' projects. Consultation and coordination included public scoping meetings, and agency and technical meetings. Chapter 7 lists references used for environmental analysis, and Chapter 8 provides a list of preparers.

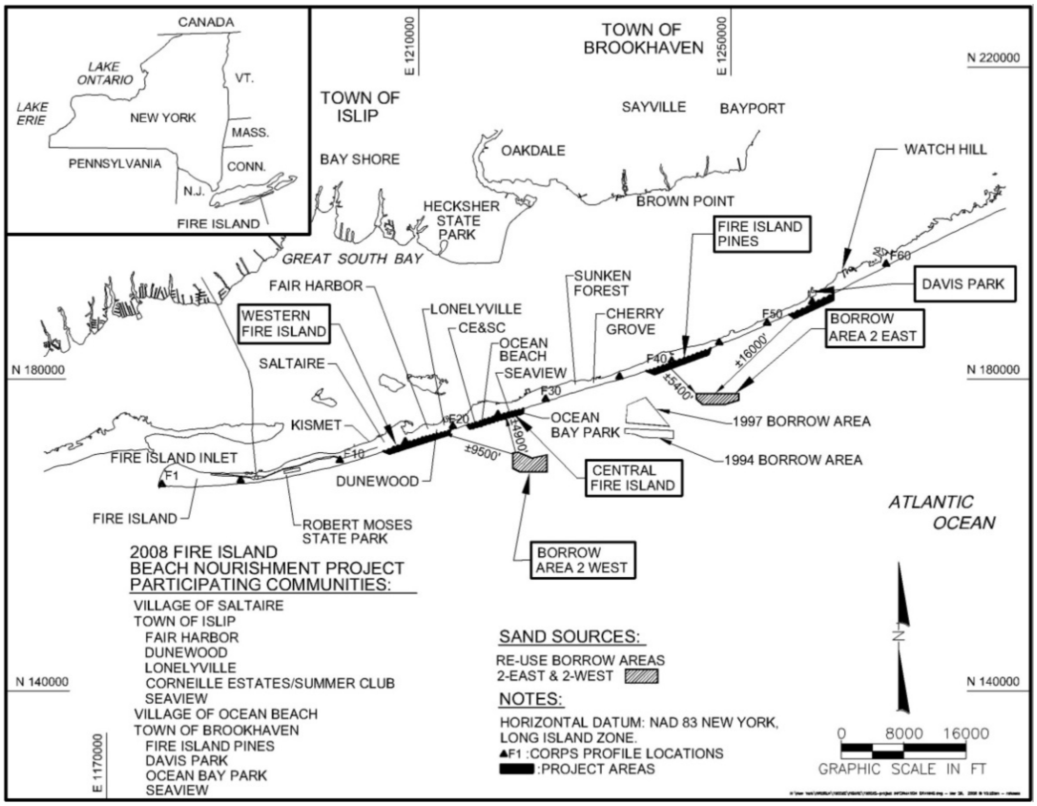


Figure 1. Location map.

Table of Contents

List of Appendices

List of Figures

List of Tables

CHAPTER 1—Project Purpose and Need

1.1 Project Purpose and Need

This Environmental Assessment (EA) was prepared in accordance with guidelines set forth under the National Environmental Policy Act (NEPA) and the National Park Service (NPS) Director's Order 12. NPS/FIIS (Fire Island National Seashore) must issue Special Use Permits before projects may be undertaken within FIIS. Prior to issuance of a Special Use Permit, FIIS must comply with NEPA, Director's Order 12, Director's Order 53 (Special Park Use permits), National Park Service Management Policies, and other relevant statutes and regulations.

This EA describes and analyzes projects proposed by the Fire Island developed communities for short-term storm protection, including beach scraping and beach nourishment. Beach scraping is designed as an annual maintenance measure for communities that qualify to scrape; scraping has been a maintenance practice on Fire Island since 1993 (Refer to Sections 1.3.3, 2.2). Beach nourishment is restricted in size and scope such that it is short-term, designed to last until the U.S. Army Corps of Engineers (USACOE) Fire Island Inlet to Montauk Point (FIMP) study is finalized (Refer to Section 1.3.1). This proposed nourishment project is the last project contemplated by the communities of this type and scale until implementation of the FIMP, assuming that FIMP will be implemented prior to the end of the effective life of the proposed project. However, failure of the implementation of FIMP prior to the end of the effective life of the proposed nourishment project may necessitate additional community nourishment projects in order to restore the protective features of the beach. Any additional nourishment required to restore the protective features of the beach will undergo the requisite environmental analysis under NEPA and SEQRA prior to implementation.

The purpose of beach nourishment and beach scraping projects is to (1) improve protection for community structures and infrastructure (both private and public) from storm waves, surge and flooding, (2) provide or improve beach width adequate for safe vehicle passage during all tidal cycles, and (3) enhance recreational use of the beaches. Under the existing retreat, the beach and dune steepen, reducing the useable beach. Currently, there are several community areas where these objectives cannot be met, as shown in photographs contained in Appendix A.

Beach nourishment projects are designed to be short-term solutions to meet the objectives listed above. Nourishment alternatives presented in Chapter 2 have been designed with a life-span of 5-6 years. The 5-6 year design life will provide an approximate level of protection from a 10-year storm and will last the duration of the bonds obtained by the communities. It should be noted that beach nourishment projects can be designed to last much longer than the current proposed projects; however, due to the FIMP project and resulting guidelines given for community projects, the current alternatives are proposed as short-term, single projects to provide protection for 5-6 years. There is a desire of some of the developed communities to recreate historic dune and beach alignments from 5 to 20 years ago, but it is not possible under current guidelines.

The 2003 beach nourishment project was designed and permitted in the same manner as alternatives presented for the proposed 2008 beach nourishment project. Communities nourished in 2003 are due for periodic nourishment in 2008, in lieu of the FIMP project which may still be years away. Planning for the proposed 2008 beach nourishment project(s) began in the fall of

2006 for the communities of Saltaire, Fair Harbor, Dunewood, Lonelyville, and Fire Island Pines (Refer to Chapter 6). The target date for implementation of initial planning stages is the fall of 2008.

In April 2007, a severe nor'easter caused widespread erosion and damage to much of Fire Island. The April 14-18, 2007 nor'easter resulted in a major presidential declaration (FEMA-DR-1692-NY) on April 24, 2007 for New York State, which included the Fire Island area. Total storm losses for the beach and dune were estimated for six communities, and are shown in Table 1. As a result of damage incurred during the April 2007 nor'easter, several communities were added to the proposed 2008 beach nourishment project, including Fire Island Summer Club, Corneille Estates, Ocean Beach, Seaview, Ocean Bay Park, and Davis Park.

Table 1. Volume of sand lost as a result of the April 2007 nor'easter.

Community	Volume Lost (cy)
Saltaire	26,250
Fair Harbor	59,070
Dunewood	2,240
Lonelyville	1,593
Fire Island Pines	86,116
Davis Park	38,600

Monitoring of the beaches and dunes affected by the April 2007 nor'easter was not conducted to determine how much volume naturally recovered after the storm. Past storms would indicate that normal seasonal beach building occurred after the storm, but was unlikely to have replaced the losses. Monitoring of large barred beaches in Florida and Fire Island has shown that it can take up to four years for major storm losses to partially recover, but complete recovery has not been documented (Keehn and Pierro 2003).

Following the April 2007 nor'easter, FEMA funding was approved under Category G for nourishment within the 2003 beach nourishment project area with the condition that the applicant(s) comply with all Federal, state, and local regulatory requirements. The 2003 project area qualifies for FEMA eligibility under Category G assistance as an engineered beach (Amendment No. 1 to the Notice of a Major Disaster Declaration, May 3, 2007). The Category G FEMA funded area encompasses six communities in two project reaches within Suffolk County, New York: Western Fire Island (Saltaire, Fair Harbor, Dunewood and Lonelyville), Fire Island Pines, and Davis Park.

Disaster work on improved beaches is eligible for Category G funding if the beach was constructed with the placement of sand (of proper grain size) to a designed elevation, width, and slope and has an established maintenance program involving periodic renourishment of sand. Total storm losses for the beach and dune within the project areas eligible for FEMA funding were 26,250 cubic yards for Village of Saltaire; 59,070 cubic yards for Fair Harbor; 2,240 cubic yards for Dunewood; 1,593 cubic yards for Lonelyville; 86,116 cubic yards for Fire Island Pines; and 17,073 cubic yards for Davis Park. Eligible losses also include sand fencing and dune vegetation. The estimated loss is approximately $5 million including mobilization and permit requirements. Descriptions of the storm losses, the pre- and post-storm comparative profiles, the pre- and post-construction comparative profiles of the 2003 projects and other required documentation were provided to FEMA as documentation for the loss.

Davis Park was also granted FEMA funding under Category B following the April 2007 nor'easter. Funding was approved for the placement of 23,520 cubic yards for construction of an emergency storm protection berm and to create a bench to ensure the emergency berm is above five-year elevation.

The proposed community beach nourishment project has been approved by FEMA with the condition that the applicant(s) comply with all Federal, state, and local regulatory requirements, and is eligible for approved cost spent to repair the damages. FEMA is funding a portion of the project actions; the applicants are nourishing the beaches in excess of the FEMA funding as a repair pursuant to the April 2007 nor'easter and other erosional events.

Protection of Homes and Community Infrastructure

Fire Island communities proposing beach nourishment and/or beach scraping are all developed communities (Figures 2-5). Beach nourishment is needed in these project areas to protect homes and community infrastructure from damage caused by storm conditions. Infrastructure within each community includes water lines, utility (electric, telephone) poles and lines, and walkways that provide access and services necessary for dwellings and recreational use. Inadequate beach protection may lead to damage to homes and infrastructure from flooding, loss of electricity and telephone service, and prevention of travel between communities. This is especially true where waters reach the toe of the dune or in locations where existing structures obstruct the beach (Appendix A). The lack of access caused by high waters becomes a public safety issue for the public school in Corneille Estates and for year-round residents living within several of these communities.

DRAFT

Figure 2: Western Fire Island Aerial Photograph taken 12/18/07.

DRAFT

Figure 3: Central Fire Island Aerial Photograph taken 12/18/07.

Figure 4: Fire Island Pines Aerial Photograph taken 12/18/07.

Figure 5: Davis Park Aerial Photograph taken 12/18/07.

Emergency Responses and Evacuation

Fire Island does not incorporate a network of roadways for transportation from town to town. There are wide walkways that can accommodate vehicles when necessary, but the majority of transport on Fire Island, including emergency vehicle travel, is conducted along the beaches. This is especially true during summer months, when the walkways are crowded with visitors. The current state of erosion prevents the use of vehicles, even emergency vehicles, from traveling along sections of beach in several Fire Island communities during high tide. During storms and even at high tide in some areas, waves and water reach the toe of the dune (Appendix A). This creates a serious public safety issue, as existing conditions limit emergency response and evacuation.

Recreational Opportunities

Travel and tourism is America's leading industry, with beaches accounting for approximately half of the travel and tourism revenue (Houston, 2002). The maintenance of safe and enjoyable beaches is therefore imperative to the economic health of many coastal communities. Beach erosion is cited as a principal concern of Americans who visit beaches for recreation (Hall and Staimer, 1995). Beaches in recession have steeper beaches and dune faces, which create narrower recreational space, since the dune in general lags the beach in retreat.

Approximately two million people visit Fire Island beaches annually. Visitors to Fire Island beaches utilize the natural environment for a variety of recreational purposes, including swimming, surfing, sunbathing, beachcombing, nature viewing, clamming, hiking, and fishing. All of these activities require adequate beach and intertidal ecosystems.

Currently, the condition of beaches in each community is declining; with smaller usable sections of beach, fewer visitors are able to enjoy recreational activities. The beach within the developed community reach (Kismet to Davis Park) was shrinking at a rate 1.5 feet per year between 1955 and 2007, after adjustment for beach nourishment (Refer to Section 3.1). Beaches within the 2003 nourishment area lost approximately 86 feet in width between February 2004 and December 2006. The April 2007 nor'easter resulted in erosion such that several dwellings in Davis Park are currently on the beach seaward of the dune.

Recreational opportunities cannot take place under dwellings; for safety, recreational activities are limited to open beaches and intertidal areas. As open beach width is lost, fewer tourists will be able to enjoy its benefits and would likely choose to visit elsewhere; fewer tourists would lead to socioeconomic impacts as discussed in Section 4.7. As such, enhancing the beach for recreation is a major objective for the Fire Island communities.

1.2 Location

Fire Island is a 32-mile long barrier island located on the south shore of Long Island, in Suffolk County, New York (Figure 1). The island is bounded by the Atlantic Ocean to the south, Fire Island Inlet to the west, Moriches Inlet to the east, and the Great South Bay to the north. Fire Island consists of a mixture of National, State, and County Parks, municipal recreation areas, and 17 residential communities. The communities, located between Robert Moses State Park and the Otis G. Pike Wilderness Area, are predominately comprised of summer cottages and a smaller number of full-time residences. Of the 17 developed communities, 11 are proposing to nourish their beaches in 2008.

1.3 Background

Fire Island is a barrier island that formed thousands of years ago. Its unusual east-west orientation results in different beach and dune responses to storms than the more typical north-south oriented barrier islands found along the Atlantic coast. Storms occurring well to the south, such as hurricanes, have the ability to impact the south-facing beaches and dunes of Fire Island, causing beach and dune erosion and flooding.

Erosion has led to several existing problems, including destruction of suitable beach and dune habitats, decrease in available recreation area, and the inability of emergency vehicles to traverse beaches for emergency response. In addition to existing problems, there is also the threat of storm damage to homes and community infrastructure, including water and electric lines. The communities are therefore proposing beach nourishment to re-establish the shoreline protection developed in previous beach nourishment projects, or re-establish historic beach and dune protection from 5-20 years ago where no protection exists. Successful implementation of a beach nourishment project will reduce the likelihood of these undesirable consequences of beach and dune erosion. Beach scraping will be used as a maintenance tool following beach nourishment, or where the beach is adequate to allow scraping to occur.

Historically, beach nourishment and beach scraping have been used for storm damage protection, to curb the problems discussed above. Summaries of storm damage protection projects within Fire Island communities are provided below.

1.3.1 Fire Island Inlet to Montauk Point Project

The Fire Island Inlet to Montauk Point Combined Beach Erosion Control and Hurricane Protection Project (FIMP) was authorized by Congress with the River & Harbor Act of July 14, 1960. Its purpose is to provide beach erosion control and hurricane protection from Fire Island Inlet to Montauk Point. The authorized project provides for beach erosion control and hurricane protection through construction of beaches and dunes, supplemented by native plantings on the dunes, interior drainage structures, and subsequent beach nourishment (http://www.nan.usace.army.mil/fimp/history.htm).

To date, FIMP project plans have not been approved. An Environmental Impact Statement (EIS) is expected for release to the public for review in 2009; a timeline for implementation has not been set (http://www.nan.usace.army.mil/fimp/index.htm).

1.3.2 Suffolk County Smith's Point Project

The Suffolk County Departments of Parks and Public Works are proposing beach nourishment as a result of the April 2007 nor'easter and other recent storms. In the winter of 2006-2007, the County implemented a Phase I nourishment project, dredging 225,000 cubic yards of sand from an offshore borrow area and placing it on the beaches and dunes at Smith Point. The April 2007 nor'easter removed approximately one-third of this sand, but the Phase I nourishment probably prevented serious damage to the park facilities and infrastructure.

Phase II of that project involved excavation of up to 250,000 cubic yards of sand from an accretional dune field in Smith's Point Park, centered 1.3 miles west of Moriches Inlet. This alternative was tabled during the scoping process.

Phase III, the current proposed project, entails dredging approximately 250,000 cubic yards of sand from the Federal navigation channel in Moriches Inlet for placement on the beaches and dunes in the western and middle portions of Smith Point Park and the western portion of Cupsogue Park. Suffolk County is in the process of preparing a NEPA Environmental Assessment for Phase III as required by the National Park Service. The County EA will examine the potential impacts of their nourishment project on all relevant environmental resources, including endangered and threatened species, essential fish habitat, coastal processes, water quality, as well as mitigation and monitoring.

1.3.3 History of Beach Nourishment on Fire Island

Sand has been placed mechanically on Fire Island since the 1930s, but much of the placement has been adjacent to inlets as a byproduct of inlet dredging. State and local parks have also been nourished periodically. Sand placement within the developed communities (Kismet through Davis Park) began in the late 1940s (Gravens, 1999); approximately five million cubic yards of sand has been placed on Fire Island since then (Gravens, 1999; CPE, 2004, Appendix B).

Between 1945 and 1979, 1.9 million cubic yards of sand was placed in the developed communities, with most effort taking place after Hurricane Donna in 1960, prior to the formation of Fire Island National Seashore. During the period between 1980 and 1997, approximately 1.9 million cubic yards was placed in the developed communities, most of it associated with the aftermath of the major 1992-93 storms. Following the 1992-93 storms, a number of communities were nourished as emergency repair using the 1994 borrow area (Figure 1). Western Fire Island was nourished with 465,000 cubic yards, Fire Island Pines received approximately 133,800 cubic yards, and Seaview, Ocean Bay Park, and Point O'Woods were nourished with approximately 382,600 cubic yards. In 1997, Fire Island Pines completed their project by placing 650,000 cubic yards from the 1997 borrow area (Figure 1). Some taper section(s) on Federal property were allowed on these earlier projects.

In 2003-04, five communities were nourished with sand from two new offshore borrow areas (NPS Special Use Permit #COMM 1750 6000 1011). Communities were grouped into two reaches, Western Fire Island (Saltaire, Fair Harbor, Dunewood, and Lonelyville) and Fire Island Pines. There were three contractual entities comprising the Incorporated Village of Saltaire, Town of Islip (Fair Harbor, Dunewood, Lonelyville), and Town of Brookhaven (Fire Island Pines). The projects were constructed by Great Lakes Dredge and Dock Company (GLDD) using their hydraulic cutterhead dredge *Alaska* and trailing-suction hopper dredge *Liberty Island*. Construction volumes for Western Fire Island and Fire Island Pines were 717,728 and 560,840 cubic yards, respectively, measured within the project limits in February 2004.

Following the April 2007 nor'easter, the community of Davis Park applied for and received Federal funding from the Federal Emergency Management Agency (FEMA) to nourish their beaches with sand from an upland source (NPS Special Use Permit #NER-1750-5700-054). Approximately 25,460 cubic yards was placed in Davis Park; 24,740 cy was placed to enhance eroded dunes in the western half of Davis Park, and 720 cy was placed landward of the vehicle access cut (Figure 6). Sand was barged to Davis Park from the south shore of Long Island, placed with a payloader, and graded with a bobcat. New/restored dunes were planted with American beach grass (*Ammophila breviligulata*) and snow fencing was installed at the toe of the dunes to protect the dunes and prevent pedestrian access. As of May 2008, approximately 8,000-10,000 cubic yards of the 24,740 cubic yards placed to enhance eroded dunes had been lost to erosion, based on site vists by Land Use Ecological Services and estimates from the contractor.

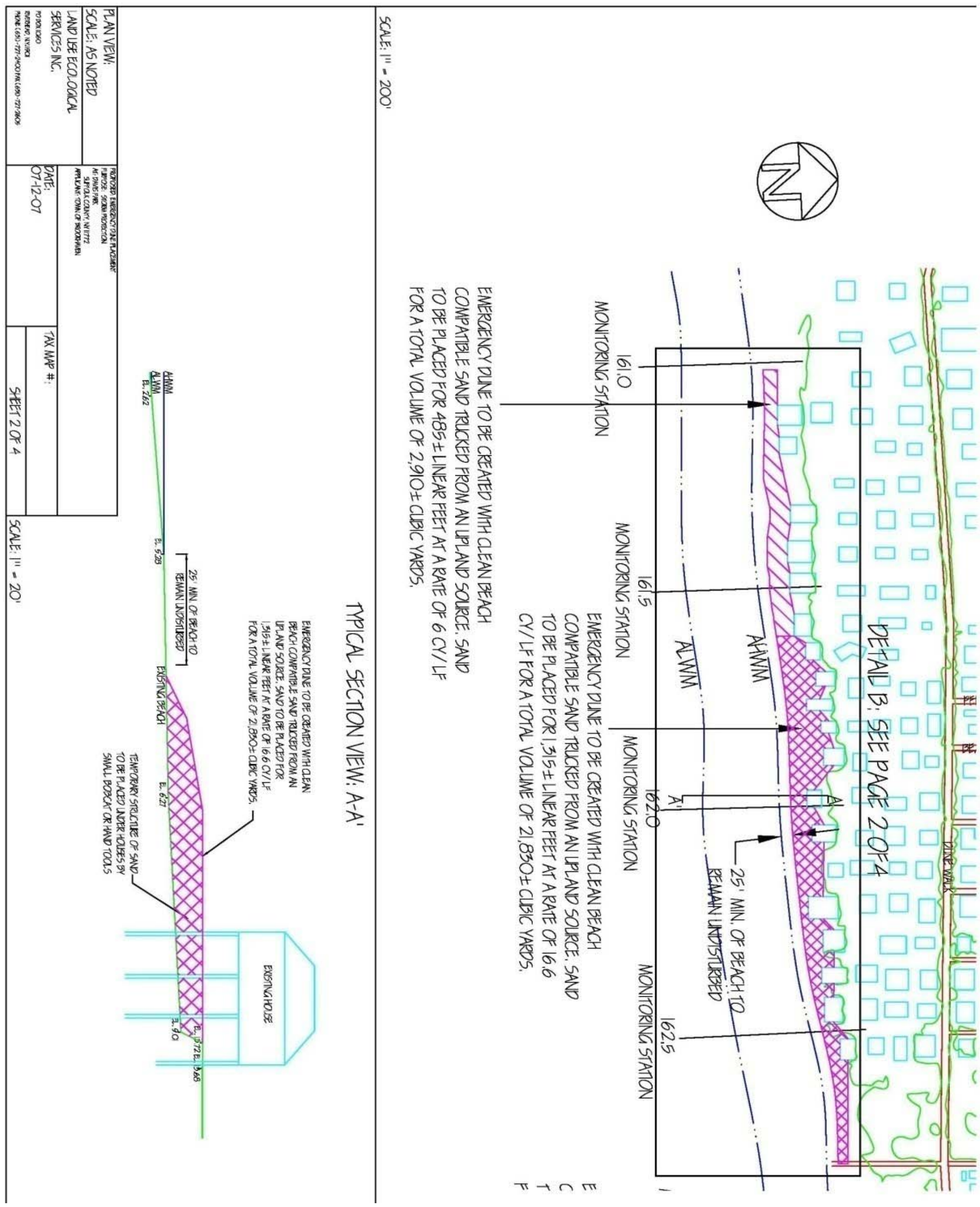


Figure 6. Davis Park 2007 Emergency Dune Restoration approved site plan for placement of sand in the western half of the BECD (not to scale).

1.3.3 Beach Scraping on Fire Island

Beach scraping, the manipulation of sand from the beach to augment the dune, has been a storm protection program in the developed communities since 1993. Approximately 150,000 cubic yards of sand has been excavated from the beach to augment dunes in the developed communities. A complete list of scraping events is provided in Table 2.

Table 2. Beach scraping projects on Fire Island, 1993-2007.

Year	Community	Excavation Length (lf)	Excavation Location
1993	Corneille Estates/FI Summer Club	900	length of community
1994	Atlantique	900	length of community
	Corneille Estates/FI Summer Club	900	length of community
	Davis Park/Ocean Ridge	3450	length of community
	Kismet	950	length of community
	Lonelyville	1000	length of community
	Robbins Rest	350	length of community
1995	Water Island	1050	Charach Walk to East Walk
1996	Kismet	950	length of community
	Ocean Bay Park	2300	length of community
	Point O' Woods	4200	length of community
	Robbins Rest	350	length of community
	Seaview	1500	eastern 1500' of community
	Water Island	1050	Charach Walk to East Walk
1997	Davis Park/Ocean Ridge	3450	length of community
	Ocean Bay Park	2300	length of community
	Seaview	1500	eastern 1500' of community
1998	Davis Park/Ocean Ridge	3450	length of community
	Ocean Beach	1800	length of community
	Saltaire	3350	length of community
	Seaview	1500	eastern 1500' of community
1999	Davis Park/Ocean Ridge	3450	length of community
	Ocean Beach	630	between jetties only
	Saltaire	3350	length of community
	Seaview	2750	length of community
2000	Ocean Ridge (Davis Park)	1730	Ocean Ridge only
2001	Ocean Bay Park	2300	length of community
	Ocean Beach	1800	length of community
	Seaview	2750	length of community
2005	Ocean Ridge (Davis Park)	1730	Ocean Ridge only
	Kismet	950	length of community
	Ocean Bay Park	1300	western 1300' of community to Ontario Walk
	Point O' Woods	975	3rd St. to 6th St. (+/-)
2006	Kismet	950	length of community
	Ocean Bay Park	1300	western 1300' of community to Ontario Walk
	Seaview	850	Brookhaven only
2007	Kismet	950	length of community
	Ocean Bay Park	1300	western 1300' of community to Ontario Walk
	Seaview	850	Brookhaven only
	Corneille Estates/FI Summer Club	900	length of community

1.3.4 Other Storm-Protection Projects on Fire Island

In addition to mechanical manipulation and placement of sand, Fire Island communities have utilized dune fencing and planting of vegetation for protection of the dune systems. Dune fencing has been shown to trap sand, resulting in dune buildup. Planting with native perennial dune stabilizing species, namely American beach grass (*Ammophila breviligulata*), encourages natural revegetation that further stabilizes the dune, as stated in the GMP. Installation of dune fencing and planting of American beach grass is an annual occurrence in most Fire Island communities, and neither requires permits from FIIS.

1.4 Relevant Laws and Regulations

Please also refer to Table 3 (p. 22) for a list of permits/approvals required.

1.4.1 Enabling Legislation for Fire Island National Seashore Title 16 U.S. Code Sec. 459e

In 1964, Fire Island National Seashore was established by Congress for the purpose of conserving and preserving for the use of future generations certain relatively unspoiled and undeveloped beaches, dunes, and other natural features within Suffolk County, New York, which possess high values to the Nation as examples of unspoiled areas of great natural beauty in close proximity to large concentrations of urban population. Section 3 of the enabling legislation states that the Secretary of the Interior shall issue regulations specifying standards, consistent with the purposes of the Act, for zoning ordinances. Section 7 states that the authority of the Chief of Engineers, Department of the Army, to undertake or contribute to shore erosion control or beach protection measures on lands within the Fire Island National Seashore shall be exercised in accordance with a plan that is mutually acceptable to the Secretary of the Interior and the Secretary of the Army and that is consistent with the purposes of sections 459e to 459e-9 of this title.

1.4.2 National Park Service Organic Act

The 1916 Organic Act was enacted to create the National Park Service within the Department of the Interior. The purpose of the NPS is to promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (http://www.nps.gov/legacy/organic-act.htm).

The Organic Act and its mandates afford the NPS latitude when making resource decisions that balance visitor recreation and resource preservation. However, resource preservation takes precedence over visitor recreation, as dictated in the NPS Management Policies and upheld in several court decisions (NPS, 2003). NPS has discretion to allow negative impacts to park resources and values when necessary, and when that impact does not cause impairment of a resource. To determine impairment, NPS must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effect of the impact in question and other impacts" (NPS, 2000). This EA analyzes the context, duration, and intensity of impacts related to beach nourishment and scraping projects within Fire Island developed communities, as well as the potential for resource impairment, as required in Director's Order 12.

1.4.3 National Park Service Management Policies

National Park Service Regulations, 36 CFR Parts 2.1 and 2.2

Section 2.1 prohibits the processing, destroying, injuring defacing, removing, digging, or disturbing from its natural state, all natural, cultural, and archeological resources. This includes all wildlife and plants, either dead or alive, as well as ensuring the preservation of all natural features, paleontological resources, cultural or archeological resources, and mineral resources. Superintendents are allowed to specify certain parameters where specific actions are allowed for each park.

Section 2.2 prohibits the taking of wildlife, except by authorized hunting and trapping activities; feeding, touching, teasing, frightening, or intentional disturbing of wildlife nesting, breeding or other activities; possessing unlawfully taken wildlife or portions thereof.

Director's Order #77-1: Wetland Protection

The Wetland Protection Procedural Manual was developed for use by the National Park Service (NPS) in carrying out its responsibilities under Executive Order (E.O.) 11990 to protect wetlands. It contains two main elements: 1) the text of Director's Order (D.O.) #77-1: Wetland Protection (last issued in 2002) and 2) detailed procedures (in Sections 3–5) by which the NPS will implement D.O. #77-1 (http://www.nature.nps.gov/water/wetlands/Wetlands_Protection_Manuals.cfm).

The National Park Service's Procedure Manual 77-1 (Wetland Protection) outlines regulations and procedures to minimize the destruction, loss, and degradation of wetlands, to maintain wetlands and their importance within the ecosystem, and to avoid development in wetland areas, if possible. Activities that have the potential to cause wetland degradation are subject to this procedure manual. The procedure manual provides a sequence of actions to follow. First, it is required that wetland impacts are avoided, minimized, and compensated. Second, all actions must be recorded in a Statement of Findings, which should contain a map of the area, proper wetland delineation records, description and evaluation of the wetland area, discussion of alternative actions, and details concerning proposed wetland compensation. A Statement of Findings is not required for this project.

Director's Order #77-2: Floodplain Management

National Park Service Executive Order 11988 (Floodplain Management) and Director's Order #77-2 (Floodplain Management) outline Procedural Manual 77-2 (Floodplain Management), which provides a guide for the protection and management of floodplains. It is NPS policy to preserve floodplain values and minimize potentially hazardous conditions associated with flooding. The manual provides information concerning how to define a floodplain, how to detect potential hazards associated with the floodplain, and floodplain management requirements.

A National Park Service floodplain policy must be instituted whenever performing actions that could directly or indirectly affect a floodplain. In order to implement a floodplain policy, the actions or work that will take place must be classified into one of three "regulatory floodplains" (100-year, 500-year, or Extreme). If a proposed action is found to be in an applicable regulatory floodplain and relocating the action to a non-floodplain site is not considered a viable alternative, then flood conditions and associated hazards must be quantified as a basis for management decisions and a formal Statement of Findings must be prepared and must describe the rationale for selection of a floodplain site, disclose the amount of risk associated with the chosen site, and explain flood mitigation plans. A Statement of Findings is not required for this project.

1977 General Management Plan (Fire Island National Seashore)

Fire Island National Seashore (FIIS) was established in 1964 "for the purpose of conserving and preserving for the use of future generations certain relatively unspoiled and undeveloped beaches, dunes, and other natural features…". The 1977 General Management Plan (GMP) was created to provide an environmentally sound management foundation for the national seashore. The plan ensures the protection and preservation of beaches, dunes, and other natural features, as well as provides reasonable access and facilities for recreational uses.

The GMP states that "Ocean-facing dunes will be repaired or restored as needed. Planting with native perennial dune stabilizing species to encourage revegetation will be initiated throughout the seashore…Such measures will be undertaken by affected communities". It further clarifies, "dune blowouts and other naturally occurring bare sand areas will be repaired or replanted in the seashore district when compelling considerations, such as threats to major developments, dictate such action. In the development district, dune blowouts that endanger homes during extreme high tides or moderate intensity storms may be filled and replanted, following evaluation of the need for such actions. Attempts will be made to restore and maintain the dune and beach system by environmentally compatible methods that acknowledge the inevitable erosional transformation of the island, a result of a rising sea level, great hurricanes, and severe northeasters." Finally, the plan recognizes that certain resource management actions are necessary to fulfill the legistlated mandate for the national seashore. Fire Island is a culturally manipulated barrier-island system, and it cannot be managed as if natural geomorphic processes had been totally unimpeded.

The enabling legislation establishing FIIS recognizes the need for beach nourishment in Section 8, PL 88-587. However, there is a conflict between developed communities and regulatory agencies over whether to let nature take its course, even if it is through the communities, or to manipulate the beaches and dunes to protect structures and infrastructure in the developed communities. Until these conflicting issues can be reconciled in the USACOE comprehensive plan, with NPS concurrence as described in the enabling legislation, FIIS has allowed beach restoration funded by the communities as a short-term solution; this is in keeping with the spirit of the enabling legislation.

National Park Service Management Policies 2006

The NPS Management Polices govern the management of the entire national park system. Policies applicable to the Fire Island community project are outlined below:

> **4.4.2.4 Management of Natural Landscapes**
>
> "Natural landscapes disturbed by natural phenomena, such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires, will be allowed to recover naturally unless manipulation is necessary to (1) mitigate for excessive disturbance caused by past human effects, (2) preserve cultural and historic resources as appropriate based on park planning documents, or (3) protect park developments or the safety of people. Landscape and vegetation conditions altered by human activity may be manipulated where the park management plan provides for restoring the lands to a natural condition. Management activities to restore human altered landscapes may include, but are not

restricted to removing constructed features, restoring natural topographic gradients, and revegetating with native park species on acquired inholdings and on sites from which previous development is being removed; restoring natural processes and conditions to areas disturbed by human activities such as fire suppression; rehabilitating areas disturbed by visitor use or by the removal of hazard trees; and maintaining open areas and meadows in situations in which they were formerly maintained by natural processes that now are altered by human activities. Landscape revegetation efforts will use seeds, cuttings, or transplants representing species and gene pools native to the ecological portion of the park in which the restoration project is occurring. Where a natural area has become so degraded that restoration with gene pools native to the park has proven unsuccessful, improved varieties or closely related native species may be used. Landscape restoration efforts will use geological materials and soils obtained in accordance with geological and soil resource *Management Policies*. Landscape restoration efforts may use, on a temporary basis, appropriate soil fertilizers or other soil amendments so long as that use does not unacceptably alter the physical, chemical, or biological characteristics of the soil and biological community and does not degrade surface or groundwaters."

Within the Fire Island communities, the short-term storm protection project falls under (1) and (3) above. The project(s) are proposed to mitigate for excessive disturbance caused by past human effects, including the groins at Ocean Beach, development of Fire Island communities, and intensive vehicle use on the beach. In addition, the projects will act to preserve cultural and historic resources within participating communities, including but not limited to the culturally significant gay community of Fire Island Pines and the historic communities of Fire Island that are well over 100 years old. Finally, projects will act to protect the safety of people utilizing FIIS.

4.8 Geologic Resource Management

"The Park Service will preserve and protect geologic resources as integral components of park natural systems. As used here, the term "geologic resources" includes both geologic features and geologic processes. The Service will (1) assess the impacts of natural processes and human activities on geologic resources; (2) maintain and restore the integrity of existing geologic resources; (3) integrate geologic resource management into Service operations and planning; and (4) interpret geologic resources for park visitors.

4.8.1 Protection of Geologic Processes

The Service will, except as identified below, allow natural geologic processes to proceed unimpeded. Geologic processes are the natural physical and chemical forces that act within natural systems and on human developments across a broad spectrum of space and time. Such processes include, but are not limited to, exfoliation, erosion and sedimentation, glaciation, karst processes, shoreline processes, and seismic and volcanic activity. Geologic processes will be addressed during planning and other management activities in an effort to reduce hazards that can threaten the safety of park visitors and staff and the long-term viability of the park infrastructure. Intervention in natural geologic processes will be permitted only when

_ directed by Congress;
_ necessary in emergencies that threaten human life and property;
_ there is no other feasible way to protect natural resources, park facilities, or historic properties;
_ intervention is necessary to restore impacted conditions and processes, such as restoring habitat for threatened or endangered species."

4.8.1.1 Shorelines and Barrier Islands

Natural shoreline processes (such as erosion, deposition, dune formation, overwash, inlet formation, and shoreline migration) will be allowed to continue without interference. Where human activities or structures have altered the nature or rate of natural shoreline processes, the Service will, in consultation with appropriate state and Federal agencies, investigate alternatives for mitigating the effects of such activities or structures and for restoring natural conditions. The Service will comply with the provisions of Executive Order 11988 (Floodplain Management) and state coastal zone management plans prepared under the Coastal Zone Management Act of 1972. Any shoreline manipulation measures proposed to protect cultural resources may be approved only after an analysis of the degree to which such measures would impact natural resources and processes, so that an informed decision can be made through an assessment of alternatives. Where erosion control is required by law, or where present developments must be protected in the short run to achieve park management objectives, including high-density visitor use, the Service will use the most effective method feasible to achieve the natural resource management objectives while minimizing impacts outside the target area. New developments will not be placed in areas subject to wave erosion or active shoreline processes unless (1) the development is required by law; or (2) the development is essential to meet the park's purposes, as defined by its establishing act or proclamation, and no practicable alternative locations are available; the development will be reasonably assured of surviving during its planned life span without the need for shoreline control measures; and steps will be taken to minimize safety hazards and harm to property and natural resources.

The community proposed short-term storm protection projects were originally intended as maintenance projects in Western Fire Island and Fire Island Pines. However, the April 2007 nor'easter made the projects a necessity for protection of human life and property (refer to Section 1.3). Extensive analysis has been done on alternatives for this project, as well as by the USACOE for the FIMP project; nourishment is the only feasible way to protect Fire Island properties on the short-term scale allowed for a community project. Finally, nourishment would restore impacted conditions and processes; the beaches at Western Fire Island and Fire Island Pines are engineered beaches impacted by the nor'easter, and therefore received FEMA funding for restoration (dependent on NEPA process and issuance of FONSI). And, although not a stated purpose of the proposed projects, nourishment may help to restore habitat for threatened or endangered species.

2000 Strategic Plan, Fiscal Years 2001-2005

The Strategic Plan addresses the mission of Fire Island National Seashore, goals to accomplish this mission, and strategies for achieving these goals from 2001-2005. Fire Island National Seashore's goals are categorized as follows:

- Preserve park resources.
- Provide for visitor experience at the park.
- Strengthen and preserve natural and cultural resources and enhance recreational opportunities.
- Ensure organizational effectiveness.

Although the Strategic Plan addresses the mission of FIIS and goals and strategies to accomplish and maintain these goals, it does not make recommendations to address the goals listed above.

1.4.4 Federal Laws and Management Policies

Environmental Justice

Executive Order 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minotiry populations and low-income populations. The population in the vicinity of FIIS is evaluated to determine the potential for the project to adversely affect minority and/or low-income populations. The demographic study area comprises all census tracts wholly or partly on Fire Island (NPS, 2003).

The census tracts that include Fire Island (excluding the west end of Robert Moses State Park) have a total population of 9,205 with median household incomes of $31,500 and $52,939 (NPS, 2003). The population of the census tracts including Fire Island is largely white (96.4-98.7%) with few minorities. The seasonal population during summer months is estimated at over 20,000; the racial composition of seasonal residents is assumed to be similar to that of permanent residents, with no significant concentrations of low-income households or minority populations (NPS, 2003).

Local and regional businesses, residents, and tourists determine the socioeconomic climate at and near FIIS, which is located in the most densely populated area of the U.S. Although park visititation is high, alternatives evaluated in this EA may have a negligible affect on local and regional tourism and would not affect socially or economically disadvantaged populations.

1918 Migratory Bird Treaty Act

This Act protects migratory birds with treaties signed by the U.S. and Canada, Japan, Mexico, and the former Soviet Union. Under the Act and associated treaties, it is unlawful to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird, included in the terms of this Convention . . . for the protection of migratory birds . . . or any part, nest, or egg of any such bird." (16 U.S.C. 703) The proposed project will have to comply with the Migratory Bird Act, although no permit or authorization is required.

1972 Coastal Zone Management Act

Congress enacted the Coastal Zone Management Act in 1972 to address development along the nation's coastlines. The Act is administered by the individual states. State participation is voluntary; however, once a state adopts a plan consistent with this Act, that state's coastal regulatory agency is responsible for making determinations on the consistency of Federal actions subject to the plan.

The Coastal Zone Management Act encourages the preservation, protection, development, restoration, or enhancement of valuable natural resources. These resources include wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as fauna using these habitats. State coastal zones include coastal waters and adjacent shorelands that extend inland to the extent necessary to control activities that have a direct, significant impact on coastal waters. In New York State, the NYS Department of State (NYSDOS) Division of Coastal Resources is responsible for administration of the Coastal Zone Management Act and the forty-four coastal policies adopted for the New York Coastal Zone Management Program. NYSDOS must issue a General Concurrence for the proposed projects under the Coastal Zone Management Act (Table 3, p. 22).

1973 Endangered Species Act

The Endangered Species Act of 1973 was passed by Congress to provide strong protections for species listed as threatened or endangered under the Act. It is illegal to harass, hunt, capture, kill, or possess plants or animals, or parts thereof, protected by the Act.

In addition, Section 7 of the Endangered Species Act mandates that all Federal agencies consider potential impacts of their actions on listed species. Consultation with the U.S. Fish and Wildlife Service (USFWS) is required for any actions that may impact a listed species, to ensure that the action will not jeopardize that species' habitat or existence. If it is determined that a Federal action is likely to result in a "take" of a listed species, the USFWS may describe conditions which must be met in order for that activity to proceed. A "take" is defined as harming or harassing a species resulting in interference of normal breeding, feeding, or sheltering behaviors.

For the proposed Fire Island community projects, a formal Section 7 consultation must be undertaken with USFWS to review potential impacts of the projects on Federally listed species such as piping plover, seabeach amaranth, sea turtles, and whales. USFWS will issue a Biological Opinion on their findings under the Endangered Species Act. If potential for a "take" is identified, a permit is required. No permit was require for the community nourishment project in 2003.

1977 Clean Water Act

Congress passed what is known as the Clean Water Act (amended) in 1977 to set water quality standards and regulate discharge of pollutants into the waters of the United States. Under the Act, it is illegal to discharge any pollutant from a point source into navigable waters without a permit. The Act also funded construction of sewage treatment plants and recognized the need for planning to address the critical problems posed by nonpoint source pollution.

The proposed Fire Island community projects will require a permit from the USACOE under Section 404 of the Clean Water Act. Section 404 of the Clean Water Act requires approval prior to discharging dredged or fill material into the waters of the United States, including wetlands (Table 3, p. 22).

1899 Rivers and Harbors Act

The Rivers and Harbors Act of 1899 established permit requirements to prevent unauthorized obstruction or alteration of any navigable water of the United States. Section 10 of the Rivers and Harbors Act covers construction, excavation, or deposition of materials in, over, or under such waters, or any work which would affect the course, location, condition, or capacity of those waters. Activities requiring Section 10 permits include structures (e.g., piers, wharfs, breakwaters, bulkheads, jetties, weirs, transmission lines) and work such as dredging or disposal of dredged material, or excavation, filling, or other modifications to the navigable waters of the United States. The proposed Fire Island community projects will require a permit from the USACOE under Section 10 of the Rivers and Harbors Act of 1899 (Table 3, p. 22).

1982 Coastal Barriers Resources Act

Coastal barrier development issues were the subject of the 1982 Coastal Barriers Resources Act passed by Congress. The goals of this Act are to minimize loss of human life by discouraging development in high risk areas, to reduce wasteful expenditure of Federal resources, and to protect the natural resources associated with coastal barriers.

The Act restricts Federal expenditures and financial assistance, including Federal flood insurance, in the Coastal Barrier Resources System (CBRS). The Coastal Barrier Improvement Act of 1990 expanded the CBRS and created a new category of lands known as “otherwise protected areas” (OPAs). Fire Island is included in this system as an OPA. The only Federal funding prohibition within OPAs is Federal flood insurance. Other restrictions that apply to Federal funding that apply to CBRS units to not apply to OPAs.

National Historic Preservation Act of 1966 (Section 106)

Section 106 of the National Historic Preservation Act requires federal agencies to consider the impacts of their proposals on historic properties, and to provide state and tribal historic preservation officers and, as appropriate, Advisory Council for Historic Preservation and the public reasonable opportunity to review and comment on these actions. The park maintains an active relationship with the NY State Historic Preservation Office (SHPO) regarding cultural resource issues and has notified the NY SHPO regarding the initiation of this EA and the intention of using this document for compliance with Section 106. As part of the NYSDEC application process, NY SHPO was also contacted for evaluation of this project.

NPS Director's Order #28: Cultural Resource Management

NPS DO-28 requires the NPS to protect and manage cultural resources in its custody through a comprehensive program of research, planning, and stewardship and in accordance with the policies and principles contained within the *NPS Management Policies, 2006.* The Order also requires the NPS to comply with the requirements described in the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation and with the 1995 Servicewide Programmatic Agreement with the Advisory Council for Historic Preservation and the National Conference of State Historic Preservation Officers.

The park actively manages its cultural resources by conducting research to identify, evaluate, document and register basic information about its cultural resources, and sets priorities for stewardship to ensure resources are protected, preserved, maintained and made available for public understanding and enjoyment. The park consults and coordinates with outside entities where appropriate regarding cultural resource management.

1.4.5 State and Local Laws and Management Policies

State Environmental Quality Review Act (SEQRA)

SEQRA was established in New York for coordinated review of major projects; it is the state's equivalent to NEPA. The proposed projects have been reviewed under SEQRA by NYSDEC as Lead Agency, and Findings of Negative Declarations have been issued for all reaches (Appendix C).

NYSDEC Tidal Wetlands Regulations (Article 25 of the Environmental Conservation Law)

In 1977, Article 25 of the Environmental Conservation Law (ECL) was enacted to regulate activities on or adjacent to tidal wetlands in New York State. Article 25 regulates activities within 300' of a tidal wetland boundary, including construction and reconstruction of structures and infrastructure, removal of vegetation, and dredging and placement of fill, among others. On the south side of Fire Island, the tidal wetland boundary is synonymous with the high water line. As such, the proposed projects require an Article 25 permit from NYSDEC (Appendix C and Table 3, p. 22).

NYS Coastal Erosion Hazard Areas Act

Article 34 of the ECL is the Coastal Erosion Hazard Areas (CEHA) Act, which regulates activities in areas designated coastal erosion hazard areas. CEHA boundaries are shown on maps prepared for this Act. The entire Atlantic Ocean shoreline of New York is a mapped CEHA.

The CEHA Act regulates construction, modification, restoration or placement of a structure, as well as any action that materially alters the condition of the land, such as grading, excavation, and dredging. On Fire Island, CEHA is administered by the NYSDEC in the Town of Islip, by the Village of Saltaire, and by the Town of Brookhaven. CEHA permits are required by each administering agency for the proposed projects (Table 3, p. 22).

2001 Long Island South Shore Estuary Reserve Comprehensive Management Plan

This plan was prepared as a result of the Long Island South Shore Estuary Reserve Act, established to address the future health of the South Shore Estuary. The southern boundary of the South Shore Estuary Reserve is the mean high tide line on the ocean side of Fire Island.

The plan recommends management actions for the protection and/or restoration of the estuary and its functions, including water quality, living resources, public use and enjoyment, and education. Voluntary implementation actions are provided in the plan; there is no legal mandate for action implementation.

New York State Public Lands and Gravel Resources Law

NY State Public Lands Laws, Article 22 Section 22, provides that the Commissioner of General Services is authorized to manage, license, and regulate the removal of sand and gravel by dredging or otherwise from underwater lands (Table 3, p. 22). The law specifically excludes from the Commissioner's authority authorizing taking of sand and gravel from waters bordering Long Island. The law does not apply to projects found by the US Army Corps of Engineers to be necessary for the improvement of navigation.

Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern

Part 182 of 6NYCRR is the Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern. This part states that all parties must avoid disrupting state listed threatened and endangered species.

1.5 Regulatory Approvals Required

Table 3 provides a list of the permits required for this project, as well as contact information for each permitting agency.

Table 3. Permits/permissions required and obtained from each of the above Federal and state agencies.

Agency	Contact	Permits/Permissions Required
US Army Corps of Engineers	Mr. George Neives NY District-Regulatory Branch 26 Federal Plaza New York, NY 10278-0090	Section 10 of Rivers & Harbors Act Section 404 of the Clean Water Act
National Park Service/ Fire Island National Seashore	Mr. Sean McGuinnes Acting Superintendent 120 Laurel Avenue Patchogue, NY 11772	Special Use Permit for activities on ocean shorefront and subtidal areas. Vehicle Access Permits for construction equipment and personnel.
NYS Department of Environmental Conservation	Mr. Mark Carrara Environmental Permits SUNY@ Stony Brook 50 Circle Road Stony Brook, NY 11790-3409	Article 15 (Protection of Waters) Article 25 (Tidal Wetlands) Article 34 (CEHA—Islip, Ocean Beach)
NYS Department of State	Division of Coastal Resources 99 Washington Ave., Suite 1010 Albany, NY 12231	Coastal Consistency Certification
NYS Office of General Services	Mayor Erastus Corning 2nd Tower The Governor Nelson A. Rockefeller Empire State Plaza Albany, NY 11242	License to Excavate, Dredge, Remove, or Dispose of Materials
Town of Islip	Mr. David Janover, P.E. Engineering Division 1 Manitton Court Islip, NY 11751	Wetland & Waterways Permit Town Board Authorization (placement of fill on Town lands)
Town of Brookhaven	Mr. Tom Carrano Dept. Environmental Protection 1 Independence Hill	Chapter 76 (CEHA) Chapter 81 (Wetlands & Waterways)

	Farmingville, NY 11738	

1.6 Scoping and Issues/Impact Topics

Several interagency and public scoping meetings were held to determine the issues identified for analysis in this EA. Table 4 provides a summary of the scoping meetings held for this EA. It was discussed at several meetings that the EA would include analysis similar to the 2003 EA prepared for the community nourishment projects, with additional information and analysis to be included.

Table 4. Summary of scoping meetings held to determine issues/impact topics.

Date	Meeting Type	Issues/Impacts Discussed
11/8/2006	Inter-agency scoping meeting	• Initial meeting to present the project and discuss permitting and environmental analysis that would be required. Specific impacts/issues were not discussed.
5/17/2007	Inter-agency scoping meeting	• Additional communities: Davis Park • Borrow Areas: cut depth, transport of sand • NPS Management Policies • Habitat protection • Timeline for project
12/14/2007	Inter-agency scoping meeting	• Offshore borrow areas: cut depth, littoral drift, onshore sediment transport, sand volume • Beach scraping: must include analysis in EA • FEMA funding component to projects
1/3/2008	Inter-agency scoping meeting	• Offshore borrow areas (see above) • Beach scraping analysis
1/11/2008	Public scoping meeting	• Presentation of issues/impacts already under consideration in EA • Borrow site: potential for anoxic conditions • Funding • Discussion of project in context of FIIS authorizing legislation • Alternative: hard structures, "sea-scaping" • Sand placement: can we modify such that areas with little/no dune get more than areas with dune
2/14/2008	Inter-agency technical meeting	• Analysis of erosion/accretion in community areas, FI shoreline changes over historical and geological timescales • Breaching/overwash in community areas • Offshore sand ridges—sand volume, impact of dredging on ridges, onshore sand transport, wave energy, quality of sand • Surf clam surveys needed • Beach scraping analysis • Alternatives: no action, 2003 permitting dimensions, 2003 dimensions with modifications, scraping • NPS restrictions: tapers, size of project
3/18/2008	Public scoping meeting	• (no new issues/impacts)

This EA will discuss and analyze the following topics, per meetings outlined above: geology (littoral processes, sediment transport, sediment compatibility analysis, borrow area analysis), water quality, terrestrial ecology, aquatic ecology, transportation, community services, socioeconomics, and cultural resources. One topic that was dismissed from analysis for the 2008 EA is air quality. There are negligible to minor impacts expected for all alternatives as discussed in the 2003 EA (NPS, 2003). No changes to impacts are expected, and as such, this topic was dismissed from detailed analysis.

Climate change was a topic discussed in scoping meetings, but is not analyzed in detail in this EA. Beach scraping and nourishment alternatives will have some effect on climate change stressors since it will contribute some carbon emissions through the fuels used to power the dredges, pumps and the heavy equipment used to transport and reform the sand. This effect is anticipated to be minor, on a global scale as well as a regional scale.

Recent direction for Federal actions regarding climate change was provided by the Deputy Secretary of the Department of the Interior, Lynn Scarlett, to a gathering of Departmental, state (including New York) and other public and private agencies. Paraphrased from a longer speech, she emphasized that:

> "Change" is the operative word. Public (federal, state or county) and private land managers need to learn what the effects of these changes will be. Land management planning must be broadened to incorporate these changes.
>
> Regardless of actions taken nationally or globally, the next 50 years will bring changes from prior conditions. It may be rapid.
>
> Adaptation, not mitigation, will need to be the near-term approach. While twenty percent of the coastal areas nationally will be flooded over this century, local effects may be greater or less, depending upon factors specific to each location. We need to maintain ecosystem processes, protect the processes that sustain coastal wetlands and marshes, adapt our management to those processes and changes, and recognize the risks. Adjust. Monitor. Adapt.

CHAPTER 2—Alternatives

The following alternatives are being considered in this EA and are described in this chapter:

2.1 No Action
2.2 Beach Scraping
2.3 Beach Nourishment from Offshore Borrow Areas: 2003 Permitted Conditions
2.4 Beach Nourishment from Offshore Borrow Areas: Modified Conditions, Combination Template, Tapers on Federal Property
2.5 Beach Nourishment from Offshore Borrow Areas: Modified Conditions, Combination Template, No Tapers on Federal Property
2.6 Beach Nourishment from Offshore Borrow Area: 2008 Dune Crest Line, FIMP Template
2.7 Preferred Alternative: Combination of Beach Nourishment (2.5) and Beach Scraping
2.8 Alternatives Considered But Rejected
2.9 Comparison of Nourishment Alternatives

2.1 No Action

No Action as an alternative would entail allowing the processes of erosion, drift, and redeposit to occur with minimal human interference. The only measures undertaken under No Action would be dune fencing and planting of American beach grass, both of which are currently utilized annually and do not require permits. Beach scraping is not included in the No Action alternative, as it requires state and Federal permits. Under No Action, only emergency measures would provide for storm damage protection of Fire Island and the south shore of Long Island until FIMP takes effect.

2.2 Beach Scraping

This alternative considers those activities that mechanically manipulate the beach or redistribute sand within the existing sand budget. Beach scraping is considered a separate alternative from no action because it requires permitting and monitoring of the beach according to NPS 2003 guidelines. Protection afforded by beach scraping is designed to last one (1) year.

NYSDEC, the state permitting agency, does not specifically list beach scraping as a potential use of tidal wetlands or their adjacent area in Article 25 of the Environmental Conservation Law (NYSDEC-6NYCRR Part 661). The closest relevant listing is filling, which is considered a "Generally Compatible Use-Permit Required" in an adjacent area (6 NYCRR Part 661.5(23)). Beach scraping activities occur landward of mean high water, considered adjacent area for permitting because the landward limit of tidal wetlands in the project areas is the high water line.

Beach scraping is the most common beach maintenance technique used by communities within the boundary of FIIS. Beach scraping (sand harvesting) has occurred within numerous Fire Island communities since 1993. NYSDEC issues permits for beach scraping, under strict permit conditions, for the maximum duration of 10 years. NYSDEC permits are currently valid and in full effect for the following communities:

- Kismet BECD
- Village of Saltaire

- Fair Harbor BECD
- Dunewood BECD
- Lonelyville BECD
- Atlantique BECD
- Fire Island Summer Club BECD
- Corneille Estates BECD
- Village of Ocean Beach
- Seaview BECD
- Ocean Bay Park BECD
- Point O'Woods BECD
- Fire Island Pines BECD
- Davis Park BECD
- Water Island BECD

Most of these current NYSDEC scraping permits held by the Fire Island communities will expire in July 2010 or 2011. NYSDEC permits require that a community or "reach" must be at least 100' wide from the toe of the dune to the beach scarp and be over elevation 7' (NGVD) in order for scraping to occur. Communities such as Kismet use scraping as their primary protection measure. However, narrow, severely eroded, or low elevation beach/dune systems are not candidates for scraping programs.

Beach scraping permits allow for the relocation of a maximum 2.2 cubic yards per linear foot of shoreline in all areas with a beach width of 100' and beach elevation of +7 NGVD/+9 NGVD at the toe of the dune. Scraping occurs in a 60' wide area that extends from 40' seaward of the dune toe to 100' seaward of the dune toe. To scrape, a bulldozer pushes sand into stockpiles on the beach. Sand is stockpiled at a rate of 2.2 cubic yards per linear foot, which equates to a cut depth of approximately one foot (1'). A payloader then transports scraped sand for placement on the dune.

According to conditions set by NYSDEC and FIIS, all scraping activities occur between July 1st and August 15th with monitoring requirements established as follows:

1. Relevant monitor stations must be set to NGVD 1929 Datum per the approved site plans (Appendix D). Monitor stations have been previously established at intervals of 500 linear feet. In the event that a station is lost, it is reset in the same position, where possible, for data consistency.
2. A pre-construction profile survey must be completed for the entire shoreline to be scraped. Profiles must be performed at 500' intervals beginning at a control station west of the scraping area and extending through the scraping area to a control station east of the scraping area. Pre-construction profiles must extend to elevation -6 NGVD with copies of profiles submitted to NYSDEC, FIIS and town agencies ten days prior to construction. Pre-construction photographs must also be submitted.
3. A post-construction profile survey and photographs must be submitted to the NYSDEC, FIIS and town agencies within five days of project completion. Additional beach profiles must be submitted in conformance with the following schedule:

    - First four (4) months—monthly surveys
    - Remainder of permit or next scraping event—bi-monthly surveys

    **Note: Profile surveys are conducted a total of ten times per monitoring station.*

4. Environmental monitoring for seabeach amaranth (*Amaranthus pumilus*) will be conducted pre, during, and post construction. Pre- and post-construction surveys for seabeach amaranth must be conducted by a trained biologist/ecologist. Environmental

monitors must be present at all times during construction to survey the project area for the presence of seabeach amaranth. If an amaranth plant is found, the area surrounding the plant must be fenced off for protection of the plant, with no sand to be scraped or placed in the fenced off area.

5. Environmental monitoring for piping plovers (*Charadrius melodus*) will be conducted according to the following schedule (M. Bilecki, FIIS, pers. comm.):
    a. If scraping occurs outside of plover season (April 1st-July 1st), or after plovers fledge, only beach profiles (above) would be required.
    b. If scraping will occur during plover season, pre, during and post construction monitoring will be required and symbolic fencing may need to be installed. Please note that plover season may extend beyond July 1st if there are birds on the beach.
    c. If scraping will occur near plover chicks, monitoring will be required until the chicks fledge.

Monitoring data has been collected per special conditions outlined within NYSDEC Article 25 and NPS/FIIS Special Use permits since 1993. Recommendations have been made for revising monitoring data collection for future scraping projects, and are summarized below:

1. Data in digital tabular form
    a. Microsoft Excel table or equivalent software
    b. Provide data in both feet and meters
2. If community scrapes, collect data for all established profile locations in the community even if only part of the beach was scraped.
3. Do not change control profile locations:
    a. A control cannot be anywhere that has been previously scraped.
    b. Maintain two controls, western and eastern.
4. Update vertical datum to NAVD88.
5. Profile data collection:
    a. Start the profile well behind the primary dune, note where previous station marker is in Notes or Comments column on data collection sheet if it has been moved landward
    b. In addition to collecting data points at major breaks in slope, collect a few more points (every few meters) between the breaks in slope or morphologic features
    c. Label major morphologic features on data collection sheet (ex. dune crest, dune toe, berm crest) and transfer this information to the spreadsheet
6. Profile display: Label all major morphologic features with arrows pointing directly to the data point. Also note on profile if in a scraped, not scraped (as in point 2 above), or control location as well as the profile number
7. Note any hurricanes, tropical storms, nor'easters and the date, and/or any visual damage that occurred around the time of profiling in the spreadsheet
8. Provide exact coordinates of each profile station marker in both latitude/longitude and UTM

Beach scraping has been used as the primary technique for protection of structures in downdrift communities such as Kismet, which scrapes annually. However, given the strict beach conditions required to allow beach scraping activities, severely eroded beach/dune systems, such as eastern Saltaire/western Fair Harbor, eastern Corneille Estates/western Ocean Beach, eastern Ocean Bay Park, eastern Fire Island Pines, and the entire community of Davis Park are not currently candidates for scraping programs. It appears from data assembled within communities that beach scraping is more appropriately utilized as a maintenance tool to repair storm damaged dune systems where beach widths are adequate.

Beach scraping will be considered within the Fire Island communities for maintenance activities per existing NYSDEC and FIIS regulations. Communities that qualify to scrape may do so on an annual basis for the duration covered by this EA. A summary of beach scraping criteria established by FIIS and outlined above is provided in Table 5.

Table 5. Criteria established for Beach Scraping.

Process and responsible party	NPS land/ impact	Seasonal restrictions	Monitoring	Scope/ level	Project design criteria
Communities must apply for all appropriate permits and funding must be private, with no public expenditures (NPS 1977) Applicant/permittee is responsible for implementing and enforcing all criteria and conservation measures as part of project design and permit conditions	Not on NPS upland, except for small lots within community boundaries Equipment transport will occur by water or interior road transport to avoid and minimize impacts to additional areas of the shoreline whenever possible	3/1-11/1* Combined safety window Derived from: 3/1-9/1 FIIS beach Threatened and Endangered (T&E) species protection 4/1- 9/1* USFWS Plover window 4/1-11/1* USFWS Amaranth window *Allowed 7/15-9/30 if surveys and monitoring (conservation measures per USFWS protocol) determine no plover nests w/in 1000m each direction and no SB Amaranth w/in 100m each direction	Shoreline and ecological resources including T&E species presence, pre-project, during, and post project-project life USFWS and NYSDEC protocol will be used and are included as part of the project requirements	Potential for max of 12-17 projects within 2.5 years Each project minimum length 500' (C/B ratio)	1) Minimum Beach width 100' @ 9.0' NGVD to be considered 2) cut depth of 1' maximum permitted to be scraped - dozer blade restriction 3) dune face slope = 1/4 4) maximum beach construction will allow a maximum of 1:4 slope dune up to a 30' dune crest @ 16.5' NGVD, 1:4 dune slope down to 9.0' NGVD, 100' of beach @ 9.0' NGVD 5) Constructed dune template must be built over existing dune. 6) vegetation preserved or planted with local genetic stock at varying densities (per USFWS protocol) 7) all debris removed or reused (fencing) 8) No southward dune placement accept where widening dune crest per NPS developed template 9) Project will meet all USFWS, NMFS and NJDEP T & E species conservation design measures.

2.3 Beach Nourishment from Offshore Borrow Areas: 2003 Permitted Conditions

This alternative describes a beach nourishment design based on the permit criteria for the 2003 nourishment project constructed in Western Fire Island and Fire Island Pines (Table 6, Appendix E). As in 2003, beach nourishment under this alternative is designed as a short-term project, to last approximately 5-6 years. This alternative utilizes the dune crest line data analyzed for the 2003 project, based on 2000 topography, as plotted on the plans dated Aug 15, 2003 and specified in the permit (Appendix E).

For this and all beach nourishment alternatives described in this EA, there are four reaches defined: (1) Western Fire Island (Saltaire, Fair Harbor, Dunewood, Lonelyville), (2) Central Fire Island (Fire Island Summer Club, Corneille Estates, Ocean Beach, Seaview, Ocean Bay Park), (3) Fire Island Pines, and (4) Davis Park. Appendix E provides site plans developed in 2003 for Western Fire Island and Fire Island Pines; if this alternative were chosen, similar site plans will be developed for the Central Fire Island and Davis Park reaches.

Dune nourishment is small for the proposed 2008 project. In most cases, no sand is added to the existing dunes. Dunes scarped or impacted by the April 2007 nor'easter will be repaired with sand pushed up to reestablish the 1:4 slope. Where dune elevations are lower than the NPS profile, they will be built up to the allowable 15 foot NGVD elevation. The most extensive dune reconstruction is for Davis Park. There has been no major dune restoration since the 1997 project, except in Fire Island Pines in 1997 and Dunewood in 2003.

The total volume of sand proposed for this alternative is that required to provide community structures and infrastructure protection from a 10-year storm, a stated objective of community beach nourishment. The volume required was calculated based on existing beach and dune conditions. It should be noted that this volume differs from the volumes discussed in Section 3.1 (p. 52), which describes sand volumes as they relate to geological processes.

Table 6. Criteria for beach nourishment using 2003 protocols.

Process	NPS land/ impact	Seasonal restrictions	Monitoring	Scope/ level	Project design criteria
Communities must apply for all appropriate permits and fund each project without Federal expenditures (NPS 1977) Applicant/ permittee is responsible for implementing and enforcing all criteria and conservation measures as part of project design and permit conditions	Not on NPS upland, except for small lots within community boundaries and for those small tracts between Kismet and Saltaire and potentially the 2 small tracts between Atlantique and Ocean Beach No tapers outside of community boundaries Equipment transport will occur by water or interior road to avoid and minimize impacts to additional areas of the shoreline whenever possible	2/1-11/1 =Combined safety window Derived from: 3/ 1-9/1 FIIS Threatened & Endangered species (T&E) protection policy 4/1- 9/1 USFWS Plover window 4/1-11/1 USFWS Amaranth window 5/ 1-11/ 15 Sea Turtle and Marine Mammal NMFS window 10/1-1/31 EFH NMFS window Surveys and monitoring (conservation measures per USFWS, and NMFS protocol) will determine species presence and along with dredge selection will determine allowable project dates	Shoreline and ecological resource monitoring including T & E, pre-project, during, and post project throughout project life USFWS, NMFS and NYSDEC protocol will be used and are included as part of the project requirements Grain size and sediment characteristics of the material to be deposited will be consistent with the existing beach substrate.	Max 6 miles 3-7 projects in 3 years	1) Beach and dune criteria generally insufficient to meet scraping criteria (width less than 100' and 9'NGVD,) 2) Design must establish a 9.0' NGVD beach and no tapers on Federal property or in front of undeveloped community property 3) Dune face slope = 1/4 4) Maximum beach construction will allow a maximum of 1:4 slope dune up to a 30' dune crest (15'to seaward and landward of the central dune crestline) @ 16.5' NGVD, 1:4 dune slope down to 9.0' NGVD, 100' of beach @ 9.0 NGVD, 1:15 slope down to 0 NGVD. Total beach/dune profile would have the following horizontal dimensions from the inland toe of the foredune to the water: foredune= 90ft (base) + beach berm (100ft) + seaward beach slope (135') = 325 ' from inland toe of foredune. Dune profiles are 16.5' in height, with a 30' crest width and 9.0'NGVD base elevation 5) Constructed dune cannot be displaced seaward of existing dune. Houses on the dune crest, the seaward margin of the dune crest may extend 15' from the central dune crestline. The dune may be widened to extend beneath existing structures. Fill material will not be considered a new primary dune. If fill cannot be tied to the dune crest, beach fill may still be utilized but no elevation beneath existing structures will be permitted. If no dune exists, or it is very irregular, a dune crestline and accompanying dimensions will be developed by the applicant for NPS approval. 6) Must include Interpretation and Education with signs, community involvement and symbolic fencing 7) Vegetation preserved or planted with local genetic stock at varying densities from 12" on center to 36" on center 8) All debris removed or reused (fencing) 9) Project will meet all USFWS, NMFS and NYDEC T & E species conservation design measures. 10) No nourishment will be permitted which would result in a dune width greater than 30 feet at the crest

Western Reach: Saltaire, Fair Harbor, Dunewood and Lonelyville

This alternative proposes a beach nourishment project with similar criteria to that approved and constructed in these communities in 2003. Nourishment would entail placement of sand to enhance the existing beach and dunes along the entire shorefront of Saltaire, Fair Harbor, Dunewood and Lonelyville, a length of 7,300 feet. A single taper on property owned by the Town of Islip is proposed, similar to that constructed in 2003. The taper is proposed for a length of 500' east of the primary beach area east of Lonelyville, bringing the total project length to 7,800 linear feet.

Sand to be placed on the beach would be dredged from a borrow source in the Atlantic Ocean 1.6 miles southeast of the communities. In addition to nourishment, the communities propose to stabilize the dune system with vegetation (American beach grass) and sand fencing. Additional dune protection will be provided by reconstructing dune walk-overs to be elevated above grade, to allow sand migration beneath them.

The 2003 project was designed and built for 654,500 cy. Approximately 717,728 cubic yards of sand was placed in this reach at a rate of 90 cubic yards per linear foot (cy/lf). Some of the volume placed in 2003 remains in the beach and dune system, and therefore, for this alternative in 2008, only 500,000+/- cubic yards are proposed at an average rate of 69-75 cy/lf. The proposed 2008 project is 24% smaller by volume.

Beach and dune nourishment consists of constructing a beach berm with an elevation of 9.0 ft NGVD (7.9 ft NAVD) with a dune elevation of 16.5 ft NGVD (15.4 ft NAVD) along the communities' length of 7,300 ft. Construction slopes will be 1 ft vertical to 4 ft horizontal between the dune crest and beach berm, and 1 ft vertical to 10 ft horizontal between the beach berm and mean tide level. A template of the proposed beach profile is provided in Figure 8 (p. 47).

Sand fill will cover approximately 25.0 acres of beach area landward of the mean high water line. Submerged lands adjacent to shore will be covered to approximately 39.3 acres at construction. The construction profile will be built with a larger berm width than the expected equilibrium profile. Following sand placement, wave and current forces will reshape the beach to the designed equilibrium beach width of 69 feet (average), as defined by the 2003 NPS profile. The equilibrium profile will intersect the existing bottom at approximately -18 ft NGVD (-19.1 ft NAVD), which is the engineering depth of closure.

The sand source for the Western Reach is Borrow Area 2-West, which is within the region of USACOE Borrow Area 2. This source was selected after a long search begun by the USACOE and completed by Coastal Planning & Engineering, Inc. (CPE). A review of historic sand search data and a sand search conducted by CPE in 2001 indicated that there is a large volume of beach compatible sand offshore of Fire Island. In order to minimize costly new offshore investigations and to meet agency requirements that the 2003 projects conform to the USACOE formulation as closely as possible, two borrow areas were developed from within the USACOE Borrow Area Region 2. In the 2006 scoping meeting conducted at FIIS, it was agreed that the 2008 project should be formulated with minimal changes from the 2003 permitted project and conditions. Since the 2003 borrow areas are able to satisfy volume requirements for the 2008 project with minimal modification, they were selected for re-use.

Borrow Area 2-West is located 1.8 miles southeast of the Western Fire Island reach (Figure 1). It has a surface area of 209 acres and lies in water depth of -47 to -55 ft NGVD. Approximately 1.9 million cubic yards of beach compatible sand is available within Borrow Area 2-West. Sand in this borrow area has a composite mean grain size of 0.39 mm and silt content of 4% and is compatible with the beach sand in these communities. Beach and borrow sand characteristics are summarized in Appendix F.

The cut depth for the borrow area will average 6 feet below the existing surface. The borrow areas contain just enough sand for the proposed 2008 project along with adequate dredging buffers. Profiles for the proposed borrow area cut are shown in Appendix E.

Central Reach: FI Summer Club, Corneille Estates, Ocean Beach, Seaview, Ocean Bay Park

This alternative proposes nourishment of the existing beach and dunes using conditions similar to the 2003 permitted construction conditions for Western Fire Island and Fire Island Pines. Nourishment would entail placement of sand to enhance the existing beaches and dunes in the communities of Fire Island Summer Club, Corneille Estates, Ocean Beach, Seaview and Ocean Bay Park, a length of 7,580 feet along the shore. Nourishment will extend with a single taper section of 500 feet to the east into Point O'Woods, bringing the total length of this nourishment segment to 8,080 feet. The volume of sand necessary to nourish the beaches and repair the dune erosion is 570,000 cubic yards, placed at a rate of 69-75 cy/lf. As with the western reach, the central communities propose to stabilize the dune system with vegetation (American beach grass) and sand fencing, and to provide further protection by rebuilding dune walk-overs elevated over grade.

Nourishment in the central reach consists of constructing a beach berm with an elevation of 9.0 ft NGVD (7.9 ft NAVD) with a dune elevation of 16.5 ft NGVD (15.4 ft NAVD) along the community's length of 7,580 feet. Construction slopes will be 1 ft vertical to 4 ft horizontal between the dune crest and beach berm, and 1 ft vertical to 10 ft horizontal between the beach berm and mean tide level.

Sand fill will cover approximately 32.3 acres of beach area landward of the mean high water line. Submerged lands adjacent to shore will be covered to approximately 43.8 acres at construction. The construction profile will be built with a larger berm width than the expected equilibrium profile. Following sand placement, current and wave forces will reshape the beach to the designed equilibrium beach width of 71 feet (average). The equilibrium profile will ultimately intersect the existing bottom at approximately -18 ft NGVD (-19.1 ft NAVD) which is the engineering depth of closure.

Sand to be placed on the beach would be dredged from Borrow Area 2-West, located 1.0 miles south of the central communities (refer to discussion above). This borrow area was permitted under the 2003 permit conditions, and represents continuity with the past project as agreed at the November 2006 scoping meeting. Additional sand searches were not conducted, since adequate quantities remain in the existing sand sources. The cut depth for the borrow area will average 6 feet below the seabed. Profiles for the proposed borrow area cut are shown in Appendix E.

Fire Island Pines

This alternative proposes a beach nourishment project with criteria approved and constructed in Fire Island Pines in 2003. Nourishment consists of sand placement along the entire shorefront of Fire Island Pines, a length of 6,400 feet along the shore. No tapers are proposed for this reach.

Sand to be placed on the beach would be dredged from a borrow source in the Atlantic Ocean 1.0 miles south of Fire Island Pines. In addition to nourishment, the community proposes to stabilize the dune system with vegetation (American beach grass) and sand fencing, and to provide further protection by rebuilding dune walk-overs elevated over grade.

In 2003, approximately 560,840 cubic yards of sand was placed at a rate of 87 cubic yards per linear foot (cy/lf) in Fire Island Pines. A small volume of the sand placed in 2003 remains in the beach and dune system, and therefore, for this alternative in 2008, only 500,000+/- cubic yards are proposed at an average rate of 78 cy/lf.

Beach and dune nourishment consists of constructing a beach berm with an elevation of 9.0 ft NGVD (7.9 ft NAVD) with a dune elevation of 16.5 ft NGVD (15.4 ft NAVD) along the community length of 6,400 feet. Construction slopes will be 1 ft vertical to 4 ft horizontal between the dune crest and beach berm, and 1 ft vertical to 10 ft horizontal between the beach berm and mean tide level.

Sand fill will cover approximately 12.8 acres of beach area landward of the mean high water line. Submerged lands adjacent to shore will be covered to approximately 38.7 acres at construction. The construction profile will be built with a larger berm width than the expected equilibrium profile. Following sand placement, current and wave forces will reshape the beach to the designed equilibrium beach width of 78 feet. The equilibrium profile will ultimately intersect the existing bottom at approximately -18 ft NGVD (-19.1 ft NAVD) which is the engineering depth of closure.

The sand source for this reach is Borrow Area 2-East, which is within the region of USACOE Borrow Area 2. This source was selected after a long search begun by the USACOE and completed by Coastal Planning & Engineering, Inc. (CPE). A review of historic sand search data and a sand search conducted by CPE in 2001 indicated that there is a large volume of beach compatible sand offshore of Fire Island. In order to minimize costly new offshore investigations and to meet agency requirements that the 2003 projects conform to the USACOE formulation as closely as possible, two borrow areas were developed from within the USACOE Borrow Area Region 2. In the September 2006 scoping meeting conducted at FIIS, it was agreed that the 2008 project should be formulated with minimal changes from the 2003 permitted project and conditions.

Approximately 740,000 cubic yards of beach compatible sand is available within the 2003 permitted border of Borrow Area 2-East, which is not sufficient for both Fire Island Pines and Davis Park reaches (see below). As such, if this alternative is chosen, Borrow Area 2-West would be utilized as an alternative sand source, although it would require expensive construction techiniques.

Borrow Area 2-East is located 1.0 mile south of Fire Island Pines. It has a surface area of 156 acres and lies in water depth of 43-48 feet NGVD. Borrow area sand has a composite mean grain size of approximately 0.42 mm. Prior to the 1997 nourishment project, the beach sand had a mean grain size of 0.46 mm. Dry beach samples had a mean grain size of 0.44 m in 2004 and 0.47 mm in 2008. Beach and borrow sand characteristics are summarized in Appendix F.

The cut depth for the borrow area will average 4 feet below the existing bottom. Profiles for the proposed borrow area cut are shown in Appendix E.

Davis Park

This alternative proposes nourishment of the existing beach and dunes using the 2003 permitted construction conditions. Nourishment would entail placement of sand to enhance the existing beaches and dunes along the entire shorefront of Davis Park, a length of 4,200 feet along the shore. No tapers are proposed. The volume of sand necessary to nourish the beaches and repair dune erosion is 305,000 cubic yards, placed at a rate of 73 cy/lf. As with the other reaches, Davis Park proposes to stabilize the dune system with vegetation (American beach grass) and sand fencing, and to provide further protection by rebuilding dune walk-overs elevated over grade.

Beach and dune nourishment consists of constructing a beach berm with an elevation of 9.0 ft NGVD (7.9 ft NAVD) and with a dune elevation of 16.5 ft NGVD (15.4 ft NAVD) along the community length of 4,200. There are no tapers proposed with this alternative. Construction slopes will be 1 ft vertical to 4 ft horizontal between the dune crest and beach berm, and 1 ft vertical to 10 ft horizontal between the beach berm and mean tide level.

Sand fill will cover approximately 11.2 acres of beach area landward of the mean high water line. Submerged lands adjacent to shore will be covered to approximately 27.8 acres at construction. The construction profile will be built with a larger berm width than the expected equilibrium profile. Following sand placement, wave and current forces will reshape the beach to the designed equilibrium beach width of 73 feet. The equilibrium profile will ultimately intersect the existing bottom at approximately -18 ft NGVD (-19.1 ft NAVD) which is the engineering depth of closure.

Sand to be placed on the beach would be dredged from Borrow Area 2-East, which is located 3.0 miles southeast of the community (see above description for Fire Island Pines). As stated above, the borrow area sand has a composite mean grain size of approximately 0.42mm. This is coarser than the beach sand in Davis Park, which has a mean grain size of 0.37 mm from a surface sample collected in 2008; however, it is compatible as beach fill.

The cut depth for the borrow area would average 4 feet below the seabed, but would have insufficient sand available for Davis Park. To obtain the volume of sand required in this reach, Borrow Area 2-West would also be utilized. Profiles for the proposed borrow area cut are shown in Appendix E.

Construction Methods and Timetable

Beach construction will be accomplished utilizing a hydraulic cutterhead dredge connected by a submerged pipeline to the shoreline of the communities or a hopper dredge that loads directly with sand, which is pumped thru a pipeline after transit closer to shore. The pipeline will be extended along the beach on community and Federal property as construction progresses. The Western Fire Island and Fire Island Pines nourishment project of 2003 and Fire Island Pines nourishment project of 1997 were successfully completed utilizing these methods.

In addition to dredge equipment, construction will require the use of bulldozers, front-end loaders, and other heavy construction equipment. Supply and crew trucks and mobile facilities will also be used. As there are no vehicular access roads to the beach within the communities, the project will require permission to use dune crossings located at the Kismet Fire Station and east of Lonelyville within the Town of Islip tract for the western communities, dune crossings west of FI Summer Club (Town of Islip) and east of Ocean Bay Park (Town of Brookhaven) for central communities, Coast Guard Walk dune crossing for Fire Island Pines and the town dune crossing for Davis Park in combination with Smith's Point Bridge and/or access by water for eastern communities.

Construction under this alternative would start in the fall of 2008, by October 1st for the cutterhead dredge and November 15th for the hopper dredge. Active construction of the 1.9

million cubic yard project will take approximately 2-3 months under normal weather conditions typical of the fall season. Mobilization and demobilization of equipment will add about one month to construction time, bringing the total time to almost 4 months.

Environmental Monitoring

Environmental monitoring was conducted annually in the communities of Saltaire, Fair Harbor, Dunewood, Lonelyville, and Fire Island Pines following the 2003 nourishment project. Trained biologists monitored for special status species and vegetation, and sampled the beaches for invertebrates. The fourth of five monitoring seasons was completed in October 2007. In addition to terrestrial monitoring, the borrow areas were sampled for finfish and commercially important invertebrates for two (2) years following nourishment. All monitoring reports can be found in Appendix G.

Once projects are completed, monitoring of the constructed beach/dune area may be undertaken with the same protocol required for the 2003 nourishment project (Appendix G). Post-construction monitoring may include identification of shorebird nesting areas for special status species such as piping plover, data collection of all nesting activities, fencing (if appropriate), and public signage indicating the importance of implementing protection measures for these species. For the 2003 project, symbolic fencing was installed along the length of the nourished reaches by April 1st and monitoring for piping plovers and other special status shorebirds was conducted three times per week at varying times and tides from April 1st to July 1st. If no nesting activity occurred, symbolic fencing was removed on July 1st; if there was nesting activity, symbolic fencing remained and monitoring continued until the chicks had fledged.

Monitoring data will be collected on the vegetative assemblages and presence/absence of seabeach amaranth. Following the 2003 project, vegetation was inventoried using the transect method for two years. Transects were spaced 900-1,100 feet apart at previously established section lines, and plants were identified and counted from the toe of the dune seaward for a width of 10' (5' on either side of transect line). In addition to transects, the entire nourished area was surveyed for the presence of seabeach amaranth each year following nourishment. Plants were located with a handheld GPS and symbolic fencing was installed for protection.

The intertidal and nearshore benthic community was also monitored for two years following nourishment. Methodology and results of invertebrate sampling is presented in Section 4.4.3 (p. 139).

Environmental monitoring for the 2008 project will be modified to include a requirement for borrow area surveys to assess geological impacts. Borrow area survey protocol, including location/extent to be surveyed, resolution, and survey schedule, will be presented in detail in the Special Use Permit once the project is approved. Permittees will ensure that all monitoring is conducted according to permit conditions for the duration specified in the permit(s).

2.4 Beach Nourishment from Offshore Borrow Areas: Modified Conditions, Combination Template, Tapers on Federal Property

This alternative describes a beach nourishment design based on the permitting criteria and construction parameters approved for the 2003 nourishment project constructed in Western Fire Island and Fire Island Pines (Table 6), with modifications. Project performance since 2003, as analyzed by coastal geologists and engineers, indicates that some change would be beneficial to the project durability, construction efficiency and safety, level of protection, and could allow for an economic price. Modifications proposed for this alternative (versus alternative 2.3) include project design cross-section, taper sections, borrow area cut depth, and construction timeline, as described below. Site plans for this alternative are similar to those developed for Alternative 2.5 (below); however, this alternative includes tapers on Federal property.

As with the previous nourishment alternative (2.3), beach nourishment under this alternative is also designed as a short-term project, to last approximately 5-6 years. This alternative also utilizes the permitted dune crest line utilized for the 2003 project, which was based on 2000 topography.

Project-Design Cross-Section

The proposed project does not envision a larger average volume density than constructed 2003, but there is a need to distribute sand alongshore according to engineering principles. Larger volume densities should be placed in erosion hot-spots, while cold-spots (stable to low erosion areas) need less density. If tapers are not allowed, the cross-section near community borders would be increased in size to mitigate for the lack of tapers. Dunes should be continuous and full.

The template developed in 2003 has a rigid placement design. It was developed to allow NPS to abide by strict policy guidelines for a short-term nourishment project. However, this template provides for the same distribution of sand regardless of erosion trends in a specific area. Cross shore placement needs to be flexible so that gaps and low points can be filled, and recently damaged dunes should be repaired to provide protection to landward structures from the design storm.

Taper Sections

Taper sections increase the durability and life of a beach nourishment project. Tapers were utilized in 1993/94 and 1997 Fire Island nourishment projects.

This alternative proposes 400-500’ tapers at the east and west ends of each reach. In the Western reach, the western taper is proposed on Federal property, while the eastern taper is proposed on Town of Islip property. In the Central reach, the western taper is proposed on Federal property, while the eastern taper is proposed on Town of Brookhaven (Point O’Woods) property. In Fire Island Pines and Davis Park, both western and eastern tapers are proposed on Federal property.

Borrow Area Cut Depth

Beach compatible sand lies 1-3 feet deeper than the 2003 borrow area cut limits for Borrow Area 2-East (refer to Appendix H cross sections for specified cut depth). Extra dredge depth can provide beach compatible sand for Fire Island Pines and Davis Park so that Borrow Area 2-West does not have to be utilized for these reaches. A wave refraction analyses was conducted to measure the potential impact of increasing the cut depth by 1-3 feet in Borrow Area 2-E. Results are discussed in Section 4.1.4 below.

Construction Timeline

This alternative proposes to start construction on or near September 15, 2008 for both types of dredges. The hydraulic dredge was permitted to start October 1st in 2003, but the hopper was not permitted to start until November 15th. In 2003, the later construction start date doubled the project time and greatly increased the cost of construction.

Western Reach: Saltaire, Fair Harbor, Dunewood and Lonelyville

Project design parameters for this alternative are similar to those described for the western reach in alternative 2.3 (see above), with the following modifications:

- Project Design Cross-Section
  - Dune height of 15' NGVD
  - Moderate dune and scarp repair along project area shoreline
- Taper
  - 400 ft taper at the western project limit, tapering to the existing 9.0 ft NGVD (7.9 ft NAVD) elevation at the border to Kismet, but not extending onto Kismet

Central Reach: FI Summer Club, Corneille Estates, Ocean Beach, Seaview, Ocean Bay Park

Project design parameters for this alternative are the same as those described for the central reach in alternative 2.3 (see above), with the following modifications:

- Project Design Cross-Section
  - Dune height of 15' NGVD
- Taper
  - 500 ft taper at the western project limit extending onto Federal property

Fire Island Pines

Project design parameters for this alternative are the same as those described for Fire Island Pines in alternative 2.3 (see above), with the following modifications:

- Project Design Cross Section
  - Dune height of 15' NGVD
  - Dune and scarp repair at FIP-2-4 and FIP-12.
  - Berm crest advancement for constructible and volume distribution, FIP-5, FIP-12 and FIP-13.
- Tapers
  - 500' tapers on both the east and west ends of Fire Island Pines
- Borrow Area Cut Depth
  - Increase cut depth by 1-3' in Borrow Area 2-East

Davis Park

Project design parameters for this alternative are the same as those described for Fire Island Pines in alternative 2.3 (see above), with the following modifications:

- Project Design Cross Section
  - Dune height of 15' NGVD
- Taper Sections
  - 500' tapers on both the east and west ends of Davis Park
- Borrow Area Cut Depth

- Increase cut depth by 1-3' in Borrow Area 2-East

Note: Engineered tapers should be 1,500 ft long, but the communities have compromised by proposing tapers no longer than 500 ft on each end.

Construction Methods and Timetable

Beach construction will be accomplished with the same equipment, methodology, and duration as described for alternative 2.3 (see above). However, construction under this alternative would start September 15th for both cutterhead and hopper dredges. Protocols for protection of sea turtles would be implemented with this proposed start date (refer to Section 4.5.4 for a thorough discussion of protection measures).

Environmental Monitoring

Environmental monitoring is proposed as described under alternative 2.3 above.

2.5 Beach Nourishment from Offshore Borrow Areas: Modified Conditions, Combination Template, No Tapers on Federal Property

This alternative is similar to alternative 2.4 above, except that there are no tapers proposed on fedearl property with this alternative. Tapers on Town of Islip and Town of Brookhaven (Point O' Woods) lands are still proposed. Site plans can be found in Appendix H. Without tapers, cross-sections near community borders have been increased in size to mitigate for the lack of tapers. All other information is as described in section 2.4, and will therefore not be reiterated.

2.6 Beach Nourishment from Offshore Borrow Area: 2008 Dune Crest Line, FIMP Template

This alternative describes a beach nourishment design based on a dune crest line ("2008 dune crest line") developed by the FIIS geomorphology consultant (Psuty, 2008), combined with the FIMP profile design method using a 15 foot design dune elevation (USACE 2002). The dune crest line is based on an analysis of 2005 aerial photographs using a stereoscope, with limited use of LIDAR based topography. The 2008 dune crest line is landward of the 2003 permitted crest line in several areas; a comparison of the 2003 versus 2008 dune crest lines is shown in Appendix I and Section 2.9 (below).

This alternative provides for a total of 275 feet from the landward toe of the dune to the mean high water (MHW) line. This distance equates to protection for overwash and breaching from a 10-year storm (Gravens and Rosati, 1999). However, the dune crest line is landward of 10 houses, bisects 45 houses and bisects decks on an additional 69 houses, for a total of 124 structures affected within the Fire Island communities proposing nourishment (Appendix I). Nourishment under this alternative does not meet project objectives, as structures bisected by or seaward of the 2008 dune crest line would not be afforded protection from a 10-year storm.

The total volume of sand that could be placed under this alternative based on the FIMP method is a significant reduction in almost all cases from the other alternatives presented in this EA as well as the 2003 permitted project volume (Section 2.9, Table 7). As a result, this design alternative would have a project life of 3-4 years rather than 5-6 years. No tapers are proposed on Federal property with this alternative.

The sand sources for this alternative are the same offshore borrow areas discussed above (Borrow Areas 2-West and 2-East), with the depth modification described in alternative 2.4 above. Construction timeline, methodology, equipment, and environmental monitoring are the same as outlined for Alternative 2.3 (Beach Nourishment with 2003 Permitted Conditions) above.

Engineered site plans have not yet been developed for this alternative, due to the long-term implications of the 2008 dune crest line. This EA is being prepared for short-term storm protection for the Fire Island communities, a plan that will not permanently alter conditions on Fire Island, which this alternative will. Long-term implications associated with the 2008 dune crest line, including lands, easement and rights of way; sediment transport; and sea-level rise, will be addressed in the FIMP study, as discussed with an NPS representative on June 20, 2008.

2.7 Preferred Alternative: Combination of Beach Nourishment and Beach Scraping

This alternative calls for a combination of beach scraping (Alternative 2.2) and beach nourishment (Alternative 2.5, Modified Conditions, Combination Template, No Tapers on Federal Property), based upon consultation between NPS staff and community representatives on June 20, 2008. The preferred alternative meets all project objectives for the 5-6 year life of the project, including protection of community structure and infrastructure for the duration of bonds obtained to fund the projects, providing adequate beach width for travel at all tides, and providing or enhancing recreation in the communities, while minimizing environmental impacts as discussed in Chapter 4.

Beach scraping and beach nourishment are two projects with very different purposes, scopes, and criteria. Different beach and dune conditions favor scraping and nourishment. There is the potential that if nourishment were used, scraping may be needed less frequently or not at all; scraping may be utilized to stabilize a non-nourished area or a nourished area after a storm. Examples of the use of this alternative are as follows:

- Kismet typically utilizes scraping only, but would nourish if beach conditions deteriorate such that they would not qualify to scrape
- Seaview, Ocean Bay Park, or Davis Park may nourish in the fall of 2008 and then scrape in subsequent summers to repair impacts to their dune(s)
- Saltaire typically utilizes nourishment only, but does obtain NYSDEC permits to scrape if needed after a storm

This alternative allows the communities to meet their needs under varying beach and dune conditions.

As stated above, the preferred nourishment alternative is engineered to last for a period of 5-6 years, while beach scraping projects are designed for one (1) year. The potential therefore exists for four beach nourishment projects (one project per reach) to be constructed once during the period covered by this EA, as well as multiple beach scraping projects to be constructed annually staring in 2009; beach scraping would be constructed both in areas nourished and areas not nourished (see above).

2.8 Alternatives Considered But Rejected

North Side Dune Nourishment

This alternative consists of dune nourishment on the north side of the remaining dunes by placing the dredge pipeline over the dune and pumping the dune cross-section to the size permitted using the approved beach profile. With the dunes proposed to retreat with the dune crest line, allowable nourishment under alternative 2.6 (2008 Dune Crest Line) may only be feasible on the dune back side.

This alternative was dismissed for several reasons. First, it would require special construction methods and regulatory allowances. Permission would be required to impact the existing vegetated dunes. Permits issued in 2003 for beach nourishment and permits issued for beach scraping all contain special conditions that prohibit placement of sand on vegetated dunes; it is highly unlikely that regulatory agencies would remove this condition to allow this alternative. In addition, a special permit to control the runoff would be needed. The dredge pipe not only pumps sand, but also water, which would have to be controlled and drained in an approved manner to avoid flooding. Finally, the back of the dunes in the developed communities are not only heavily vegetated but also contain community and privately owned infrastructure (utility lines, sanitary systems, etc.) and structures (dwellings, decks, etc.) that would need to be protected. Given all of these factors, this alternative was dismissed from consideration.

Trucking/Barging Sand from Upland Source(s)

This alternative considers sand from an alternate source, via upland transport. However, sand fill transported from an upland source is not a feasible alternative for a project of this scale due to a much higher cost and a much greater environmental impact associated with trucking sand. The cost associated with trucking sand from Democrat Point stockpile is approximately $800,000 for mobilization plus $2/cy, $4/cy and $7/cy to transport to various locations in the project area (Reiter, pers. comm.). Barging sand is an even greater expense. The cost for Davis Park's 2007 emergency dune restoration project was $68/cy.

Trucking sand from an upland fill source would call for double handling of the sand and transportation by truck haul for a significant distance (approximately 14 miles). This level of truck transport for even a minimal volume of sand would result in much greater impacts to beach habitat from oversand vehicles. As an example, the 27,440+/- cubic yards placed at Davis Park in the fall of 2007 would have required close to 1,000 trips with a 30-yard truck from either Smith's Point (distance of 8 miles) or Democrat Point (distance of 12 miles). The volume placed for the 2007 FEMA project, however, was designed to provide emergency protection for the community only until the larger beach nourishment project. To contrast, Davis Park is slated to receive over 300,000 cubic yards of sand for protection with the beach nourishment project.

Due to the high cost and excessive vehicular trips that would be required to transport the 1.9 million cubic yards of sand proposed for placement along several Fire Island communities, trucking sand from an upland source was dismissed from consideration.

Retreat/Relocation of Dwellings and Infrastructure

New development on Fire Island has been steadily decreasing since the 1960's and 1970's, and has slowed to less than two units per year since 1991. Currently, there are about 4,100 structures on Fire Island (USACOE, 1999), with very little developable land remaining. Based on a comparison of the structure survey maps with 1998 aerial photographs, it has been estimated that there are only 35 available lots left for development on the entire island (USACOE, 1999). Inspection of the affected communities revealed that the majority of threatened properties are not located in close proximity to a vacant lot that could be utilized for relocation (Figures 2-5). It should be noted that the majority of lots located within the affected communities are situated on small single and separate parcels with existing lot coverage maximized per current zoning regulations. This small lot size does not provide for any significant cover to relocate homes landward. Additionally, vacant lots adjacent to threatened parcels are not available for relocation. Implementation of relocation/retreat for threatened structures was undertaken on a limited number of parcels after the severe 1992/93 storms that devastated the northeast Atlantic coastline. At that time, houses that required relocation and incorporated lots large enough to accommodate retreat or relocation were moved farther landward or reduced in size. Therefore, little opportunity now exists within the communities to further develop this option.

Retreat/relocation of structures was dismissed from consideration as an alternative for several reasons. First, as stated above, there is a lack of available land. Second, retreat/relocation of structures does not meet the needs of the communities for storm and flood protection for structures and infrastructure, including existing dwellings and associated sanitary systems, public utilities and services, and access stairs. Similar to the no action alternative, retreat/relocation of structures would not mitigate for continued erosion of the beach and dunes, thereby leading to increased risk of storm damage to additional homes and infrastructure, beaches, and dunes in each community. In addition, retreat/relocation of structures would not provide adequate passable land for emergency vehicles to travel along all sections of beach in the project area during high tide, specifically sections of Davis Park, Saltaire, and Ocean Beach, thus potentially effecting emergency response.

Although there are some areas where structures on the beach block vehicular passage, such as the groins at Ocean Beach, there are others where the dune or natural features block vehicular passage, such as in Davis Park. Retreat/relocation of structures would therefore not meet the objective of providing for safe vehicular passage through all communities at all tides.

Groin Construction and/or Removal

Groins are hard structures constructed perpendicular to the shoreline to slow shoreline change. Groins extend from the back beach into the water at varying lengths. In the project area, there are two (2) groins present in Ocean Beach (Figure 3).

Construction of new groins does not meet objectives of the project sponsors, as it does not provide adequate storm protection on a community-wide scale. In addition, groins are hardened structures, and therefore permanent; the purpose of this project is to provide short-term storm protection to the communities.

Removal of the groins at Ocean Beach would benefit downdrift communities, which have been negatively impacted by the groins. However, removal of the groins will not meet the objectives of updrift communities east of Ocean Beach such as Seaview, Ocean Bay Park, Fire Island Pines, and Davis Park. The shoreline adjustment after groin removal will lead to the destruction of approximately half a dozen lots and houses behind and updrift of the groins, which is an issue that is not suitable for resolution in a short term project horizon. In addition, removal of groins is a permanent means of addressing erosion. During agency meetings with FIIS and project sponsors, it was stressed by FIIS staff that the communities may only seek a short-term storm protection plan until FIMP is completed and implemented. Removal of groins does not meet the objectives of short-term storm protection for the communities as required by FIIS. As such, removal of the groins was dismissed from consideration.

Concrete Breakwaters, Bulkheads, Seawalls

Breakwaters, bulkheads, and seawalls are hard structures constructed parallel to the shoreline to protect beach (breakwaters) and upland areas (bulkheads, seawalls) from wave action and erosion. There are no such structures in the project area.

As with groins above, construction of breakwaters, bulkheads, or seawalls does not meet the objectives of project sponsors for short-term storm protection, nor does it meet the objectives of the NPS/FIIS GMP. Hard structures such as these must be constructed along the entire length of communities to be effective on a community wide level, and are a permanent, rather than short-term, solution. Therefore, this alternative was dismissed.

Geotubes

Geotubes are installed parallel to the shoreline, typically against the toe of a dune, to protect upland areas from wave energy and erosion. There is currently a geotube between the groins in Ocean Beach and another on a private property in Seaview. Geotubes are essentially very large, hard sandbags, and are therefore considered a hardened, permanent structure. This does not meet the needs of either the communities for short-term storm protection, or the NPS/FIIS GMP. As such, geotubes were dismissed from consideration as an alternative.

Sandbags

Sandbags are typically installed as temporary emergency measures. Sandbags do not provide adequate protection on a community wide scale. They have been used on Fire Island on a case by case basis to ensure protection of individual structures or infrastructure, and will continue to be utilized as a temporary, emergency measure.

Flood Proofing

The USACOE evaluated a nonstructural plan of flood-proofing, raising structures, ring walls, and buyouts to protect structures on Fire Island and the mainland of Long Island (USACOE, 1999). Their analysis showed that nonstructural measures to provide protection for a 44-year frequency storm would require flood-proofing of greater than 9,500 structures, rising of over 3,600 buildings, and providing ring walls for an estimated 150 buildings, at a cost of $400-500 million. Since the 1999 USACOE evaluation, additional structures have been constructed and costs have increased, which would only raise the cost estimate provided in 1999. Due to the high cost of this alternative and the fact that flooding proofing does not meet the objectives of providing adequate beach width for recreation and vehicle traffic, flood proofing was dismissed from consideration.

2.9 Environmentally Preferred Alternative

It is required that the environmentally preferred alternative be identified in NEPA documents for public review and comment. The NPS, in accordance with the Department of the Interior policies contained in the Departmental Manual (516 DM 4.10) and the Council on Environmental Quality's (CEQ) NEPA's Forty Most Asked Questions, defines the environmentally preferred alternative (or alternatives) as the alternative that best promotes the national environmental policy expressed in NEPA (Section 101(b) (516 DM 4.10). In their Forty Most Asked Questions, CEQ further clarifies the identification of the environmentally preferred alternative, stating "Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources" (Q6a).

No Action is the environmentally preferred alternative, as it will not result in measurable impacts to natural resources. However, a catastrophic storm will likely result in major damage to structures and possibly human safety, since the entire Island lies within the 100 year flood plain. Therefore, even no action has negative environmental consequences since, during catastrophic storm events, no action will probably mean a loss of property and potentially even human life. Since the No Action alternative does not meet the needs of the the communities, it is not the socially preferred alternative.

As done in 2003, FIIS, with support of this environmental assessment and the data presented herein, therefore proposes to allow communities to develop plans for privately funded beach scraping, beach nourishment, and a combination of both, as a means to protect themselves from storm events until the Fire Island to Montauk Point Reformulation Plan for Storm Protection is completed. Plans will be reviewed by Fire Island National Seashore along with the appropriate Federal, State, and local permits, and Special Use Permits for work inside Fire Island National Seashore will be issued when all conditions have been met.

Of the action alternatives, beach scraping (2.2) appears to have the least impact, while beach nourishment (preferred nourishment alternative is 2.5) or combination (2.7) projects are anticipated to have minor to moderate effects (some negative and others positive) extending beyond the year of nourishment. It is well documented in literature that the effects of sand nourishment are temporary, recovering usually within 12 months, and that the benefits derived from such activities are also short term, since the geomorphologic dynamic balance of the barrier island system is not being overcome. The long term viability of beach nourishment placed into the intertidal zone and allowed to adhere to vegetated dunes has not been fully studied, but the Cherry Grove situation points to this as a possible way to build more durable and resilient dunes. Since beach scraping and beach nourishment clearly serve different functions (scraping for beach maintenance and beach nourishment) they are designed to be used under different conditions. Alternative 2.7 provides FIIS with the flexibility to consider both of these methods as the communities apply for Special Use Permits and NPS/FIIS reviews each application, applying these new criteria and restrictions to these activities. For this reason, Alternative 2.7, Combination of Beach Scraping and Beach Nourishment, is believed to provide the best balance for FIIS to protect the environment and provide for private community storm damage protection.

2.10 Comparison of Alternatives

Table 7 provides a summary comparison of all alternatives presented in Chapter 2. Alternatives were compared for proposed volume, rate of sand placement, duration of project, and project objectives such as protection of communities, emergency response/evacuation, and recreational opportunities.

Table 7. Summary of alternatives presented in Chapter 2.

Alternative	Description	Volume Proposed (cy)	Rate of Sand Placement (cy/lf)	Duration of Project	Protection Level for Structure, Infrastructure (yr-storm)	Provide Emergency Response/Evacuation	Enhance Recreational Opportunities
2.1	No Action	0	0	n/a	< 5-yr storm	Areas too narrow for emergency response to remain unchanged.	Recreation will not be enhanced.
2.2	Beach Scraping	n/a*	2.2 cy/lf*	1 year	1-yr storm (protection w/existing beach)	n/a**	n/a**
2.3	Beach Nourishment: 2003 Permitted Conditions	2,100,000	78-90 cy/lf	6 years	10-yr storm	5-6 years (life of project)	5-6 years (life of project)
2.4	Beach Nourishment: Modified Conditions with Combination Template and Tapers on Federal Property	1,875,000	69-75 cy/lf	6 years	10-yr storm	5-6 years (life of project)	5-6 years (life of project)
2.5	Beach Nourishment: Modified Conditions with Combination Template, No Tapers on Federal Property	1,875,000	69-75 cy/lf	6 years	10-yr storm	5-6 years (life of project)	5-6 years (life of project)
2.6	Beach Nourishment: 2008 Dune Crest Line	1,176,000	32-75 cy/lf	3-4 Years	5-yr storm	3-4 Years	3-4 Years
2.7	Combination of Beach Nourishment (2.5) and Beach Scraping (2.2)	1,875,000	69-75 cy/lf	6 years	10-yr storm	5-6 years (life of project)	5-6 years (life of project)

* transfer of sand from beach to dune; no new sand proposed within the system
** beach must be of adequate width and height to allow scraping; will have no impact on emergency response or recreation

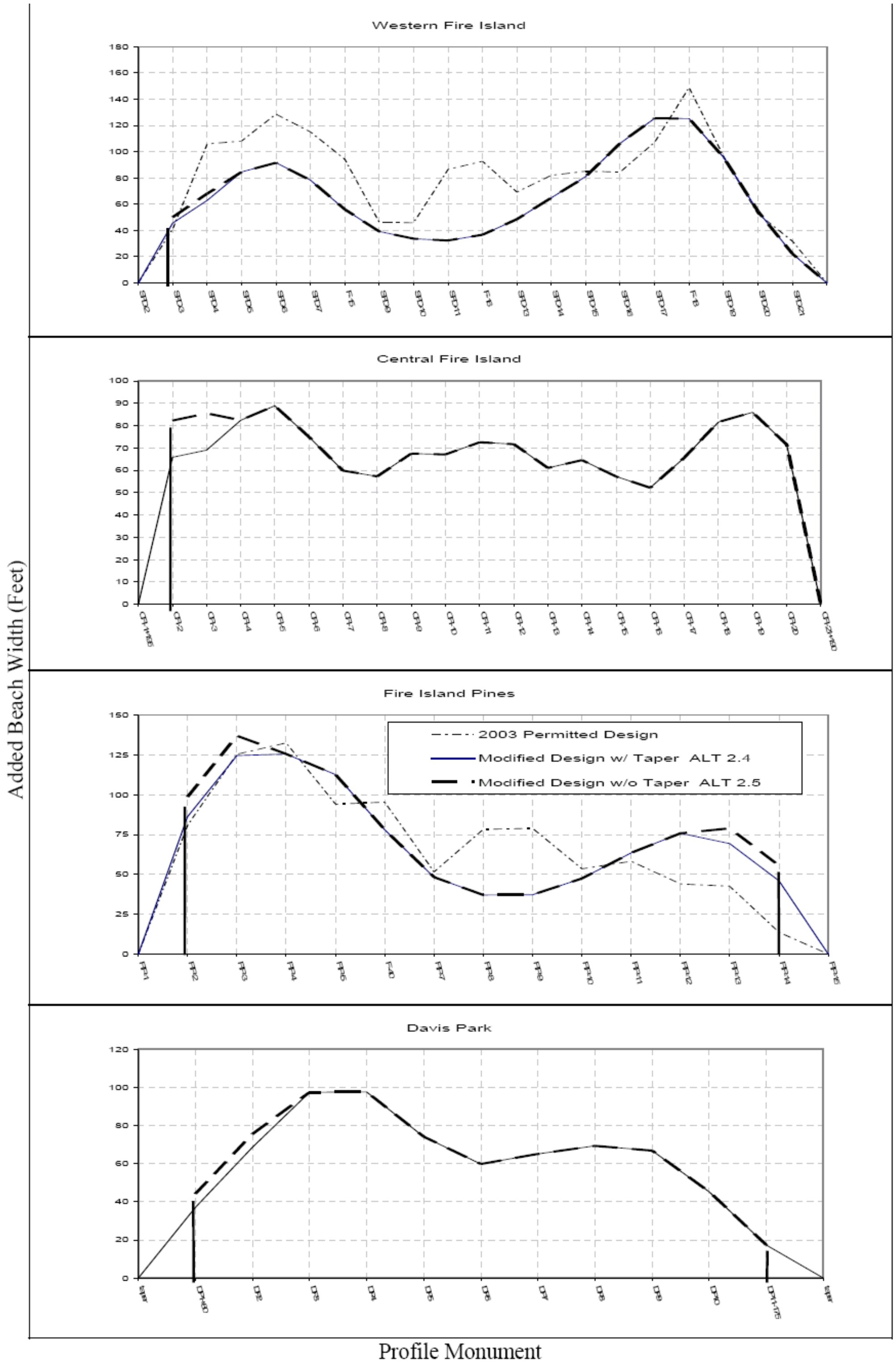
In addition to the comparison of all alternatives, the beach nourishment alternatives were compared to provide the reader with a visual interpretation of each. On a site plan view, beach nourishment alternatives vary in the amount and distribution of sand allowed along shore, and the use of taper section(s) onto Federal property (Figure 7). Beach nourishment alternatives 2.3, 2.5, and 2.6 do not have tapers on Federal property, but may include tapers on adjacent non-Federal property. Alternates 2.4, 2.5, and 2.6 include modifications to the 2003 permit conditions, generally in the distribution of fill placement with minor changes in volume. Alternative 2.6 is based on the new dune centerline published by Dr. Psuty in April 2008 and is not shown. A comparison of volumes for each reach of each nourishment alternative is provided in Table 8, which shows that alternatives considered are either smaller than or equal in size to the 2003 project constructed in Western Fire Island and Fire Island Pines.

Table 8. Comparison of alternative fill volumes compared to the 2003 project.

Reach	Alt. 2.3	Alt. 2.4, 2.5
Western	654,000 cy	500,000 cy
Central		570,000 cy
FI Pines	500,000 cy	500,000 cy
Davis Park		305,000 cy

For alternatives without taper sections, tapers will be truncated at the border with Federal property, as illustrated in the schematic drawings comparing the alternative added beach widths shown in Figure 7 below.

Figure 7. Comparison of beach width for each nourishment alternative.



Comparison of NPS and USACOE Nourishment Templates

Standard beach fill templates have been developed by NPS and the USACOE (for FIMP) for beach nourishment projects on Fire Island (Figure 8). The USACOE has developed both an interim and comprehensive project profile. It is a FIIS objective that any interim or short term project be smaller than the comprehensive project. The guidance was changed with the introduction and suggested use of Dr. Psuty's dune center line and beach profile in 2003. Guidance received on June 20, 2008 indicated a preference for the FIMP dune profile with a 15 ft NGVD (13.9 ft NAVD) elevation. As describe below, the profiles differ in dune height, dune and berm slopes, berm width and start point.

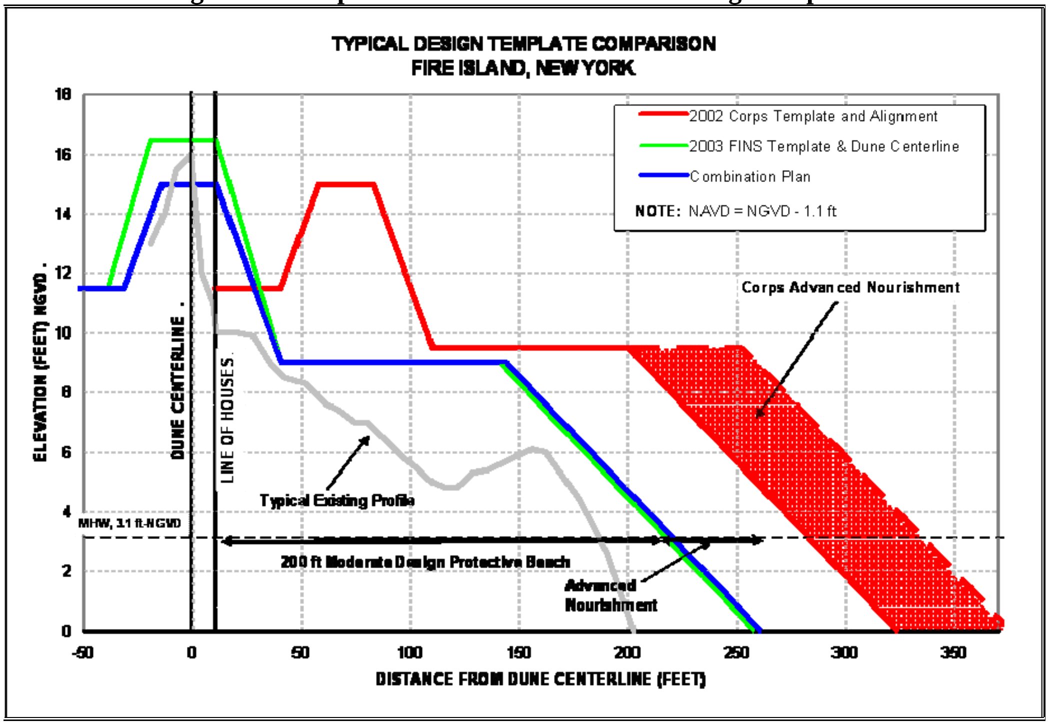
The 2003 Fire Island community project utilized the following cross-section developed by the FIIS geomorphology consultant. This template was taken from the 2003 EA (NPS, 2003).

> <u>*NPS Template*</u>: Dune template to be constructed with a 30 feet wide crest at 16.5 ft NGVD (15.4 ft NAVD). This 30 feet will extend 15' seaward and landward of the central dune crest line ~ OR - where no dune is present the dune crest line will be located by following the trend of the adjacent (east and west) dune crest lines. The inland slope of 1:4 will extend to the position of the natural grade. The beach is always measured from the seaward toe of the dune. From that seaward of an existing dune that is already 30 feet wide at the crest at 16.5 feet NGVD, and sloping seaward to the beach at 9.0 ft NGVD (7.9 ft NAVD), the allowable beach width will be 100 feet at 9.0 ft NGVD plus a 1:15 slope down to 0 ft NGVD which will equal 135 feet for a total of 235 feet from the seaward dune toe down to 0 feet NGVD. This method does not use the location of existing houses nor the local erosion rate as a basis of design. The template is the adjusted profile.

The USACOE developed a second cross-section, which is similar in shape but different in implementation, as described below:

> <u>*USACOE Design Cross-section*</u>: It has a similar shape to the above, but differs in its implementation. The Corps cross-section has a dune width of 25 ft at elevation 15 ft NGVD, and seaward and landward dune slopes of 1:5. In the original formulation, the landward toe of dune has a buffer area from existing development required by the State of New York for access to the back of the dune. The beach berm is 90 ft long to the seaward berm crest with an elevation of 9.5 ft NGVD (8.4 ft NAVD), from which the dune slope descends at 1V:15H slope to -2.25 NGVD. Higher dune elevations are proposed for levels or protection greater than 44-year storm. The Corps has varied this start point to incorporate the existing size of the protective dune and beach width, so that in combination with the design cross-section it achieves the desired level of protection. The Corps is considering other alternatives with different landward start points, requiring the acquisition and removal of selected houses. It appears that the removal of a few houses may be economically justified.

Figure 8. Comparison of beach nourishment design templates.



The 2003 community project used the beach profile developed by Dr. Psuty and described in the 2003 EA (NPS, 2003). This profile, which includes a 16.5' dune elevation, was the required design standard for the project. As a result of the 2006 scoping meeting, the 2008 project was considering the 2003 EA standard to the greatest degree feasible. The project is sized smaller than the USACOE standard. The USACOE standard described here is based on earlier FIMP studies (1999, 2002) and updated based on conversations with the USACOE NY District. The actual USACOE's alternatives have not been publically released, and therefore a direct comparison is not feasible. The communities' goal is to use the NPS prescribed template to the maximum degree feasible for some of the considered alternatives, but with positional modifications.

One of the most striking differences between the NPS template and the FIMP (USACOE) template, besides starting point, is advanced nourishment (Figure 8). Based on interpretations in 2003 provided by FIIS staff and consultants, the NPS template has no provisions for advanced nourishment, while the USACOE template places advanced nourishment seaward of the berm face. Advanced nourishment is a quantity of sand expected to erode during the project life. The NPS template cannot be considered an engineered design without a consideration for local erosion rates.

The NPS cross section is too small or landward to be universally applied, and will not provide years of protection in all areas. In previous Fire Island designs by Coastal Planning & Engineering, a protective two hundred foot beach width from the line of houses to the mean high water (MHW) line was found to offer a moderate level of protection (CPE 2002). This beach width was provided with 5-6 years of advanced nourishment. Dune crests with 15-17 foot elevations were placed where they could fit seaward or tangent with existing line of houses. This method explicitly protects the houses and provides advanced nourishment proportional to the local erosion rate, creating a design that will endure for the project life of 5-6 years. It provides an indication where protection may be inadequate using the NPS template method, and was used as a basis of modifying a few cross sections in Fire Island Pines and Western Fire Island. The 200 ft design was the start for design considerations for Davis Park and the Central Fire Island reaches.

The NPS template has a width of 235 feet from the seaward dune toe to the 0 ft NGVD (-1.1 ft NAVD) contour. In the plan and profile drawings of the projects, the width of fill exceeds this distance by a substantial amount, for two reasons. First, since it accounts for the underwater portion of the profile, which can extend to depths up to -12 feet, adding more than 120 feet to the profile length. The full dune with frontal slope will add another 60 feet. The total width including the entire dune width of 30 feet to -12 feet underwater will cover a width of 415 feet. This width will vary at each cross-section to accommodate unique local features. Secondly, the plans show the construction width, which will decrease substantial as the profile equilibrates. The NPS and FIMP profiles are equilibrated. The 2003 permit defined the template with a dune crest line established based on aerial photograph and Lidar surveys in 2000. This line has been updated for 2008 using 2005 aerial photographs. Figure 8 shows a comparison between the templates, illustrating that the NPS template and the 200' standard has a seaward projection smaller than the USACOE plan, a prerequisite for a project set by FIIS in 2002. The communities need flexibility to vary the width alongshore in proportion to the local erosion rate and advanced nourishment requirements.

A composite plan is being used for the preferred alternative. It is a combination of the 15 ft FIMP dune and the 9 ft NGVD NPS berm as illustrated in Figure 8. The goal is to use the FIMP/NPS composite template to the maximum degree feasible for some of the considered alternatives, but with positional modifications.

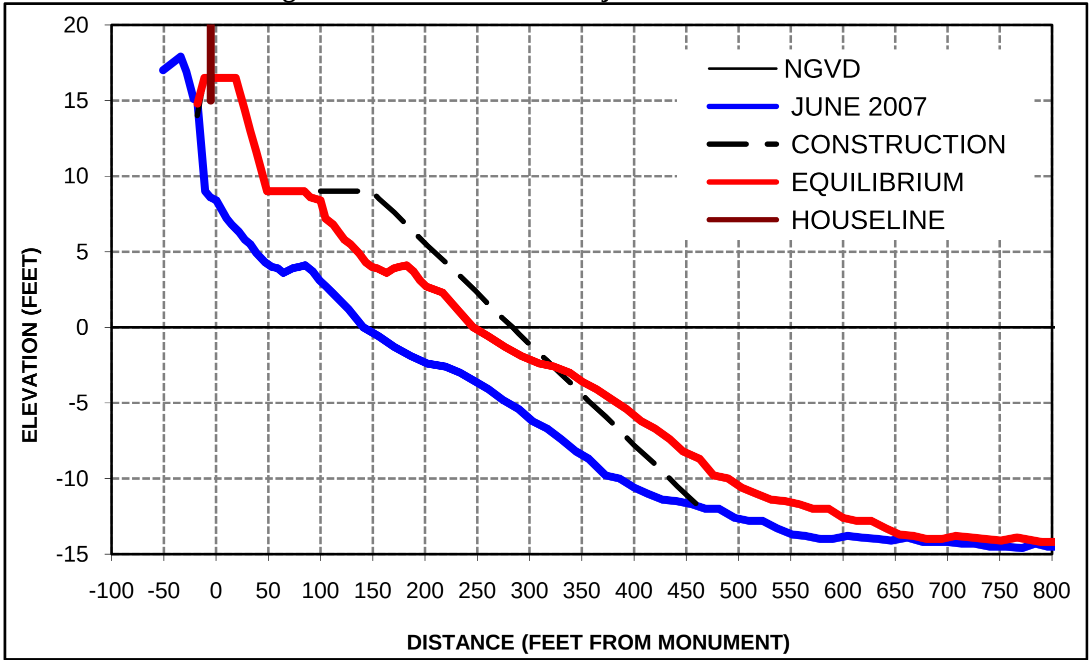
Design Methods and Consideration

The volume of sand needed to provide 6 year design life requires more than the simple replacement of the background erosion. An understanding of beach design methods and considerations is necessary to evaluate the beach nourishment alternatives presented in this document and understand the role of design templates in that process. Beach design has matured in the last 30 years, and is able to predict beach performance using basic coastal process data and design procedures (Houston, 1996; USACOE CEM, 2002). Essential to an effective design is knowledge of the local erosion rate, sand grain size, and wave climate.

Design accounts for more than historic (background) losses. Recent physical monitoring results combined with historical information illustrate this point. The long-term erosion rate within the developed communities of Fire Island is approximately 98,000 cy/yr (75,000 m^3/yr) from 1955-2007, after adjustment for fill placed. Recent erosion rates for the Fire Island Pines and Western Fire Island project areas were 76,000 cy/yr (1997-2007) and 55,000 cy/yr (1994-2007) respectively (CPE 2001, 2004, 2007). Loss rates since the latest nourishment in 2003 are double the rates for the previous beach nourishments in the 1990s. This is partially explained by impacts of recent storms, the reduced use of tapers in the 2003 project, and the younger age of the project when measured. Losses are higher during the early years for a project.

The art of design is to predict these erosion rates ahead of time, so that the design can meet its objective to maintain a given beach width or location for a designated project life. The method described in the 2003 NPS EA makes no allowance for advanced nourishment; therefore the design objective for the 2008 proposed nourishment project is the FIMP/NPS template defined in the 2003 EA after initial adjustment of the constructed beach profile. The constructed beach will adjust after construction to its equilibrium shape as illustrated in Figure 9.

Figure 9. Construction vs. Adjusted Beach Profile



Under normal design methods, losses through the project life are calculated and placed in front of the design beach. This advanced nourishment can be placed proportionally to the local erosion rate at specific points along the beach. The design beach is the location that will be maintained to achieve the project objective, normally a measure of beach width needed to protect upland structures or other desired resources. The normal components of a design are the design volume, advanced nourishment volume, diffusion volume (to account of alongshore spreading of the fill), and various adjustments to account for construction losses such as bulking factor of fill sand and mitigation for difference in the borrow and beach mean grain size (overfill). Diffusion is often incorporated into the advanced nourishment volume.

The design volume is the amount of sand needed to bring the profile to the beach width objective, and advanced nourishment and diffusion is what is needed to hold it there for the project life of 5-6 years. In the case of the 2003 EA standards, the initial adjustment and initial losses due to bulking factor, new equilibrium adjustment and other losses are needed for the design. The proposed projects are using a combination of both design methods, so as to define a design life and objective within the 2003 EA standard.

Diffusion can be partially mitigated by the use of taper sections on the fill, and the impact of diffusion increases as the fill length gets smaller. If the entire length of the developed communities were nourished, the diffusion volume would be negligible. Diffusion for the proposed projects with a 6 year life is approximately 64% of the advanced nourishment volume (CPE 2002). The bulking factor of sand removed from the borrow area is normal 10% to 20%, meaning that the sand expands when it is taken out of the borrow area, thereby reducing the actual amount of sand removed from the borrow area for a given amount on the beach volume.

The bulking advantage is lost if the new fill re-consolidates during adjustment. Other losses will contribute to a decrease in the amount of sand that will be on the beach after profile adjustment occurs (Figure 9).

Based on recent monitoring, Western Fire Island and Fire Island Pines will need a minimum of 6 times the measured erosion rate to last for the project life, or 425,600 cy and 456,000 cy respectively, or up to double this amount if the erosion measured since 2004 persists. This does not include the design fill needed to reestablish the dunes and beach width indicated by the template nor the adjustment to the fill volume caused by bulking or other construction related losses. These two communities are traditionally Fire Island hot spots with the largest natural erosion rates. The effective advanced nourishment plus diffusion volume is lower for Central Fire Island and Davis Park; they were not measured from monitoring results, but calculated by other means.

CHAPTER 3—Affected Environment

3.1 Geology

3.1.1 Coastal Geological Framework

Summary

There are numerous environmental issues related to coastal protection, particularly barrier island stabilization and shoreline maintenance (Psuty *et al*., 2005). Almost all human activities have some sort of environmental impact; some actions have disastrous consequences while others are generally benign. Beach nourishment, the shore protection method of choice around the world (Finkl & Walker, 2005), is commonly accepted as the most environmentally friendly method of shore protection because impacts to offshore borrow areas and beaches are minimal (Finkl, 2005).

The purpose of the following section is to address possible concerns of beach nourishment and maintenance on the integrity of the natural coastal (eco) systems on Fire Island National Seashore, Long Island, New York, especially within the developed communities. Concerns focus on the coastal geological framework and morphodynamic processes that are important to the comprehension of dynamic processes, as described in part by Allen and Psuty (1987) and Tanski (2007), that are related to island stability/instability (*e.g*., shore erosion, littoral drift and alongshore sediment transport, subsidence, relative sea-level rise) and acquisition of beach-quality sand from offshore ridge fields on the continental shelf. Various relevant topics considered here include brief summaries of the coastal geology and geomorphology, coastal evolution in relation to tectonics and eustasy, provenance and transport of marine sediments on the continental shelf, an analysis of sand ridges and their sediment volumes, and recent shoreline and volume changes.

Introduction

Shore erosion along the developed communities on Fire Island National Seashore, Long Island, New York, has been the subject of concern over whether to let nature take its course or to allow human intervention in the form of beach nourishment to stabilize the shore. In an attempt to address potential impact of natural systems, shoreline changes are quantified and the coastal geology of onshore and offshore areas is briefly summarized in terms of sediment transport and potential sand resources on the continental shelf.

In a paper titled “The origin, classification and modeling of sand banks and ridges” Dyer and Huntley (1999) have divided the major geologic influences into periods. The first period refers to post-glacial rise in sea level, *i.e.* that period of rapid sea-level rise after the peak of the last glacial maximum about 18,000 years ago. Once sea-level rise slowed down (5,000 to 3,500 years ago), coastal configuration became locally controlled by hydrodynamic forces of waves, currents and tides. In recent years, this hydrodynamic phase may have been modulated by human action on the coastline that slowed down or dominated some of the major hydrodynamic forces.

Historically, Fire Island was influenced by sand from off- and along-shore, but in recent decades the influence has changed as a result of impacts of human action and coastal processes entering a different morphodynamic stage. Recent geology of Fire Island and the south shore of Long Island was shaped by influences that have occurred since the last glaciation. In addition, the influences pertinent to the developed communities on Fire Island need to be viewed in a context that separates long-term general coastal-marine processes along Long Island from specific near-term time frames. The long-term geologic processes, although important to the current shape of the island, are less important for determining future actions.

Many of the policy discussions that are directed towards Fire Island and specifically the developed communities on Fire Island incorporate older island-forming geological processes that today are not relevant to near-term Fire Island coastal processes. In addition, not all coastal processes are significant in today's geomorphology. Facts pertinent to management of Fire Island today and in the future can be divided into two categories as illustrated below in Table 9. Column A consists of those perspectives that may be too old, too broad an area, insignificant or with insufficient resolution to draw any pertinent conclusion(s). Our ability to resolve coastal processes has been improved by higher resolution surveys (sled with GPS-RTK or LIDAR) and/or more accurate aerial photographs. What is pertinent to the Fire Island community nourishment project must be significant, recent, hydrodynamic and based on good resolution data. The recent rate of sea level rise has not risen to the historic post-glacial magnitude where it is the primary shaper of the geomorphology. It is still the smaller influence in this era where hydrodynamics (waves and currents) dominate. Put another way, the source of beach sand in the post-glacial or even the early hydrodynamic period may not be pertinent for sand management today or in the future a century out. The degree that coastal processes are changing in the hydrodynamic era is unresolved and still being defined by coastal studies.

Table 9. Perceptions and points of view that affect interpretation of coastal morphodynamics and their status relevant to management scenarios.

Long-term, Large Scale, Geologic Origins		Short-term, Small Scale, Present Day
Millennial time frames		Decadal time frames
Long Island at large (island scale)		Western Fire Island (community scale)
General morphodynamic processes Sand shoals/ridges Create Post-glacial sea level rise	Vs	Specific morphodynamic processes Maintain Hydrodynamic
Resolution poor		Resolution good

Coastal Geological Framework

Long Island and adjacent continental shelf areas occur within the northern extension of a large physiographic province referred to as the Atlantic and Gulf Coastal Province. This physiographic unit incorporates a large suboceanic (continental shelf) area in addition to its subaerial (terrestrial) segment. The subaerial portion, usually referred to as the Coastal Plain, extends from Long Island in New York (with outliers in Martha's Vineyard and Cape Cod) to the Mexican border in Texas (Walker & Coleman, 1987). Structurally, the coastal plain is bordered seaward from Long Island by a shallowly buried (crustal) platform referred to as the Long Island Platform (Hutchinson *et al.*, 1986; Uchupi *et al.*, 2001), which subtends the continental shelf. The coastal geomorphology of Long Island and adjacent shelf area, summarized by Psuty *et al.*, (2005), pertains to inherited glacial and glaciofluvial landforms on the island *per se* and as drowned features on the continental shelf. These subaerial and submarine landforms have been modified to various extents by human action and have been the subject of debate when associated with dune building and beach nourishment.

Long Island is the longest island (190 km) in the United States (Fisher, 1985); its basic shape and coastal outline are the result of continental glacial deposits such as ice-contact moraines and glaciofluvial outwash (sandur) plains. Outwash plains, with gently undulating topography, are broad, tabular landforms of similar materials deposited beyond rapidly melting glacier fronts. On occasion, outwash plains are pitted by kettle holes, depressions formed by melting remnant ice. Extending east from the Narrows (water gap between Brooklyn and Staten Island, which serves as the entrance to New York Harbor), the Harbor Hill end moraine divides the island with the ground moraine to the north and the outwash plain to the south. This moraine separates into a recessional moraine extending to Orient Point (eastern tip of Long Island's north fork). The southernmost and older Ronkonkoma terminal moraine extends to the Montauk Point sea cliffs. These moraines are responsible for the two peninsulas, north and south of Great Peconic Bay, at the eastern end of Long Island.

The master feature of the topography of Long Island is a glacial outwash plain that slopes southward from an elevation of 60 m at the north shore (southern shore of Long Island Sound) and occupies the entire width of the island (Fenneman, 1938; Gayes & Bokuniewicz, 1991). The plain contains some boulder clay interbedded with the glaciofluvial outwash as well as kettle holes. Glaciofluvial outwash deltas and sand sheets associated with the moraines underlie the coast and continental shelf (Williams & Meisburger, 1987; Schwab *et al*., 2000). The coast from Southampton to Montauk Point, where the Ronkonkoma moraine and associated outwash sediment are eroded directly by wave action (Williams, 1976), is a cliffed headland region that supplies sediment to the littoral drift system. The south shore west of Southampton (fronting the eastern margin of the New York Bight) contains reworked glaciofluvial outwash but also includes shallow back-barrier bays, marshes, and low-relief sandy (fine to medium-grained sand) barrier islands (Psuty *et al*., 2005).

Coastal Evolution, Tectonics, and Sea-Level Change

The major part of the volume of the island is ascribed to late glacial (Wisconsinan) till (diamictite) and outwash, mainly the latter. Even in the morainic ridges the proportion of till is small. Prominent barrier islands, from Coney Island to Fire Island, make up Long Island's south shore, backed by large bays with tidal marsh islands (Fisher, 1985). Outwash plain sands submerged by a rising sea level are the source material for these barrier islands, although marine erosion of the Montauk sea cliffs provides additional sediment (Williams & Meisburger, 1987). As far as Holocene coastal evolution is concerned, Fairbridge (1992) classifies Long Island coastal areas as a 'Subsiding Forebulge with Sedimentary Sequences." This coastal sector, with a wide continental shelf and great interplay between post-glacial isostatic recovery and marginal forebulge collapse, corresponds to the climate belt of the *east-coast westerlies*. Holocene submergence, according to Fairbridge (1992), seems to be controlled initially by the subsiding forebulge; later, the mean sea-level rise appears to be influenced more by a secular weakening of the Gulf Stream. The area is an example of a youthfully drowned coast, the tectonic submergence of which continues today.

From their analysis of drowned coastal features (subaerial morphosedimentary features on the coastal plain that was submerged to become the present continental shelf), Gays and Bokuniewicz (1991) report that unraveling sea-level curves for the Long Island area are complicated along the southern terminus of the Wisconsinan glacial maximum due to the proximity of a collapsing peripheral forebulge and sediment loading effects (see also Fairbridge, 1992). Features preserved on the open shelf probably record only relatively major changes in sea level or sediment supply during Holocene sea-level change. The average or typical depth to the base of the erosive shoreface off the east coast of the U.S. is about 10 m (Niedoroda *et al*., 1984,

1985) and about 13.5 m for the south shore of Long Island (Zimmerman, 1983). The deeper depth of closure south of Long Island would theoretically allow greater preservation of sedimentary records of Holocene relative sea-level change and coastal evolution.

Earlier barrier islands may have existed offshore before drowning by the Holocene sea-level rise (Sanders & Kumar, 1975). Reflecting a submerged ground moraine, the western half of Long Island's north shore (south shore of Long Island Sound) is highly embayed. If the glacial materials were removed from Long Island, its area would probably be not much more than one-fourth what it is now (Thornbury, 1965). On the southeastern shore of Long Island, Leatherman & Allen (1985) report that the numerous relict flood-tidal deltas occurring east of Watch Hill, as well as outcrops of tidal-marsh sediments on the upper shoreface, provide evidence of landward migration of the eastern portion of the barrier-island system. Most of Fire Island to the west of Watch Hill, on the other hand, shows *in situ* submergence over the last thousand years, according to Sanders & Kumar (1985) and Leatherman & Allen (1985). Tanski (2007) summarizes what has been reported by many others on the movement of what are largely the developed communities on Fire Island as follows: "Geologic evidence indicates that the central portion of Fire Island between Ocean Beach and Watch Hill has not migrated for the last 750 to 1,300 years. This section of the island has experienced erosion on the ocean and bay shorelines, but the position of the island has remained in the same location. Interestingly, there is no evidence of historic inlets in this area over the last several centuries".

Sediments on the Continental Shelf

Sediments on the continental shelf off southern Long Island consist of sand-sized particles with 80% of the grains occurring between 0.062 mm and 2.0 mm. The New England-New York 715 mile (1150 km) long coast is unique in being the only marine United States coast influenced by continental glaciations (Fisher, 1985). New York's embayed and barrier islands (Coney Island, Fire Island, Jones Island, *etc*.) coastline is about 124 miles (200 km) in length. Unconsolidated Pleistocene glacial deposits, primarily Wisconsinan in age (late Pleistocene), influence southern coastlines.

Basement rocks beneath Long Island and the Long Island Platform consist of Paleozoic gneisses and schists intruded by pegmatites and granites. Cretaceous formations rest on the basement rocks and form the core of the island (Thornbury, 1965). These upper Cretaceous strata are unconformably overlain by Pleistocene sediments south of Long Island on the continental shelf with no preservation of Tertiary sedimentary units (Williams, 1976). This regional unconformity, identified by Emery & Uchupi (1965, 1984), is reported to have been initially created during the mid-Oligocene and correlates with the Atlantic Coastal Plain Reflector of Paog (1978). Repeated emergence and submergence (mostly due to the interplay of eustatism, tectonics and climate in the late Quaternary) of the continental shelf led to dissection of the Cretaceous strata and Quaternary section by subaerial fluvial incision and shoreface ravinement during the Holocene transgression. These combined processes resulted in the stratigraphic placement of Wisconsinan glacial outwash plain and modern barrier island complexes unconformably over a sequence of pre-Wisconsinan Pleistocene glaciofluvial and shallow marine units (Suter *et al*., 1949; Oldale and Coleman, 1992). These processes have left a lithologically complex Quaternary stratigraphic record that contains age-mixed deposits that resulted from similar physical processes but differed widely in time of formation.

The Long Island Platform south of Long Island is the source of the additional sediment to the coastal sand budget, as described by Williams & Meisburger (1987) from a study of seismic reflection profiles and cores. Their work, using glauconite[i] as a natural tracer of sediment transport under present oceanographic conditions (and probably throughout the Holocene transgression), shows that the inner continental shelf has been an important source of sediment for the Long Island barrier beaches. Glauconite is an important mineralogical tracer, as applied by Williams & Meisburger (1987) in this region, because the relatively thin Pleistocene glacial outwash deposits rest on top of coastal plain cuestas[ii] that contain Cretaceous glauconitic sands, which subcrop at about -25 m. Using coastal sediment budgets of record, McCormick & Toscano (1981) compared present offshore bathymetry with projected Pleistocene outwash slopes and found that the modern continental shelf surface exhibits evidence of erosion (which could entrain glauconitic sands on cuestas) in 50% of the studied cross-shore transects. They thus concluded that landward transport of sand is an important process that maintains the Long Island barriers.

Modern sediments lie unconformably on top of the Pleistocene glaciofluvial and early Holocene estuarine deposits, as reported by Foster *et al*., (1999). Schwab *et al*., (1999, 2000) interpret this unconformity as a Holocene ravinement[iii] surface where 'modern sediment' lies above the time-transgressive Holocene ravinement surface. Where they occur in sufficient thickness, these modern sediments are organized into a series of sand ridges up to 20 km offshore (Duane *et al*., 1972; Hayes & Nairn, 2003). The sand ridges are oriented at angles of 30°– 40° to the shoreline west of the Watch Hill area. Allen & Psuty (1987) report that these sand ridges are attached, or occur in close proximity to, a well-developed nearshore bar system found off Fire Island in water depths less than 8 m. Sand ridges, up to 5 m thick immediately west of the outcropping Cretaceous strata off Watch Hill, become progressively thinner westward until they are about 1 m thick offshore the Fire Island inlet. Grab samples and vibracores show that these contain very well to moderately sorted, medium- to very fine-grained sand; mean grain sizes range from 1.0 to 3.5 phi (0.50 to 0.09 mm) with S.D. (standard deviations) falling between 0.34 and 0.91 (Schwab *et al*., 2000). Sand ridges, up to 3 m in thickness, also occur east of Watch Hill, but they are located seaward of the 18-m isobath and are thus not attached to the shoreface.

On-Shore Sand Movement

Although prior research suggests or concludes that there is an onshore migration of sediments for Fire Island beaches (*e.g*., Kana, 1995; Leatherman, 1985; Taney, 1961a; Taney 1961b; Williams & Morgan, 1993; Williams & Meisburger, 1987), when and how these sediments migrated to the beaches remains problematic. There are indicators supporting both the onshore and offshore sand transport scenarios for Fire Island, but taken in aggegreage, they are not yet conclusive about the current situation. As a counter point to the traditional geologic view of Fire Island presented above, the following indicators are provided.

Numerous publications (Schwab *et al*., 2000; Williams & Morgan, 1993) misinterpret Williams & Meisburger (1987) by stating that specific marine sediments are found on Fire Island. Although Williams & Miesburger (1987) conclude that significant additions of sediments to the entire Long Island coast come from offshore, their data indicate that only beaches west of Jones Beach contain glauconite, a phyllosilicate mineral with a marine origin, which was the basis of their statement. The Williams & Meisburger (1987) study uses glauconite as evidence of onshore sediment transport. Because Jones Beach lies downdrift of Fire Island, onshore migration of sediments to Fire Island beaches may not be proven. Further research by Williams & Morgan (1993) link specific onshore quartz sand grain surface textures to areas of offshore sediments. However, Williams & Morgan (1993) do not specify whether the sediment source is onshore or offshore and do not differentiate between migration of sediments during the Holocene transgression and recent migrations of sediments. While onshore migration of sediments may have occurred over the past 6,000 years contributing to the building of Fire Island, prior studies have not shown their current significance.

Some recent studies indicate that the onshore sand supply to Fire Island may be less important today than in the early stages of the hydrodynamic period. A bathymetric map of the ocean adjacent to Fire Island is shown below (Figure 10). A comparison of the -20 foot (orange) and -35 foot (red) contours show that the former is not influenced by the offshore ridges while the latter shows some ridge influence (Figure 10). The active profile for Fire Island runs from the toe of dune at approximately +8.1 feet NAVD (+9 feet NGVD) to -18 to -27 ft NAVD, the latter ranges being the closure depth [Batten 2003, USA Engineering Research Center (USAERC) 2008, CPE 2004]. Closure depth is “the water depth beyond which repetitive profiles or topographic surveys do not detect vertical sea bed changes, generally considered the seaward limit of littoral transport (USACOE, 2006). Their influence of the ridges appears to halt before the active profile region.

The map in Figure 10 was created with the same NOAA bathymetry and procedures discussed with Figure 15. Although historic bathymetric data may not be dense or accurate enough for some engineering and geological work, it can be sufficient for a study of nearshore influences at the scale shown in Figure 10, especially when supplemented with accurate profile survey data that confirms the lack of influence out to the -27 foot contour and beyond, shown in Figure 11 and in USAERC (2008).

The depth of closure is often confused with the point of profile interception measured after a storm. Panama City Beach, FL and Fire Island, NY have similar big barred coastal profiles with similar big storm responses (Keehn and Pierro 2003). In response to Hurricanes Opal and Ivan, the large bar at Panama City Beach was sheared off at it base, and the sand scattered out to a depth of -40 to -50 feet NGVD. A study of monitoring profiles (1995-2007) indicates that partial recovery took approximately 4 years, but it was never complete. The same has occurred on Fire Island, but pre-storm surveys from the early 1990s were non-existent. Monitoring in the Western Fire Island reach between 1993 and 2002 indicated that post–storm recovery from the 1991-3 storms took until approximately 1996. Again, only partial recovery occurred, with the unaccounted for sand probably lost offshore (Keehn and Pierro 2003).

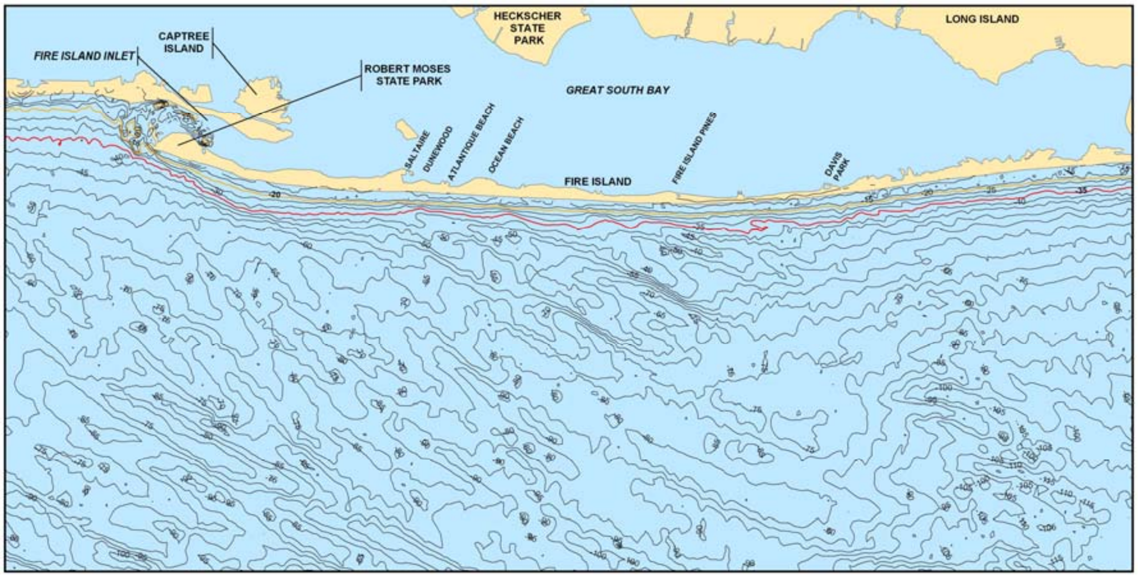


Figure 10: Ocean bathymetry adjacent to Fire Island with the -20 foot (orange) and -35 foot (red) contours highlighted. Note the size of influence at Saltaire in western Fire Island (Created by CPE 2008).

Figure 11 shows four average profiles for Western Fire Island, which includes Saltaire for the 1996-2007 period. The profiles are the average of 17 surveyed profiles using a sea sled controlled with GPS-RTK system. A sled survey using GPS-RTK is the most accurate for measuring beach profiles. Western Fire Island has been surveyed using the sled since 1996. This series of profiles covers the period of the 2003 nourishment of Western Fire Island. Average profiles smooth out perturbations due to along- and cross-shore natural variability among profiles, preserving the signal that shows important trends or processes. The profile illustrates the movement of sand offshore, but there is no indication of the ridges shown in the above figures or the on-shore movement of sand. Between 1996 and 2006, a build-up of the profile is shown down to the -20 foot contour, which would be the closure depth for this period.

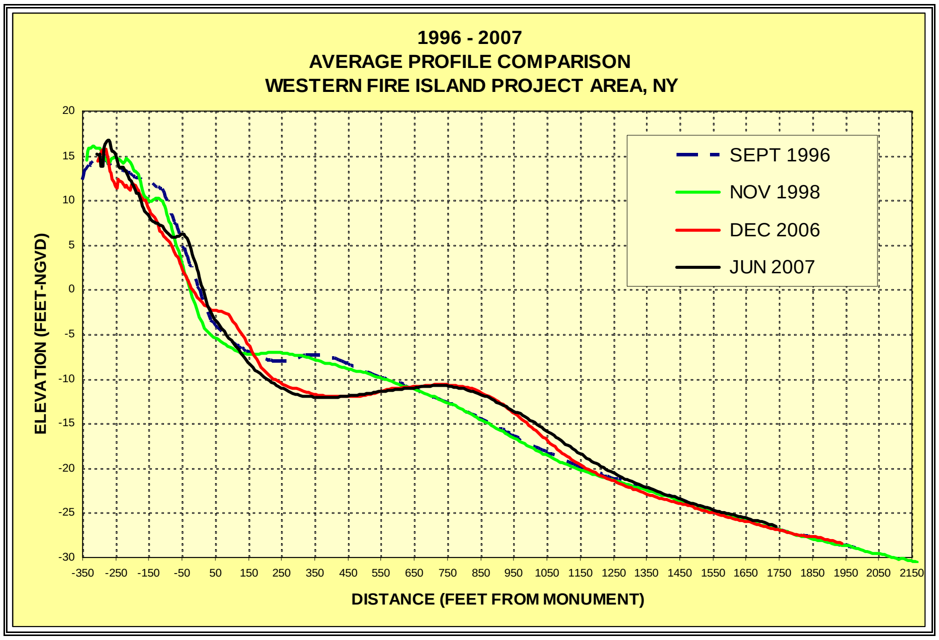


Figure 11: Western Fire Island Average Profile Comparison 1996 - 2007

The 2007 survey reflects the impact of the April 2007 storm, which shows a build-up of the profile down to -27 feet. Average profile at Western Fire Island shows a gain of 100,000 cy between 1996 and 2007, which is in the volume change seaward of the -18 foot contour. This volume is proportional to the adjustment expected for the 2003 nourishment project, and indicates offshore sand movement. Beach monitoring conducted between 1994 and 2007 for Fire Island Pines and Western Fire Island indicates a strong offshore loss component to the nourishment project, and no moderation for sand moving off the ridges. It may be that the onshore contribution of sand from the ridges is no longer effective this late in the hydrodynamic cycle.

Littoral Budgets

Analyses of littoral sediment budgets (*e.g.,* RPI, 1985; Williams & Meisburger, 1987) show that, in general, sediment volumes increase along the south shore from east to west in the direction of net longshore transport. Perhaps more importantly, sediment volumes exceed sand supply from erosion of the Montauk headlands and updrift beaches. Both spring-summer and fall-winter sand transport occur on the Long Island inner shelf. Analysis of tracer studies and current observations by Lavelle *et al*. (1978, 1982) show that, on a yearly time scale, westward winter storm flow along the Long Island shelf is the major mechanism of sand transport at depths less than 22 m. Niedoroda & Swift (1981) additionally report from their studies that erosional shoreface recession, which has caused up to 0.6 miles (1 km) of shoreline retreat on the Long Island coast in the last century, results from intense winter storms.

Westward sediment transport along the south shore of Long Island, based on interpretation of coastal sediment budgets, is additionally corroborated by studies of water movement on the seafloor. Bumpus (1965) used a seabed drifter and reports net flow on the western Long Island continental shelf to be westerly with a dominant onshore (landward) component. Using radioisotope tracers and bottom current meters, Lavelle *et al*. (1978) found an annual eastward sediment transport during fair weather conditions to be frequent but much less intense than the westward, shore-parallel transport that results from extratropical storms. Vincent *et al*. (1981, 1983) report similar results, that is, a net westerly bedload transport across the Long Island shelf to at least 30 m water depth with a strong onshore component landward of the 10-m isobath.

Like previous reports, Rosati *et al*. (1999) show a net westward sediment transport (349,000 m^3/yr or 456,000+/- cy/yr) for Fire Island (Figure 12). However, Rosati *et al*. (1999) also calculated a net offshore transport of 88,000 m^3/yr (115,000+/- cy/yr), which contradicts the onshore transport found by Bumpus (1965) and Vincent *et al*. (1981, 1983). Rosati *et al*.'s (1999) numbers are based on a conceptual budget inferred from shoreline changes between 1979 and 1995, and the main driver of shoreline recession is sea level rise.

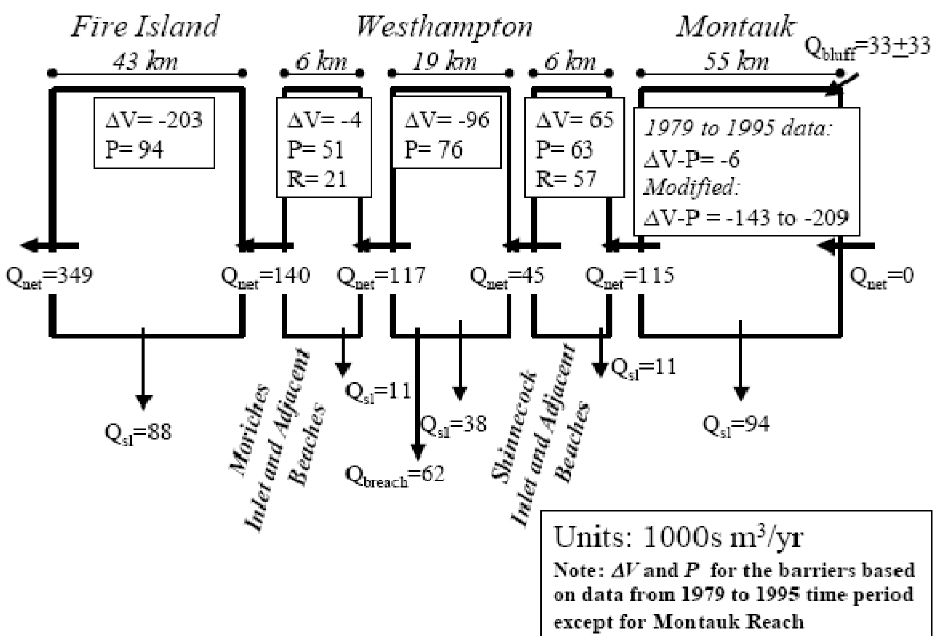


Figure 12. Regional sediment budget for the south shore of Long Island (after Rosati *et al*., 1999).

The USACOE has balanced the sediment budget without need for onshore sand movement from the ridge zone, but they have stated the following about onshore sediment transport: "It is not definitively happening, we acknowledge there could be some onshore movement of sand, and it could be in the range of 70-200k cy" (Couch, 2008). The range is the upper limit of uncertainty.

Batten (2003) analyzed profile survey data collected by the USACOE and NY State from the period of 1995 to 2002. He calculated an onshore transport of 586,000 m^3/yr (766,000+/- cy/yr) based on his profile analysis between Jones Inlet and Montauk Point. This finding appears to support the position for significant onshore transport (Lentz *et. al*., 2008). The calculation was based on the use of widely spaced profiles for a time period varying from 6 months to a couple of years. The onshore transport estimate appears high, and a rudimentary review shows some areas of concern. First, most of the change is based on the spring 1995 to fall 1995 period. Experience using the spring 1995 data showed it to be unreliable, because survey control points differed between survey periods, and did not reconcile well. No matter how precise the survey methods, the accuracy will suffer if the profile origins change between surveys, as they did between the spring and fall of 1995. This can lead to divergence between the profiles as they approach the closure depth, which can be misconstrued as significant volume change. Volume estimates calculated using profiles with varying spacing well tend to overweigh those in the sparse regions. Batten sediment budget needs more work to address anomalies in the data set.

Erika E. Lentz, Cheryl J. Hapke, and William C. Schwab in a recent report prepared for the NPS, titled "A Review of Sediment Budget Estimations at Fire Island National Seashore, New York" (Technical Report NPS/NER/NRTR--2008/114), concluded:

> "Existing studies of sediment budgets at Fire Island indicate that there is a deficit between Q_{source} and Q_{sink} unless material is added to the littoral system between Moriches Inlet and Fire Island Inlet. It has been suggested that contributions might come from beach erosion, nourishment projects or from an offshore source. A combination of these is likely the most feasible. There is currently a large discrepancy in the relative distribution of the suggested contributions, which some estimates needing no offshore source [Rosati, 1999] and others suggesting that more than 370,000 m^3/yr [484,000 cy/yr] is added to the system from the offshore. Mapped linear shoals in the offshore would be the likely source of the sediment, but no data currently exist to provide information on the processes and pathways of cross-shore sediment transport at Fire Island. Data from an adjacent barrier island indicate large amounts of sediment can be transported offshore during storm events and returned to the shoreface during fair weather conditions. Studies from other areas document both onshore and offshore sediment transport during large storms. This is also likely to occur at Fire Island and provides an explanation for how material from the offshore may enter the nearshore system. Over longer timescales (several decades to half centuries and longer), the active shoreface may shallow and move landward, as documented in other regions. Previously established DoC [depth of closure] estimates would not have documented this shoreface migration due to spatial or temporal limitations.
>
> Increases in storm intensity anticipated as a result of climate change are expected to heavily impact coastal systems. Offshore borrow sites have the potential to alter patterns of wave refraction and ultimately beach response (erosion and accretion), particularly with increases in storminess, and may remove material that serves as a natural buffer to the coastal system if the sand-ridges feed the nearshore bar system. It is not a completely safe assumption that dredging material from below the currently established DoC will have no impact. Widening the beach via replenishment will provide added buffering and protection to homes and properties from coastal storms and hazards, however, the transfer of sediment from offshore regions could cause the impacts of storms to be greater on the shoreline. It is critical to understand how changes will impact the coastal system over the short and long term, and what unanticipated consequences may arise as a result of such actions."

This report by Lentz (2008) acknowledges the need for a widened beach, but offers some concerns about borrow areas in the nearshore ridge region based on analysis of previous studies and reports.

There is a wealth of recent information that has been analyzed about Fire Island. Results in the USAERC (2008) analysis of the Lentz (2008) report along with the information presented here provides support for use of the borrow areas based on actual data analyzed from the project area. Although the USGS study offshore of Long Island conducted in the late 1990s (Schwab 1999 & 2000) did use remote sensing methods extensively, review of the bathymetric survey data created by these cruises showed it to be of insufficient accuracy for most engineering and scientific uses, and the seismic and side scan results are of a relative scale and do not extend into the nearshore region. As such, and given the uncertainties in the sediment budgets presented above, a pre-construction bathymetric survey should be conducted in the vicinity of the borrow areas, and used as a basis for monitoring.

Although Galgano & Leatherman (1999) did not quantify the littoral budget, they did quantify shoreline changes before and after 1933 for Fire Island (Figure 13). This year is significant as it is about the time Moriches Inlet, the inlet that represents the eastern boundary of Fire Island, was formed. Moriches Inlet formed naturally, but is no longer a natural inlet since it was stabilized with jetties in 1952 to keep it open. In the 1980's, it became a Federal navigation channel, requiring periodic dredging to maintain its channel (USACOE, 1999).

Galgano & Leatherman (1999) found that shoreline changes before the inlet's existence were relatively stable (1830-1933), but after the inlet formed they found an "arc of erosion." This arc is a large area of erosion downdrift of the inlet caused by its sediment sink behavior. Beaches downdrift of the inlet do not receive the amount of sediments carried by littoral processes without inlet conditions. Galgano & Leatherman (1999) estimated that the "arc of erosion" would hit developed communities on Fire Island in 2012, based on the 1996 position and a rate of arc advance of 1,377 ft/yr. Sediment loss over the eastern 17 km of Fire Island is 120,000 m^3/yr (158,000 cy/yr) based on this arc of erosion. The amount lost through 1996 is 7.64 million m^3 (9.98 million cy) during the 1933-1996 period. This may be the biggest threat to Fire Island development and that of the communities bordering the adjacent bays. Inlet bypassing may have improved with the recent Westhampton Dunes nourishment and groin modification. Allen analyzed and compared inlet bathymetries from 1995 and 1996, and he concluded that the "results provide strong support for substantial sediment bypassing of Moriches Inlet due to system equilibration by natural processes." In the study of inlets, it generally takes a comprehensive sediment budget to determine the magnitude of inlet bypassing or the amount of inlet impacts. The longer the period analyzed the better, since it diminishes the impact of survey variability and smooths temporal anamolies. Short of this, the long term shoreline changes by Galgano and Leatherman provide a record of the downdrift impact due to the natural inlet opening which was later made permanent.

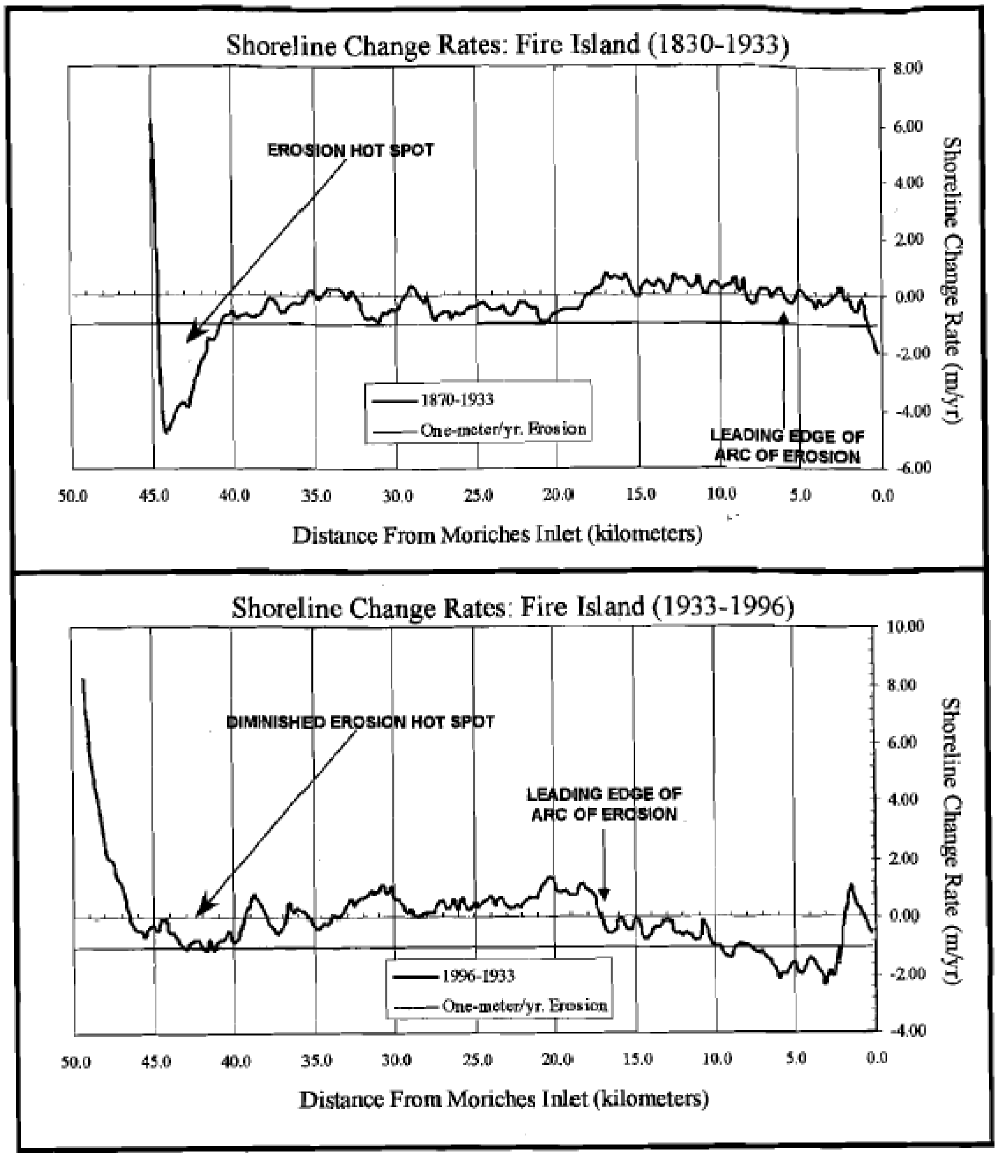


Figure 13. Westward migrating "arc of erosion" due to the opening and stabilization of Moriches Inlet (after Galgano and Leatherman, 1999)

The formation of inlets in a barrier island is integral to maintaining the system. However, there is conflict among regulatory agencies and the Fire Island communities regarding inlet formation. If Fire Island was located far from significant development, it would not matter if inlets opened and closed as they did prior to the 1940s. But with significant development on mainland Long Island and within the Fire Island developed communities, damage to houses and infrastructure may be an unavoidable consequence of allowing inlets to form. Breaching or overwash may be a natural consequence of an unimproved inlet allowed to migrate and close naturally, but it may not be a policy desireable to the development bordering the bay.

Shoreline Change

Given the recent trend of landward shoreline migration and loss of homes due to the encroaching ocean, there is a need to quantify more recent rates of shoreline change to gain an understanding of the current shoreline status for Fire Island. Regardless of onshore or offshore transport of sand, present-day rates of shoreline change can help determine if Fire Island shorelines are stable or if they are losing sediments. In addition, quantification of offshore sediment volumes that may naturally nourish Fire Island beaches is necessary to determine if borrowing from such sources could possibly increase coastal erosion.

Methods

Shoreline and Volume Change

Shoreline positions were based on historical data and extracted from topographic airborne laser data. The 1979 shoreline was provided by Leatherman & Allen (1985), where they digitized the wet-dry interface on aerial photography. Airborne laser data (i.e. LIDAR) from 1998, 1999, 2000, and 2005 were obtained from NOAA's Coastal Services Center (www.csc.noaa.gov). Airborne laser data collected in 2007 were provided by USGS. Each airborne laser data set was provided as irregularly spaced point measurements including horizontal coordinates and vertical elevations of topography. Analysis required interpolating these data onto a regularly spaced grid to produce a digital elevation model (DEM). The data were gridded at 5 ft resolution using kriging interpolation and a linear variogram.

Other sources of data have been developed to document moderate term shoreline and volume changes pertinent to the proposed project area, including the USACOE/NY State profile database from 1995 to 2002 (Batten 2003), CPE profile survey data from 1993 to 2007 for selected communities, and a 30 year temporal dune line database by Dr. Psuty (FIIS, 2008). The Lidar data set supplemented with earlier Leatherman & Allen MHW lines was selected for its utility in the engineering process; the others were not used in this document because of time limitation and availability. In addition, the shoreline data utility was verified by its good agreement with volumes calculated using profile survey for the same period. Measured and net volume changes are calculated for each of the four reaches, the downdrift area from the 2003 project areas, and the entire developed community reach.

Since the shoreline is not a topographic feature, its position cannot be directly measured by airborne laser points. Therefore, local tidal datums were used to extract a shoreline contour from the three-dimensional airborne laser data. Previous studies indicate that the digitized high water line from orthorectified digital aerial photographs is similar to contours corresponding to tidal datums (Stockdon *et al*., 2002; Robertson *et al*., 2004). All data were contoured at the MHW level of 2.0 ft above NAVD88. The elevation of MHW was based on the ocean tidal datum developed by USACOE Waterways Experiment Station in 1997. The contours were vectors that represented the shoreline position at the time of airborne laser data collection.

Shoreline change was quantified using the Metric Mapping system developed by the International Hurricane Research Center (Zhang *et al*., 2005). In this system, a spine was created parallel to the shoreline, and transects perpendicular to the spine were created at every 100 feet, producing 687 transects. Distance was measured from the spine to the intersection of each shoreline vector. This allows the calculation of shoreline change as a function of along-shoreline position.

Sand Ridge Volumes

Sand ridge volumes were calculated by CPE staff using methods and tools in common use by coastal engineers, geologists and GIS specialists. Bathymetric data (NOS Hydrographic

Survey Data) were obtained from the NOAA Geophysical Data Center (www.ngdc.noaa.gov). The hydrographic data consists of historic survey information from 1924 and 1999. Original spacing of data varied from about 100 to 1,500 feet. New 250-foot bathymetric grids, which used historical grid spacings indicated above, were created using Surfer to interpolate the original hydrographic data by equally spaced intervals so that resulting spatial distribution patterns would better resemble recognizable topography that could be color ramped. The result is a rasterized image that provides spatial continuity of point data in a format that represents a smoothed topographic surface. Differences in elevation can thus be shown as continuously varying spatial units that are amenable to color coding.

Creation of Terrain Models of the Continental Shelf

Variations in bottom topography are visualized using a color ramp that grades from reddish tones nearshore through yellowish tones on the middle shelf to brownish tones seaward in preference to bluish tones that are traditionally used to show water depth. The new color ramp was produced here to show submarine (sand ridge) topography (morphosedimentary features), which is the subject of this report, not water depth. The essential points of the mapping procedures are described, for example, by Benedet *et al*. (2004), Finkl & Warner (2004), and Finkl (2005).

Determination of Sediment Volume in Morphosedimentary Features

Sediment volume calculations in the sand ridges were based on the reformatted bathymetric data. These data were provided as a *.csv file of northing, easting and z points. The data were converted to a shapefile using the ArcGIS 9.2 “XY Event Tool”. Using the ArcGIS 9.2 “Select by Location” function, individual polygon units were used to select the corresponding elevation point data. A 500-foot buffer was applied during the selection process to enable complete coverage of the unit during TIN (Triangulated Irregular Network) creation. A TIN is a data structure used to model surfaces such as elevation as a connected network of triangles. TINs are assembled from a series of data points with *X*, *Y*, and *Z* values that partition geographic space into contiguous, non-overlapping triangles (called faces). The nodes of each triangle are the elevation or surface points. To eliminate the overlap edges due to the triangulation creation process of the TIN unit, these individual TINs were edited by the three-dimensional individual unit polygon it was designed to represent.

The resulting TIN was then imported into ArcScene. Using the “Spatial Analysis” function within ArcScene, an estimated volume and area was obtained for each individual unit. This tool examines each of the individual triangles in the network and determines its contribution to the overall total area and volume. The baseline for estimated sediment volume is the lowest elevation within the morphosedimentary unit. All calculations were set to determine area and volume above this elevation. To determine potential sand volume, a three-dimensional rendering in ArcScene of each unit was visually analyzed, such as ridge fields, for percent ridge coverage. This visually determined percentage was used to calculate potential sand volume from the estimated total sand volume of each morphosedimentary unit. The percentage coverage of specified bathymetric features within morphological units is tabulated at appropriate locations in this report. The computer program thus uses the difference between maximum and minimum elevations within the unit to calculate volume, but also takes into account other differences in elevation within the unit as determined by TINs.

Results

Shoreline and Volume Change

Endpoint shoreline change rate analysis shows evidence of landward and seaward shoreline migration (Figure 14). Rates of change were calculated for three primary time intervals: 1979 to 1998, 1998 to 2007, and 1979 to 2007. The 1999-2007 time interval was examined for a higher erosion rate, which is consistent with the 2000-2005 and 2000-2007 periods measured using the LIDAR data. Summary statistics by region show that on average the developed communities have a seaward shoreline migration of 0.3 ft per year (Table 10) for the entire period. Areas of seaward shoreline migration include Kismet, Western Fire Island (Saltaire, Fair Harbor, Dunewood and Lonelyville), Central Fire Island (Ocean Beach, Seaview, Ocean Bay Park and CE-SC), Cherry Grove, and Fire Island Pines.

Measured and net volume changes are calculated for each of the four reaches, the downdrift area from the 2003 project areas, and the entire developed community reach. This subdivision is illustrated in Figure 14. Conversion of shoreline change to volume change using the profile translation method (1 foot of shoreline change = 1 cy of volume change over a 1 foot length of shoreline) shows a net volume gain of over 586,000 yd^3 (Table 11). Only Davis Park has an erosion trend. However, during this time period there were several beach nourishment projects that added sediments to the beach profile. These nourishment projects must be accounted for in order to gain an understanding of the true volumes that naturally add or subtract from the beach system.

Documented volumes of sediments placed on Fire Island exceed 3.1 million cubic yards (2.4 million m^3) (Table 12) within the developed communities. Net numbers exceed sum of rows due to volumes also placed at Point O'Woods and Barrett Beach. Western Fire Island and Fire Island Pines amount to most of the nourishment activity, with almost 1.3 million cubic yards (1 million m^3) of sand placed on each of their beaches. When the volume change in Table 11 is subtracted from the volume placed (Table 12), the difference is the volume change without nourishment activity, or the background or chronic erosion rate (Table 13). Net adjusted volume change from 1979 to 2007 is less than 2.6 million cubic yards (2 million m^3), with Fire Island Pines and Western Fire Island each having losses of more than 1.2 million cubic yards (1 million m^3). The net rate of the adjusted volume change is a loss of approximately 92,000 cubic yards per year (70,000 m^3 per year) (Table 14). The nourishment in the last 30 years is counter-balancing the background erosion rate and can be continued as a means of erosion control.

DRAFT

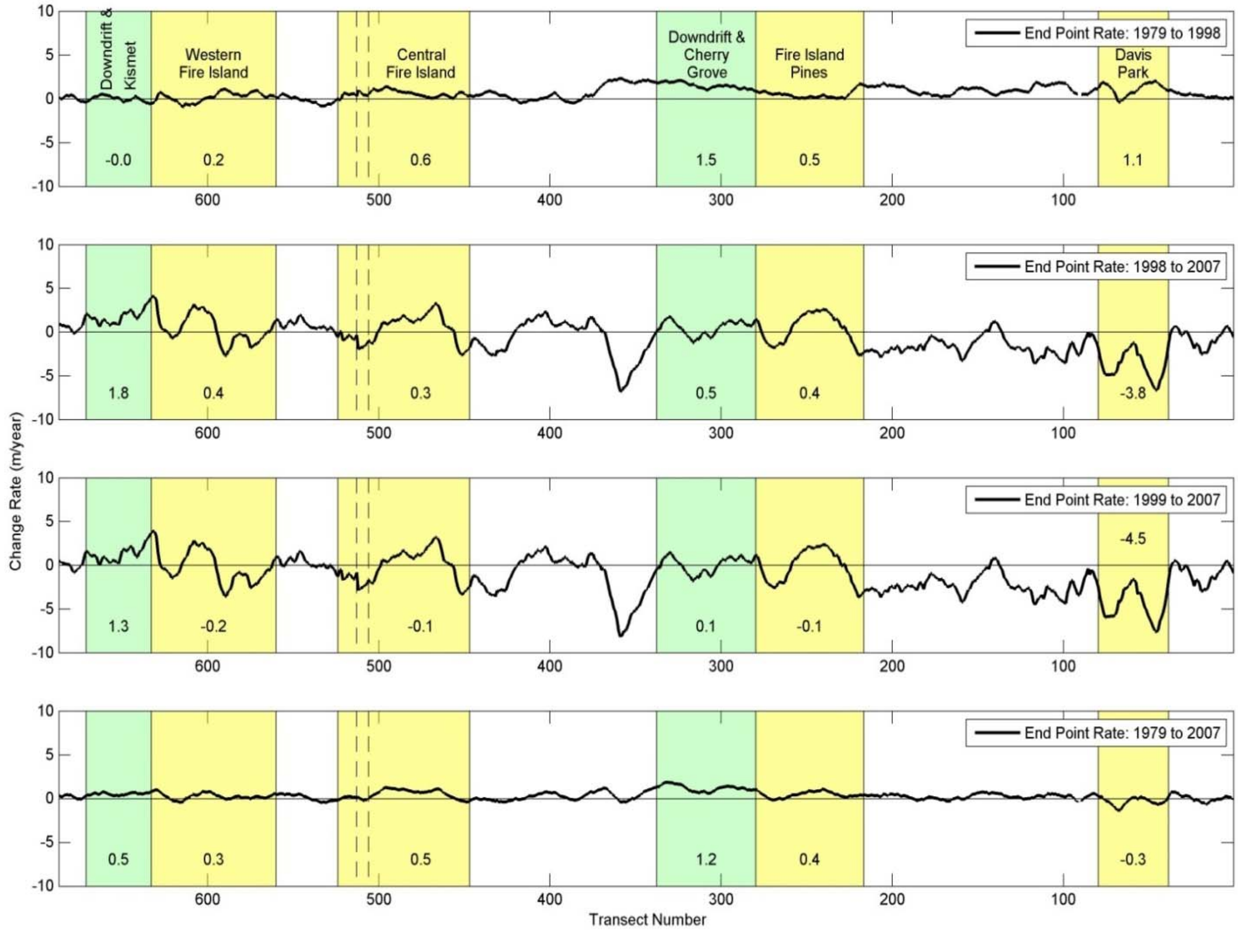


Figure 14. Shoreline change rates for developed areas of Fire Island, NY. Average shoreline change rates are at the bottom of each section for each time period. Transects are from east to west (right to left) spaced 100 ft apart.

Table 10. Shoreline change rate.

Time Period	Downdrift & Kismet	Western Fire Island	Central Fire Island	Downdrift & Cherry Grove	Fire Island Pines	Davis Park	Developed Communities
	ft/yr	ft/yr	ft/yr	ft/yr	ft/yr	ft/yr	ft/yr
1979 to 1998	-2.0	0.1	-0.4	2.7	0.6	1.2	0.3
1998 to 2007	10.8	3.1	6.7	7.0	3.7	-6.3	3.1
1979 to 2007	1.8	1.0	1.7	4.0	1.5	-1.0	1.1

Table 11. Volume change based on shoreline change rate.

Time Period	Downdrift & Kismet	Western Fire Island	Central Fire Island	Downdrift & Cherry Grove	Fire Island Pines	Davis Park	Developed Communities
	yd^3	yd^3	yd^3	yd^3	yd^3	yd^3	yd^3
1979 to 1998	-46,599	3,425	-20,071	97,447	24,755	31,070	103,979
1998 to 2007	107,916	58,939	133,957	105,535	60,505	-67,614	482,217
1979 to 2007	61,316	62,364	113,886	202,982	86,155	-36,543	586,196

Table 12. Volume of sediments placed on Fire Island.

Time Period	Downdrift & Kismet	Western Fire Island	Central Fire Island	Downdrift & Cherry Grove	Fire Island Pines	Davis Park	Developed Communities
	yd^3	yd^3	yd^3	yd^3	yd^3	yd^3	yd^3
1979 to 1998	0	658,161	194,885	0	878,775	20,012	2,016,823
1998 to 2007	0	637,700	0	0	516,363	0	1,154,063
1979 to 2007	0	1,295,861	194,885	0	1,395,138	20,012	3,170,886

Table 13. Adjusted volume change.

Time Period	Downdrift & Kismet	Western Fire Island	Central Fire Island	Downdrift & Cherry Grove	Fire Island Pines	Davis Park	Developed Communities
	yd^3	yd^3	yd^3	yd^3	yd^3	yd^3	yd^3
1979 to 1998	-46,599	-654,736	-214,955	97,447	-854,020	11,059	-1,912,844
1998 to 2007	107,916	-578,761	133,957	105,535	-455,858	-67,614	-671,846
1979 to 2007	61,316	-1,233,497	-80,998	202,982	-1,308,983	-56,555	-2,584,691

Table 14. Adjusted volume change rate.

Time Period	Downdrift & Kismet	Western Fire Island	Central Fire Island	Downdrift & Cherry Grove	Fire Island Pines	Davis Park	Developed Communities
	yd^3/yr	yd^3/yr	yd^3/yr	yd^3/yr	yd^3/yr	yd^3/yr	yd^3/yr
1979 to 1998	-20	-31,608	-5,328	8,855	-41,078	3,710	-61,199
1998 to 2007	7,055	-72,666	2,542	2,891	-59,022	-15,966	-167,608
1979 to 2007	2,079	-43,787	-2,993	7,086	-46,371	-2,127	-92,764

Some previous sediment budgets, like the 1999 USACOE budget, do not illustrate this counter balance, since their borders do not coincide with the developed communities. The previous sediment budgets imply stability on central Fire Island that relies largely on the stability at Watch Hill in conjunction with nourishment. During the last 8 years (1999-2007), all project communities have experienced erosion and warrant nourishment. Based on the experience downdrift of two previous nourished beaches since 1998, the project will benefit adjacent communities. This downdrift gain shows that sand placed on the beach remains in the littoral system as it moves downdrift. The nourishment of the Central Fire Island segment should mitigate for any impact from their groins by increasing natural bypassing.

Shoreline change curves, such as Figures 13 and 14, are sensitive to the time interval that they represent. In Figure 14, the time intervals from top to bottom for the three primary curves (top, middle top and bottom) are 19 years, 9 years, and 28 years, respectively. The longer the time period, the quieter the signal. Not surprisingly, standard deviations from top to bottom for the three curves are 0.7, 1.8 and 0.5, respectively. When analyzing shoreline change, the longer time periods tend to average out outliers (*e.g.*, large erosion events, nor'easters and natural shoreline variability) that may skew the results. At long intervals, the difference beween dune and shoreline retreat rates converge, as short term variations are averaged out.

Cherry Grove and Kismet are benefitting from nourishment projects that occur updrift from their location. With exception to the 1979 to 1998 study period, Kismet, Cherry Grove and locations downdrift show significant seaward shoreline migration (Figure 14). These areas have not nourished their beaches, but they show volume increase. Cherry Gove shows a net increase of 203,000 cy (155,000 m^3) of sand and Kismet shows a gain of 60,000 cy (46,000 m^3) for the entire period. The source of excess sediments is most likely from nourishment projects to the east and account for approximately 20% of the placed material. Background erosion exists in Kismet and Cherry Grove, and may be in the range of at least 39,000 cy/yr (30,000 m^3/yr). If erosion is factored in, material placed in Western Fire Island and Fire Island Pines could account for at least 50% of the material found in the two downdrift communities. The fact that 50% of the placed sediments can be accounted for in the subaerial region alone suggests that this coastal system is maintainable through beach nourishment, since a significant portion of the material remains in the system, and that offshore borrow area sand is not lost to the system. But this gain does not benefit the project communities as much; since sand placement is largely restricted to their borders, it provides limited synergistic benefits. It will slowly reduce the sand volume needed for nourishment with each nourishment event, since lateral sand movement will slowly create the tapers and offshore foundation of the new beach needed for greater durability and stability, but lateral losses will be great initially. The proposed project in Western Fire Island and Fire Island Pines is approximately 154,000 cubic yards smaller than the 2003 project constructed in these reaches.

The adjusted volume rate indicates a constant erosion of about 91,500 cubic yards per year (70,000 m^3/yr) for the entire study area. Downdrift erosion effects of the stabilization of Moriches Inlet could increase beach erosion when it arrives in the developed areas of Fire Island by 2012 (Galgano and Leatherman, 1999). 91,500 cubic yards per year (70,000 m^3/yr) is manageable if looking at the system as a whole. Nourishment projects for Western Fire Island and Fire Island Pines alone require a volume greater than this amount to maintain the current shoreline position. If the Fire Island developed community region were nourished as one, the average annual nourishment volume would approach this volume, but would be much higher for piecemeal projects.

Table 15: Volume Change Summary, Fire Island NY 1955-2007

Period	Calculation Depth	Calculated Volume Change	Fill Placed	Adjusted Volume Change
	feet	cy/yr	cy/yr	cy/yr
1955-1979	-36	-108,578	62,615	-171,193
1955-1979	-24	-43,229	62,615	-105,844
1979-1998	-18	3,990	77,385	-95,822
1998-2007	-18	43,875	105,004	-79,798
1955-2007		-11,262	75,046	-97,845

The above results can be expanded to include the 1955-79 period by use of Kana's 1994 report. Kana developed a sediment budget with four distinct reaches within the developed Fire Island region for the 1955-79 period. His sediment budget included not only the volumetric change rates, but also the amount of fill placed. A summary of the volumetric and fill quantities for the period 1955-2007 is provided above in Table 15. The table shows that for a fill rate of 85,300 cy/yr (75,046 + 11.262), the average shoreline could have been maintained for the entire period. It also appears to indicate that the average adjusted (background) erosion rate has decrease from 105,800 cy/yr during the 1955-1979 period to 79,800 cy/yr during the last 9 years, although the calculated differences may not be significant. These changes were calculated with an engineering depth of closure of between -18 and -24 feet. During the 1955-1979 periods, the region between -24 and -36 lost 65,000 cubic yards, which suggests an offshore loss rate and not onshore transport.

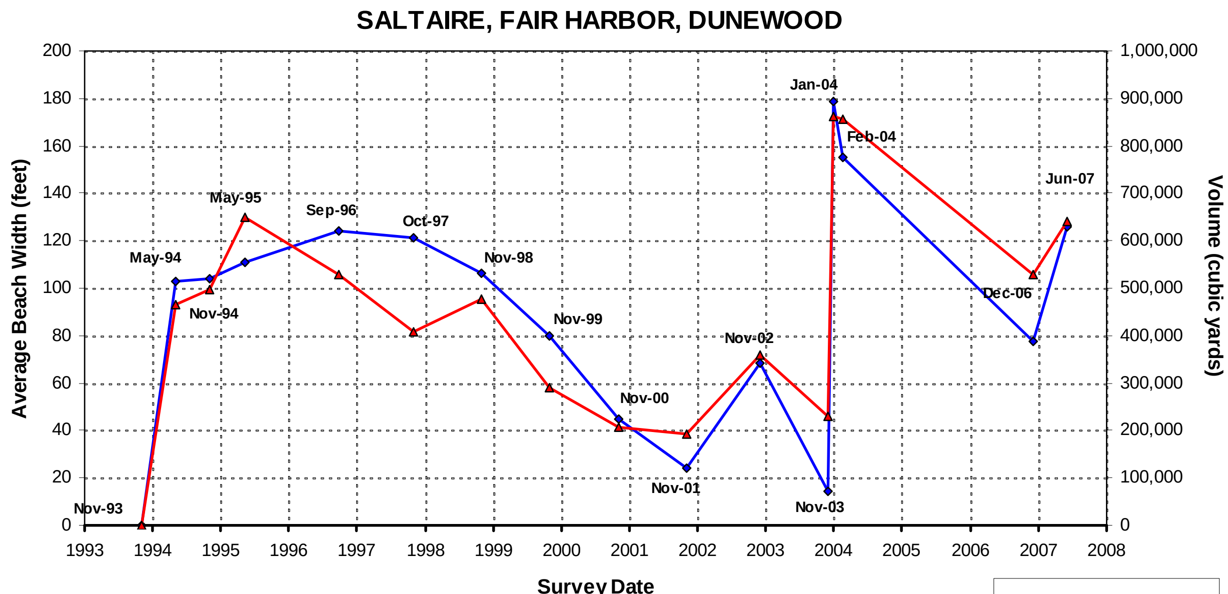
Table 15 shows that beach nourishment has had a positive impact on Fire Island. Since 1979, the fill quantity has kept ahead of the retreat rate on average, and even made a contribution to maintaining a stable average shoreline position during the 1955-1979 period. Projects have generally been moderate in size, and have lasted from 5-10 years between nourishments (CPE 2007). By its nature, beach nourishment cannot change the background erosion rate, but it has maintained a protective shoreline for decades. The Captiva Island, Florida nourishment project was 8 years old when Hurricane Charlie struck, and received no damage due to waves and overwash (CPE 2004). Similarly, the April 2007 nor'easter hit 3 years after the latest beach nourishment with no damage occurring within the project communities. This is a stark contrast to the damage that occurred in the 1990s without significant nourishment.

Beach Monitoring

Physical monitoring of Western Fire Island and Fire Island Pines has occurred through two beach nourishment projects. Beach profile surveys, predominately using a sea sled, have been conducted since 1994 to measure the performance of the projects (CPE 2001, 2004, 2007). The results are the basis for engineering a beach nourishment project and confirm the results described in the previous section. For the purpose of engineering calculations, a depth of closure of -18 ft NGVD was used, although the surveys extend to a depth of -27 ft NGVD.

Western Fire Island (Saltaire, Fair Harbor and Dunewood) had a composite volumetric change of 54,990 cy/yr between 1994 and 2007. The composite includes the changes for the 1994 and 2003 nourishment projects without counting the construction periods. The volumetric and shoreline changes for this period are illustrated in Figure 15 below. The first three years of monitoring was a slow accretional period caused by recovery from the 1991-93 storms and a sand infusion from an eastern sand wave. Without this 3 year period, the composite volume change increases to 70,927 cy/yr for the 1997-2007 period. The 1998-2007 period described in the previous section (Table 14) shows a volume change rate of 68,970 cy/yr (52,661 m^3/yr), which is a good agreement.

Figure 15: Western Fire Island Volumetric and Shoreline Change Summary 1993-2007



Notes:
1. Baseline is November 1993 survey.
2. Volumes measured to -27' NGVD.
3. Beach width measured at MHW (+3.1' NGVD, +2.1' NGVD prior to 2002).

The composite change rate for Fire Island Pines for a similar period showed an average annual erosion rate of 76,716 cy/yr between 1997 and 2007. The previous section shows an erosion rate of 54,322 cy/yr (41,478 m^3/yr for the 1998-2007 period), which is a fair level of agreement.

The erosion rate within these two reaches is much higher than the average for the entire developed community shoreline, which is 80,060 cy/yr (61,130 m^3/yr from Table 14). There are two primary reasons for the difference. First, the developed communities' shoreline has hot spot and cold spot erosion regions. Areas previously nourished are generally hot spots (which is the reason they were nourished), while regions un-nourished or not needing nourishment are low erosion or accretion (cold spots) regions. The hot spots need most of the sand.

The second influence is the alongshore diffusion of the sand placed within a relatively short project length. This sand migrates to the adjacent beaches. The stable or accreting regions of Kismet and Cherry Grove are benefiting from diffusion. Engineering calculations (CPE 2008) indicate that approximately 40 percent of the measured erosion within the previously nourished reaches is due to diffusion. The longer a project length, the less diffusion contributes to erosion. There are other loss types that contribute to erosion to including overfill (adjustment due to grain size differences), bulking of sand during dredging, and dredging losses between the borrow area and the beach. A project built for the entire shoreline length of the developed communities would approach an average annual nourishment rate of 91,370 cy/yr (70,000 m^3/yr). However, with a 6,350 feet average project length, ample allowance must be made for diffusion, overfill and other loss factors in addition to the background erosion rate. The proposed fill volumes for the communities are predominantly advanced nourishment needed for a project life of 5-6 years.

The background erosion rate for Central Fire Island for the period 1999-2007 was 45,000 cy/yr based on an analysis for shoreline changes, and was almost double that amount for the 2000-2005 period. For Davis Park, the background erosion rate was 14,755 cy/yr for the period between 1998 and 2007, and there were periods of higher erosion during this timeframe. If diffusion is factored in, the rate would be 37,800 cy/yr and 65,490 cy/yr for Davis Park and Central Fire Isalnd respectively. This is the rate that should be used for advanced nourishment.

Project duration can be anywhere from a few years to decades. Many projects have had project lifes of a decade or more, such as the Broward County, Florida projects of the 1980s and 1990s. Coney Island has only been nourished a few times since the 1920s. The Western Fire Island projects went a decade between 1994 nourishment and nourishment in 2003. Projects can be designed for long project life, even with the impact of major storms. For this project the design life is 5-6 years, although under good climate conditions, the project may last longer.

Sand Ridge Volume Results

Bathymetric analysis on the continental shelf offshore southern Long Island shows the geographic distribution of sand ridges in relation to the Fire Island National Seashore. The image in Figure 16, based on reformatted NOAA bathymetry, shows the spatial distribution of sand ridges between Watch Hill and Fire Island Inlet. The ridges increase in size and number with distance westward, to form a prominent ridge field that contains more than a dozen major ridges. About 13 km offshore on the shelf floor, the sand ridges lie more or less parallel to the shore but on the shoreface the ridges are angled about 30 to 40 degrees to the shore. Some of the major ridges extend up to 25 km in length and are 2 km in width.

The total sand ridge area shown in Figure 16 covers about 285,000 acres (1154 km^2; Table 16). Of the total area, about 85% is occupied by sand ridges that make up about 18.0×10^9 yd^3 (13.8 billion m^3) of sediment. The sand ridges range in water depth from 9 m to about 40 m depth. Approximate areas of borrow areas, as summarized in Table 17, account for a very small percentage of the offshore ridge field. Volumes of potential sand resources within the borrow areas are also very small compared to sand volumes in the ridges, 41.0×10^6 m^3 (31.4 million m^3) in Ridge 1 and 135.1×10^6 yd^3 (103.3 million m^3) in Ridge 2 (Table 18, Figure 16). Comparison of borrow areas with individual sand ridges shows that the borrow areas take in less than 7% of the area for the ridge that they are associated with (Figure 16). As shown in Table 18, the percent of sand ridge covered by the borrow areas are as follows: Borrow Area 2 West; 7.16%, 1994 Borrow Area, 2.73%; 1997 Borrow Area, 5.87%; and Borrow Area 2 East, 3.26%.

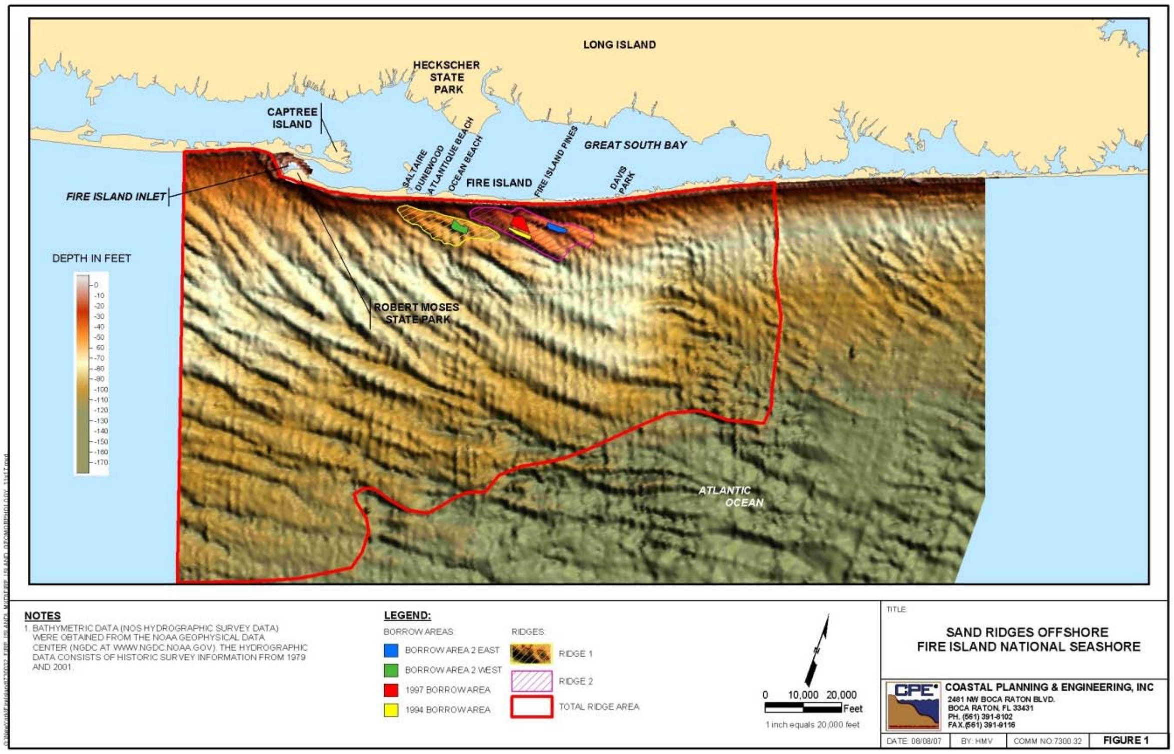


Figure 16. Color shaded relief map of offshore Fire Island (Created by CPE 2008).

This morphometric data shows that the borrow areas occupy a very small part of the sand ridges with which they are associated, when considered in terms of both area and sand volume. The percent area used in volume estimates was based on visual inspection of the reformatted bathymetry where ridge areas were compared to non-ridge areas within the borrow areas (Table 18).

Table 16. Sand ridge parameters offshore Fire Island National Seashore, Long Island, New York.

Morphosedimentary Feature	Shelf Area (acres)	Height of Plane (ft)	Maximum – Minimum Range (ft)	% Ridge Area Used in Volume Calculations	Sediment Volume (yd^3)
Total Ridge	285,162	-129.921	-129.92 to -1.12	85	18,086,697,795

Table 17. Comparison of borrow areas to total sand ridge areas and volumes.

Morphosedimentary Feature	Shelf Area (acres)	% of Total Ridge Area	Height of Plane (ft)	Maximum – Minimum Range (ft)	% Ridge Area Used in Volume Calculations	Sediment Volume (yd^3)
Borrow Area 2 West	210	0.07	-53.48	-53.4 to -43.96	80	1,275,049
1994 Borrow Area	131	0.05	-47.05	-47.05 to -39.04	40	345,716
1997 Borrow Area	279	0.10	-47.90	-47.90 to -34.12	60	1,273,771
Borrow Area 2 East	156	0.05	-43.60	-43.60 to -37.07	80	772,317
Ridge 1	2918	1.02	-61.19	-61.19 to -28.02	75	41,079,486
Ridge 2	4774	1.67	-67.68	-67.68 to -17.49	75	135,147,500

Table 18. Comparison of borrow areas to individual sand ridges.

Morphosedimentary Feature	Shelf Area[1] (acres)	% of Total Ridge Area	Height of Plane (ft)	Maximum – Minimum Range (ft)	% Ridge Area Used in Volume Calculations	Sediment Volume (yd^3)
Borrow Area 2 West	210	7.16	-53.47758333	-53.48 to -43.96	80	1,275,049
1994 Borrow Area	131	2.73	-47.04715	-47.05 to -39.04	40	345,716
1997 Borrow Area	279	5.87	-47.90016666	-47.90 to -34.12	60	1,273,771
Borrow Area 2 East	156	3.26	-43.602275	-43.60 to -37.07	80	772,317

[1] Sand ridge plus non-ridge area.

Discussion

The morphometric analysis results show that extensive shoreface-attached sand ridges occur offshore of Fire Island National Seashore. Large sediment volumes are associated with these sand ridges (nearly 18 billion cubic yards) that extend up to 82,000 ft offshore on the continental shelf. Potential sand resources within the borrow areas account for a small fraction of the sand ridge volume with which they are associated and an even smaller part of the total ridge field sand volume. Assuming the large volume of offshore sand that is moving shoreward, removal of such small quantities in the borrow areas on sand ridges on the shoreface would not impact the morphodynamic system that occurs along Fire Island. Consideration of the borrow areas in the morphodynamic context in which they occur is essential to interpretation of potential impacts that might result from dredging.

Updated shoreline change rates and subsequent volume and adjusted volume estimates indicate that Fire Island beaches are maintainable if a long-term nourishment project is implemented. USACOE suggested 6.8 million cubic yards (5.2 million m^3) to nourish and protect beaches within our study area. This report shows that Western Fire Island (WFI) and Fire Island Pines (FIP) are in need of immediate nourishment, but the entire study area can be maintained by placing approximately 100,000 cy of sand each year, after initial nourishment. This can be done following storms or on a six-year interval depending on coastal conditions. In addition, given the immense size of the offshore sand ridges near our study area, relatively small borrow areas can provide ample sediments for nourishment projects with minimal or no impact to the onshore movement of sediments. Most of this sand is beyond the Corps latest guidelines for selecting sand sources beyond the -37 foot contour. The proposed sand borrow areas will be depleted with this project, and a new borrow area will be required, which will have to meet new selection standards based on depth and distance offshore necessary to reduce or elimate impacts to nearshore sediment pathways.

Schwab *et al*. (2000) conclude that the outcropping strata offshore of Watch Hill and the deposit of Pleistocene sediment shoreward of this outcrop (Fisher *et al*., 1999) are a primary control on the modern sea floor functioning as the core of a subaerial headland during the Holocene marine transgression. This bathymetric high continues to function as a submerged headland and thus influences sediment deposition. Erosion of this headland during the Holocene transgression provided the sediment that was subsequently reworked by oceanographic (hydrodynamic) processes (*e.g.,* Duane *et al*., 1972; Swift & Field, 1981; Swift e*t al*., 1984; Trowbridge, 1995) into a field of sand ridges west of Watch Hill (Schwab e*t al*., 2000). The hypothesis that the inner continental shelf off Watch Hill remains an eroding headland is supported by the fact that these sand ridges thin progressively westward or downdrift from the headland source area. According to Leatherman & Allen (1985), the oldest (about 750 to 1,300 years) and most stable part of the barrier island system is located between Watch Hill and Point O'Woods, shoreward from the outcropping Cretaceous strata and the thickest modern sand ridges. On the basis of their own studies and previous works, Schwab *et al*. (2000) concluded that on onshore sediment flux from the shoreface-attached sand ridges west of Watch Hill provide sufficient sediment to the beaches west of Watch Hill to maintain island stability. This finding is based on long-term geology of hundreds to thousands of years, and has not been substantially linked to present conditions. East of Southampton, sediment eroded from the headland remains in the littoral zone with little or no modern sediment on the inner shelf shoreward of the -18 m isobath. Schwab e*t al.* (2000) suggest that higher erosion rates of the headland area east of Southampton during the early Holocene introduced more sediment onto the inner continental shelf. These sediments were subsequently reworked into sand ridges that are now detached from the shoreface. Consequently, the barrier islands east of Watch Hill are transgressive and more susceptible to overwash and inlet breaching.

There are a number of indications that we are transitioning into a third period influencing the geomorphic changes on Fire Island. The third period is human influence and reflects a slowdown in the hydrodynamic processes that were important to the formation of Fire Island during the last 6,000 years. The most significant indicator is the change in alongshore transport and beach erosion occurring within the developed communities on Fire Island in the last century. Historically, most of what is now the developed community region on Fire Island has been labeled as the most stable for hundreds of years before present. Tanski (2008) states that the central portion of Fire Island, between Ocean Beach and Watch Hill, has not migrated in the last 750 to 1,300 years. This stability in central Fire Island may be coming to an end as indicated in a number of recent studies. Longshore transport curves developed by the USACOE (Gravens, 1999) show that stability existed along the central areas during the period 1933-1977, but that the curves indicated an increasing erosion trend in the period from 1979-1995.

This change in the stability of central Fire Island is also shown in the potential longshore transport curves from the same Gravens (1999) report. The longshore transport curve for the 1933-79 periods shows a region of stability to accretion and very low erosion in Fire Island between Watch Hill and Saltaire. During the 1979-95 period, conditions shifted towards greater erosion, and a number of erosional hot spots areas are indicated near Davis Park, Fire Island Pines, Ocean Bay Park and Saltaire, which are four of the communities being considered for nourishment in 2008.

Potential longshore transport curves based on wave hind cast data show a larger erosional hot spot region, one extending from Watch Hill to Point O'Woods and the second extending west from Saltaire. There is a small region extending west from the Ocean Beach groins.

One of the major hypotheses is that Fire Island receives substantial sand infusion from an offshore source, the sand ridges. The ridges originate at Watch Hill and stretch west to Fire Island Inlet. Recent changes indicate that the sand supply is no longer operating to the degree it has in the past. This is supported by an analysis of equilibrium profiles within the Western Fire Island project area and the Fire Island Pines project area over the last 10 years. These equilibrium profiles show a general translation of the profiles seaward that is consistent with the fill placed, but there is no indication that significant sand volume from the offshore is entering these profiles. In fact, monitoring of the western Fire Island area (Saltaire, Fair Harbor, Dunewood) and Fire Island Pines since 1994 indicates that offshore losses are the most probable cross-shore net sediment direction. Offshore losses appear to be significant but secondary to the losses due to the longshore gradient on Fire Island. Therefore, it appears that the geomorphic changes caused by hydrodynamic forces of waves and currents may be entering a new period with a diminished supply of sand from the offshore and a longshore deficit caused by the gradient in alongshore wave energy enhanced by the losses caused by the stabilization of Moriches and Shinnecock Inlets, not to mention other man-made intrusions into the coastline.

There is a divergence in opinions on the magnitude, net direction and significance of cross shore sand transport offshore of Fire Island and whether the borrow area will interrupt a significant sand pathway leading from the ridges to the shore. In most coastal engineering projects, borrow areas located in water depth approaching twice the depth of closure have no significant impact on adjacent shorelines, and the most recent USACOE sediment budget and borrow area depth guidance supports this position. Information exists in the literature (Schwab 1999, Lentz 2008) to support the other sides of this argument, but further studies and analysis may be needed to resolve these differences. This long term analysis is beyond the scope of this document, since the project horizon is 6 years (M. Foley, NPS, pers. comm) and actual performance data of dredged borrow area has not indicated any significant impact on Fire Island in the short term. There is general agreement that background erosion of the shoreline and dunes exists along the developed communities, with a rate of approximately 1.5 feet/year. This erosion is not uniform alongshore or in time, and can be addressed with moderate sized beach nourishment projects, if community protection is the objective.

3.1.2 Beach and Dune Sediments

Composite beach sand characteristics were determined for Fire Island by the USACOE in 1995. Composites represent the average of sand samples taken across the entire active beach profile, from the dune toe to the depth of closure. The results were averaged for two reaches for the developed communities, Kismet to Cherry Grove (west) and Fire Island Pines to Davis Park (east) by the USACOE in 1996.

Sediments located landward of the mean tideline to the base of the foredunes had a composite mean grain size of 0.42 mm and 0.41 mm for the western and eastern reaches respectively. These sediments are composed primarily of quartz sand with low silt. In 2007, dry beach samples were collected from the Western, Central and Davis Park Reaches, and they generally confirmed the USACOE composites, except in Davis Park, which had a mean grain size of 0.23 mm. This finer sand may have represented an anomoly in beach grain size caused by a specific process; Davis Park was resampled in 2008, which had a mean grain size of 0.38 mm. Beach sand deposits may also include naturally occurring magnetite and garnet sands, which are transported alongshore with the littoral drift and show up as black and purple layers in the beach sand.

The intertidal sands had a mean grain size of 0.51 mm and 0.46 mm respectively within western and eastern developed community reaches. Below the tidal region, the respective mean grains size is 0.24 mm and 0.31 mm. The composite mean grain size for the eastern and western reaches respectively is 0.37 mm and 0.39 mm.

Dunes are large aeolian sand deposits without soil horizons found parallel to the shoreline. The primary function of dunes is the protection of resources landward of dunes, including natural and developed areas. Dunes in the project area average 12–20 feet in height.

Areas with little or no dunes, such as western Davis Park and eastern Ocean Bay Park, offer minimal protection of resources.

3.1.3 Borrow Areas

Sand for the proposed projects will be dredged from Borrow Area 2-West (Western and Central Fire Island) and Borrow Area 2-East (Fire Island Pines and Davis Park). Both sources are located in the region of USACOE Borrow Area 2 (Figure 1). The USACOE completed a new investigation of Borrow Area 2 from 1996-1999 in conjunction with USGS. The new investigation was used as a basis for twenty additional vibracores taken by Coastal Planning & Engineering in 2001. Five exploratory cores were taken first to determine the best locations for the remaining fifteen cores. The results were used in conjunction with bathymetric surveys to ultimately define the two proposed borrow areas, which were permitted for use with the 2003 nourishment project. Vibracore logs for Borrow Areas 2-East and 2-West are included in Appendix F; they indicate the previous cut depths at the location of the vibracores, and the proposed cut depths across the entire borrow area limits. Table 19 shows the composite grain size for the beach and borrow areas, and dry beach samples taken recently to confirm historic composite grain sizes. Based on this grain size comparison and analysis, the sand sources are beach compatible. The performance of the 2003 project further confirms that these sand sources are compatible.

Borrow Area 2-West: This sand source is located 1.6 miles southeast of the Western Fire Island communities and 1 mile south of Ocean Bay Park and contains approximately 1.9 million cubic yards following the 2003 nourishment project. Borrow area sand is medium to light gray in color with a silt content of 4%. The borrow area sand and the sand on the beach (1995) both possess a mean grain size of 0.39 mm. With similar characteristics as the native beach, the sand source is compatible as beach fill. Beach and borrow area sand characteristics for the Western and Central reaches are summarized in Table 19. Borrow Area 2-West has a surface area of 209 acres, and lies in water depth of 44-53 feet NGVD.

Borrow Area 2-East: The sand source for the Fire Island Pines and Davis Park project is located 1.0 miles south and 3.0 miles southwest of the communities, respectively, and contains approximately 942,000 cubic yards of sand following the 2003 nourishment project. Borrow area sediment is medium gray sand with a silt content of less of 2%. The borrow area sand has a composite mean grain size of approximately 0.42 mm, which is compatible as beach fill. The beach and borrow area sand characteristics for Fire Island Pines and Davis Park are summarized in Table 19. Davis Park has a dry beach mean sand grain size smaller than all the other reaches, and may be a contributor to the high erosion rate. Borrow Area 2-East has a surface area of 156 acres, and lies in water depth of 38-43 feet NGVD.

Table 19. Borrow Area and beach grain size comparison.

Location	Mean Grain Size (mm)	(phi)	Sort (phi)	Silt (%)	Mean Grain Size (mm)*
1995 Composite Sand Size					
Saltaire	0.39 mm	1.39	0.77	0.14 %	0.36* mm
Fair Harbor	0.42 mm	1.24	0.64	0.12 %	0.34* mm
Dunewood	0.37 mm	1.44	0.96	0.18 %	0.32* mm
Fire Island Pines	0.45 mm	1.14	0.75	0.19 %	0.29 mm
East	0.48 mm	1.07	0.86	0.10 %	0.29* mm
West	0.45 mm	1.14	0.75	0.19 %	0.29* mm
2007-8 Dry Beach Sample					
Saltaire	0.44 mm	1.17	0.51	0.83 %	
Dunewood	0.48 mm	1.07	0.68	0.39 %	
Fire Island Pines(08)	0.47 mm	1.10	0.52	0.25 %	
Davis Park (07/08)	0.23/0.38 mm	2.10/1.41	0.38/0.42	0.46/0.22 %	
Ocean Bay Park	0.39 mm	1.37	0.51	0.19 %	
Seaview	0.42 mm	1.26	0.60	0.52 %	
Ocean Beach	0.37 mm	1.45	0.57	0.17 %	
Borrow Area Composite Mean Grain Size					
2-West	0.39 mm	1.36	1.02	4.12 %	
2-East	0.42 mm	1.25	0.73	1.90 %	

NOTE:
*2001 Dry Beach Samples.

The use of the 1993-94 Fire Island and the 1997 Fire Island Pines borrow areas (Figure 1) caused concern among some communities, especially Cherry Grove, about potential borrow area impacts. Based on a review of USACOE and CPE monitoring data since 1995, there appears to be no intensification of erosion in the shadow of the dredged 1993 and 1997 borrow areas. In addition, the USACOE Interim Study (1999) includes a combined refraction and shoreline change model, which evaluated the potential for dredging impacts. The model was used to predict with and without project conditions for Fire Island, including impacts of dredging the USACOE borrow area. The model indicated that potential impacts were minimal. Moreover, the proposed borrow areas are smaller than the USACOE modeled area and located in deeper water. A comparison of size and cut depth between the proposed and modeled borrow areas indicates that only negligible effects will occur.

Further analysis based on the performance of the 1993-94, 1997 and 2003 projects indicates that borrow area impacts should be minimal. The 1993-94 borrow area is located in water depths of 42-46 feet NGVD and approximately 1 million cubic yards were removed from it. The 1997 borrow area was used to place 650,000 cubic yards of sand at Fire Island Pines, and was located in water depths of 35-44 feet NGVD. In both cases, there has been no significant impact to the adjacent shoreline in the vicinity of the borrow areas. An analysis of the 1998 and 2007 shorelines created from LIDAR data shows no signature indicating impacts from the 2003 use of Borrow Areas 2-East and 2-West. Based on the performance of the four previously dredged areas, the continued use of Borrow Areas 2-East and 2-West should have nelgigible impact.

The borrow areas will not be a trap for littoral sands. The closure depth (limiting depth) defines the seaward limit of the active beach profile. Significant sand movement does not occur beyond the closure depth. Hands (1991) determined a closure depth of -27 feet for the south shore of Long Island. Comparisons of annual beach profiles since 1995 indicate a shallower closure depth of –18 feet NGVD based on profile closure (CPE, 2001; Batten, 2003). The shallowest portion of the proposed sand source is almost twice these depths. The borrow areas are approximately ½ mile beyond the closure depth and will not impede nearshore littoral sand transport. The USACOE recently established a planning depth of -37 NGVD as the shallowest depth for borrow areas. This is shallower than both Borrow Areas 2-West and 2-East.

Borrow area 2-East is proposed to be deepened 1-3 feet on its east end compared to the 2003 permitted borrow area. Due to concerns outlined above, a refraction analysis was conducted to evaluate any change in impact. Results are provided in Section 4.1.3 below.

Borrow areas 2-East and 2-West will be exhausted after the 4 reaches are nourished, and they will not be used again.

3.1.4 Offshore Sand Ridges

The offshore area has been extensively investigated with at least rudimentary sand source characterization. Most of the sand source investigations leading to proposed or permitted borrow areas have been closer to shore on the nearshore end of the ridges. This area has the most accessible and economical sand. Based on these investigations, the USACOE has developed borrow areas in Regions 2 and 3 to support future Fire Island projects. Initial Corps nourishment of Fire Island would require approximately 3% of the two ridges shown in Figure 16 (p. 71). This leaves near shore sources at Moriches and Fire Island Inlets and in Borrow Area 1 region.

The USACOE and USGS have characterized sand beyond the nearshore sand region, and it holds promise for beach compatible sand sources (USACOE 2008 and 1996) based on surface samples and some vibracore sampling. Based on the volume of the ridges, only a small percentage of this region needs to be beach compatible to support future projects. Fire Island is not the only region that may need sand from sources farther from the beach. In many regions of Florida, the second or third line of sand has been developed for nourishment. Without major changes to existing dredging equipment, sand can be mined economically in water depth up to approximately 70-80 feet based on recent experience. Although the potential exists, only Borrow Area 2-East and 2-West are developed and permitted sufficiently to support the proposed projects. Any change at this stage would cost up to a million dollars and take up two to three years to develop and permit, even using Corps borrow area information developed for FIMP.

Sand on the ridges is generally coarser than the sand in the troughs and other low points offshore. Sand sorting caused by waves and currents make the tops of ridges good prospects for beach compatible sand. Waves and currents move fine sand readily, but the coarser sand is more resistant. This has implications for onshore sand transport. Finer sand has the greatest potential to move cross-shore to the beach, but may not be sufficiently beach compatible (coarse enough) to provide any beach width. A recent sand sample collected on Davis Park beaches may be an indicator. This dry beach sample had a mean grain size of 0.23 mm in 2007, compared to mean grains sizes of 0.36 and 0.41 taken in 2005 (CPE 2005). A beach with this composite grain size would not produce a significant beach width, and would have to be considered only partially effective compared to a volume of coarser native beach or borrow area sand, based on the equilibrium profile theory (Houson 1996). Davis Park is next to Watch Hill, the primary historic source of off shore sands. Many locations were considered in 2001 for borrow areas, and the two selected best met the needs of the project and permit conditions in 2003. Their continued use as a viable sand source for this project is based on a wide variety of indicators and earlier preference by NPS.

3.2 Water Quality

Limited data exist on surface water quality in the offshore waters of the Atlantic Ocean near Fire Island. The USACOE collected some water chemistry measurements associated with a multispecies biological inventory in 2001 (USACE 2002). Sampling occurred offshore of the eastern project section, near the communities of Fire Island Pines/Cherry Grove, and west of Shinnecock Inlet. Water quality parameters sampled included surface and bottom temperature, salinity, dissolved oxygen, pH, conductivity, and light transmission/secchi depth. Temperatures ranged from 2°C at the ocean floor in January 2001 to ~20°C on the ocean surface in September 2000. Mean dissolved oxygen values at the ocean surface ranged from 5.2 to 11.5 mg/L with peak values observed in the winter months and minimum values observed during the early fall. Salinity values remained fairly constant ranging between 29.5-32.3 ppt. Peak salinity values were observed at the Cherry Grove sampling site in May. Light transmission/secchi depth fluctuated greatly at both Shinnecock and Cherry Grove sites; ranging between 2.7 and 4.8 meters at Cherry Grove. Greatest values for light transmission were observed in September and minimum values were observed in December. Maximum and minimum monthly means from this study for several water quality parameters are outlined in Table 20.

Table 20. USACOE water quality results for samples taken May-October off of Cherry Grove, Fire Island (near to Borrow Area 2-East).

Description	Low Value	High Value
Temperature	2.5°C (bottom)	22.3°C (surface)
Salinity	29.6 ppt	31.9 ppt
Dissolved Oxygen	4.7 mg/L (bottom)	11.1 mg/L
PH	8.2	8.6
Light transmission (Secchi)	2.0m (December)	4.8m (September)

There are no known Hazardous, Toxic, Radioactive Waste (HTRW), Comprehensive Environmental Response, Compensation, Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) sites within the borrow areas. No assessment for HTRW was required, as the borrow areas are not within a site designated by the U.S. EPA or NY State, nor are they part of the National Priority List under CERCLA.

Sand from the borrow areas is predominantly quartzose sand, which lacks the affinity for binding of contaminants. In addition, the extremely low organic carbon and clay content of the borrow area sediments makes the presence of contaminants highly unlikely other than at trace levels.

3.3 Terrestrial Ecology

3.3.1 Maritime Beach and Dune Communities

Ecological and geological processes are inter-connected along the shorelines of barrier islands as the ecological communities present are influenced heavily by the variable patterns of accretion and erosion of sediment. Accordingly, maritime beaches are sparsely vegetated; the vegetation present on maritime dunes is a mosaic influenced by the stability of the dune, recent erosional events, and distance from the ocean. Similarly, these plant communities are integral to the formation, persistence, and health of beach and dune environments. For instance, primary dunes are created by the slow accumulation of aeolian sand at the base of beach vegetation, particularly American beachgrass (*Ammophila breviligulata*), and beach debris. The root and rhizome systems of beach flora together with mychorrizal fungi serve to bind together fine sand and soil particles, thereby minimizing erosion and stabilizing the dune. Remaining plants and their rhizomes still attached to a dune may also aid in the repair and/or re-accretion of sand on that damaged dune. In addition, beach and dune vegetation provides critical food, nesting sites, and protective cover for various types of wildlife.

The vegetation communities found in beach and dune environments exhibit a characteristic pattern of zonation in response to an environmental gradient of the frequency of tidal inundation and severity of wind-blown salt and sand. The floral species most tolerant of tidal inundation and salt spray are located on the open beach and foredune, whereas the more sheltered dune swales and secondary dunes are colonized by less tolerant plant species. Plant species commonly found seaward of the primary dune and on the foredune in the project areas include American beachgrass (*Ammophila breviligulata*), sea rocket (*Cakile edentula*), beach pea (*Lathyrus japonicus*), dusty miller (*Artemisia stelleriana*), seaside goldenrod (*Solidago sempervirens*), common saltwort (*Salsola kali*), seaside spurge (*Chamaesyce polygonifolia*), and seabeach atriplex (*Atriplex arenaria*). Beach and dune vegetation provides critical food, nesting sites, and protective cover for various types of wildlife.

In addition, the open beach and foredunes are the preferred habitat for two special status species, seabeach amaranth (*Amaranthus pumilus*) and seabeach knotweed (*Polygonum glaucum*). Seabeach amaranth is designated as Federally threatened, and seabeach knotweed is listed as rare in New York State. Seabeach amaranth is an often inconspicuous annual plant with fleshy stems and leaves. It grows prostrate to the sand surface and forms mats of branched stems up to 0.4 meters in diameter. Seabeach knotweed, listed as rare in New York State according to the New York State Natural Heritage Program (NYNHP, 2007), also grows prostrate to the substrate. A prostrate growth presumably allows these plants to avoid damage by wind-blown salt and sand that would cause the plants to lose precious moisture. Seabeach knotweed is occasionally found on sandy beaches, brackish swales, and the edge of salt marshes and can be most common in beach overwash situations (NPS 2001, 2002).

On the leeward side of the primary dune and the swale, one would expect to find the aforementioned species, as well as less salt-tolerant woody vegetation including beach plum (*Prunus maritima*), bayberry (*Myrica pennsylvanica*), rugosa rose (*Rosa rugosa*), Virginia creeper (*Parthenocissus quinquefolia*), and poison ivy (*Rhus radicans*). Bearberry (*Arctostaphylos uva-ursi*), beach-heather (*Hudsonia tomentosa*), and the lichens (*Cladinia submitis* and *Cetraria arenaria*) may also be found in the swale or near secondary dunes. Behind the primary dune and swale, other ecological communities are present on Fire Island including freshwater wetlands, bogs, and maritime shrublands, heathlands, and forests. These communities often possess a large diversity of plant species and provide habitat for a wide variety of wildlife. These ecological communities are not typically located immediately behind the primary dunes in the 2008 nourishment areas.

Following the 2003 beach nourishment project, vegetation surveys were conducted along the length of the communities of Saltaire, Fair Harbor, Dunewood, Lonelyville, and Fire Island Pines. Vegetation surveys were conducted once per month in 2004 and 2005 throughout the project area, weather permitting. Vegetation was inventoried utilizing the transect method. Transects were established along existing section lines, approximately 900-1,100 feet apart. Species identification and abundance were inventoried out five feet (5’) to the west and five feet (5’) to the east of each transect line, for a total transect width of ten feet (10’). Vegetation was photographed and a GPS position of any threatened or endangered species, especially seabeach amaranth (*Amaranthus pumilus*), was recorded.

Species observed during the 2004-2005 survey period included American beachgrass (*Ammophila breviligulata*), beach pea (*Lathyrus japonicus*), dusty miller (*Artemisia stelleriana*), common saltwort (*Salsola kali*), seaside spurge (*Chamaesyce polygonifolia*), sea rocket (*Cakile edentula*), seabeach amaranth (*Amaranthus pumilus*) and seabeach knotweed (*Polygonum glaucum*). A detailed discussion of seabeach amaranth observed within the 2003 nourishment project areas is provided in section 3.4.2.5 below.

As expected, these surveys indicated that beach vegetation is most abundant in areas of wide, high-elevation beaches with limited vehicle and pedestrian traffic that result in the destruction of plant seedlings and root systems. Central Fire Island Pines from Coast Guard Walk to Ozone Walk had the most abundant and diverse vegetation during the 2004-2005 survey period. Plant communities in the project areas have since been negatively impacted by continued vehicle traffic, recreational use of the beaches, and erosion caused by high tides and storm events. Vehicle and pedestrian traffic can crush plant seedlings and rhizomes resulting in depauperate vegetation communities. Monitoring for piping plover and seabeach amaranth in 2007 and 2008, required following the 2003 nourishment, indicated that erosion following the April 2007 nor'easter and erosion events in May of 2008 has also contributed to very sparse vegetative cover seaward of the crest of the dune in the 2003 nourishment communities. Typically, the pioneer plant species described above can only successfully germinate and grow landward of snow fencing placed on the beach to trap aeolian sand and afford protection for these plants from ORV and pedestrian traffic. Seaward of this snow fencing, the beach consists ruts and ridges of unconsolidated sand caused by the repeated disturbance of ORV traffic.

3.3.2 Beach Invertebrates

A wide variety of invertebrates may be found in the vegetated areas of the upper beach and the supratidal beach. These organisms are typically associated with areas of beach vegetation and wracklines. A monitoring study employing core sampling to collect burrowing organisms, sight-sampling of wracklines, and pitfall trap sampling, conducted subsequent to the 2003 beach nourishment project, found a diverse assemblage of invertebrates. Represented taxa included Canaceidae, Cicadellidae, Hymenoptera (Chalcidoidea, Formicidae, Procurtrupoidea), Simuliidea, Diptera (Culicidae, Muscidae, Ephydridae), and Coleoptera (Staphylinidae, Chrysomelidae, Notoxidae) (Land Use Ecological Services, 2005). Some of these taxa are also present in the swash and intertidal zones.

3.3.3 Wildlife

Birds

The diverse upland, wetland, beach, and nearshore habitats present on Fire Island are utilized by many species of residential and migratory birds at various times of the year. In fact, 110 avian species are considered to be abundant or common on Fire Island with another 165 species expected to be observed uncommonly, occasionally, or rarely on Fire Island (FIIS, 1999).

The intertidal zones, including beaches, marshes, and intertidal flats, of the ocean and bay shorelines of Fire Island provide essential foraging habitat for a wide variety of resident and migratory shorebirds. Migratory shorebirds are expected to utilize these shorelines during the spring (late winter through June) and fall (late July through early fall) migrations (NYSDOS

1998a). Shorebirds will feed on invertebrates in these intertidal areas and rest above the high tide line (USACE 1999). Shorebird species expected to utilize the ocean and bay shoreline including sanderlings (*Calidris alba*), semipalmated plovers (*Charadrius semipalmatus*), piping plover (*Charadrius melodus*), semipalmated sandpipers (*Calidris pusilla*), least sandpipers (*Calidris minutilla*), western sandpipers (*Calidris mauri*), black-bellied plover (*Pluvialis squattarola*), American oystercatcher (*Haematopus palliates*), dunlin (*Calidris alpine*), ruddy turnstone (*Arenaria interpres*), purple sandpipers (*Calidris maritima*), short-billed dowitchers (*Limnodromus griseus*), and yellowlegs (*Tringa sp.*) (Howe, 1978; USACE, 2003). A few of these species are expected to overwinter on Fire Island in small numbers including sanderling, black-bellied plover, purple sandpiper, and common snipe (*Gallinago gallinago*) (NYS DOS 1998a).

Beach and dune habitats are also utilized as courting and nesting grounds for several species, including the piping plover (*Charadrius melodus*), killdeer (*Charadrius vociferous*), least tern (*S. antillarum*) and black skimmer (*Rynchops niger*). The piping plover is listed as a Federally threatened and state endangered species, while the least tern is listed as a state threatened species. However, review of available data on shorebird breeding activity indicates that the Fire Island community beaches have not been significant nesting habitats for these vulnerable species (NPS, 2003).

Open beach areas are utilized for resting and loafing by residential species such as the herring gull (*Larus argentatus*), great black-backed gull (*L. marinus*), ring-billed gull (*L. delawarensis*), laughing gull (*L. atricilla*), and mallard (*Anas platyrynchos*). During winter months, ocean beaches may also be utilized by the glaucous gull (*L. hyperboreus*) and Iceland gull (*L. glaucoides*) as these species will be found with resident gull species feeding on large invertebrates, including surf clams and crabs, in the wrackline. In addition, smaller gulls such as Bonaparte’s gull (*L. philadelphia*), little gull (*Larus minutus*), and black-headed gull (*Larus ridibundus*) can be found hovering/dipping in the inshore ocean waters feeding on small invertebrates.

Migratory terns utilizing open beach areas include the NY State threatened common tern (*Sterna hirundo*), least tern (*Sterna atillarum*), and roseate tern (*Sterna dougali*). These will be discussed in the following section on special status species.

Other birds observed in open beach habitats on Fire Island include American crow (*Corvus brachyrynchos*), barn swallow (*Hirundo rustica*), common grackle (*Quiscalus quiscula*), eastern kingbird (*Tyrannus tyrannus*), European starling (*Sternus vulgaris*), fish crow (*Corvus ossifragus*), rock dove (*Columbra livia*), eastern towhee (*Piplio erythrophthalmus*), red-winged blackbird (*Agelaius phoeniceus*), rusty blackbird (*Euphagus carolinus*), snow bunting (*Plectrophenax nivalis*), song sparrow (*Melospiza melodia*), and house sparrow (*Passer domesticus*). In addition, the swales located behind dunes and dominated by beach grass and other herbaceous vegetation may be utilized by many of the aforementioned passerines and other species including common yellowthroat (*Geothlypis trichas*), northern harrier (*Circus cyaneus*), killdeer (*Charadrius vociferus*), brown-headed cowbird (*Molothrus ater*), grey catbird (*Dumatella carolinensis*), mourning dove (*Zenaida macroura*), horned lark (*Eramophila alpestris*), northern mockingbird (*Mimus polyglotta*), northern flicker (*Colaptes aura*), American tree sparrow (*Spizella arborea*), grasshopper sparrow (*Ammodramus bairdii*), and yellow-rumped warbler (*Dendroica coronata*) (USACOE, 2003).

Large numbers of migrating and wintering waterfowl utilize the shallow waters of the Great South Bay for resting and feeding during the winter months. Waterfowl species documented to utilize the Great South Bay include greater scaup (*Aythya marila*), common loon (*Gaviaimmer*), long-tailed duck (*Clangula hyemalis*), American black duck (*Anas rubripes*), brant (*Branta bernicula*), red-breasted merganser (*Mergus serrator*), common goldeneye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), and scoters (*Melanitta spp.*) (NYSDOS 1998a). Large concentrations of these waterfowl are expected to be found primarily in the bays to the north of Fire Island; however, the nearshore waters of the ocean beaches of Fire Island are also expected to be utilized by various scoters (*Melanitta spp.*).

Fire Island National Seashore serves as an important migration corridor for numerous species of raptors including sharp-shinned hawk (*Accipter striatus*), merlin (*Falco columbarius*), peregrine falcon (*Falco peregrinus*), turkey vulture (*Cathartes aura*), northern goshawk (*Accipter gentilis*), Cooper's hawk (*Accipter cooperii*), red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), rough-legged hawk (*Buteo lagopus*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucophalus*), and gyrfalcon (*Falco rusticolis*). Between 1980 and 1995, ~5,000 migrating raptors, on average, were observed on Fire Island annually (NY Audubon 2002). In addition, several owl species are expected to utilize Fire Island as habitat including great horned owl (*Bubo virginicus*), eastern screeh owl (*Otus asio*), snowy owl (*Nyctea scandiaca*), short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), saw-whet owl (*Aegolius acadicus*), and barn owl (*Tyto alba*).

Following the 2003 beach nourishment project, the communities of Saltaire, Fair Harbor, Dunewood, Lonelyville, and Fire Island Pines were monitored during the spring and summer months. Species observed during this monitoring included the herring gull (*Larus argentatus*), great black-backed gull (*L. marinus*), ring-billed gull (*L. delawarensis*), laughing gull (*L. atricilla*), common tern (*Sterna hirundo*), least tern (*Sterna atillarum*), piping plover (*Charadrius melodus*), sanderling (*Calidris alba*), semipalmated plover (*Charadrius semipalmatus*), song sparrow (*Melospiza melodia*), common grackle (*Quiscalus quiscula*), American crow (*Corvus brachyrynchos*), rock dove (*Columba livia*), and mallard (*Anas platyrhynchos*) (Land Use Ecological Services, 2005-2007).

Mammals and Herpetiles

A variety of mammal and herpetile species are known to utilize the diverse upland and wetland habitat present on Fire Island. A USACOE study (2004) found that small mammals tended to be most abundant in heavily vegetated habitats including *Phragmites* marshes, shrub thickets, high marshes, and woodlands while herpetiles were typically most abundant around freshwater wetlands. However, several mammals and herpetiles were found to utilize open beach and dune swales habitats, although their densities were lower than those observed in more vegetated habitats. Observed mammals included white-footed mouse (*Peromyscus leucopus*), meadow vole (*Pennsylvaniana maniculatus*), masked shrew (*Sorex cinerus*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), and woodland vole (*Microtus pinetorum*). Larger mammals present in these habitats include white-tailed deer (*Odocoileus virginianus*), cottontail rabbit (*Sylvilagus floridanus*), and red fox (*Vulpes vulpes*). Herpetiles are not expected to be particularly abundant in open beach and dune habitats. However, Fowler's toad (*Bufo woodhousei*) may be present in sandy areas near marshes and ephemeral pools and box turtle (*Terrapene carolina*) in vegetated swales behind the primary dunes.

Special Status Species

Federally listed terrestrial wildlife and plants documented on FIIS include the threatened piping plover (*Charadrius melodus*), endangered roseate tern (*Sterna dougallii*), peregrine falcon (*Falco peregrinus*), and seabeach amaranth (*Amaranthus pumilus*). Threatened and endangered marine mammals and sea turtles also occur in the waters along FIIS; they are addressed here and will also be addressed in the following section on aquatic ecology (Section 3.4). A number of state listed species also have the potential to occur on FIIS, including the tern species addressed below (Table 21). Seabeach knotweed was delisted from a threatened classification in New York State; it is now listed as rare. Input and comments were solicited from USFWS, NMFS, NYSDEC and NYNHP since the first EA scoping meeting December 2007 in order to access the most current, available data and to address agency concerns.

Table 21. Special status species of potential concern in the action area.

Common Name (*Scientific Name*)	Status*	Documented in Action Area	Presence in Action Area
Piping plover (*Charadrius melodus*)	FT, SE	Yes	Have been documented nesting and foraging at more locations in park in recent years. Most nesting activity occurs in the Otis Pike Wilderness Area to east of action area. Plover nests in western Fire Island typically occur in the Sailors Haven/Sunken Forest area. In 2007, four plover nests were located in western Fire Island. Nesting plovers were observed at Talisman/Barrett Beach, Sailors Haven/Sunken Forest, and Lighthouse Beach. In 2004, a plover nest was located in Fire Island Pines. In 1997, a plover nest was located in Water Island. Plovers typically begin arriving at the park in mid-March where they commonly nest on beaches, foredunes, and overwash areas from mid-April through July. Adult and juvenile plovers feed on oceanside beaches near the tide line and in shallow, near-shore areas of Great South Bay. Adults and fledged offspring typically have left the park by early September (USFWS 1988, NYSDEC 2000).
Roseate tern (*Sterna dougallii*)	FE, SE	No	Have been infrequently/sporadically observed foraging but not nesting at the park. Roseate terns typically begin arriving in New York in late April where they nest on sandy, shelly, or gravely beaches. Historically, they have nested on islands within FIIS boundaries, but not on Fire Island itself (NPS 2003a unpublished). Adults and fledged offspring begin leaving New York in late August or early September (NYSDEC 1998a, NYSDEC, 1998b).
Least tern (*Sterna antillarum*)	SE	Yes	Have been documented nesting and foraging at several locations in the park, including Sunken Forest approximately four miles west and Watch Hill approximately three miles east of the action area. Failed nests have occurred in the western communities including Atlantique and Point O'Woods. Least terns typically begin arriving at the park in late April where they nest on sandy beaches or offshore islands (NYSDEC, 1998c). Adults and fledged offspring begin leaving the park in late August or early September.
Common tern (*Sterna hirundo*)	ST	Yes	Have been documented nesting and foraging at several locations in the park, including Sunken Forest approximately four miles west and Long Cove approximately four miles east of the action area. Common terns typically begin arriving at the park in late April where they nest on sandy, gravely, or shelly beaches or offshore islands. Adults and fledged offspring begin leaving the park in late August or early September (NYSDEC, 1998b; NYSDEC, 1998d).
Seabeach amaranth (*Amaranthus pumilus*)	FE, SE	Yes	Has been documented at several locations in the park, including lower foredunes and oceanside beaches in the action area.

*FE = Federally endangered, FT = Federally threatened, SE = State endangered, ST = State threatened,

Piping Plover

Piping plovers are small, sand-colored shorebirds, approximately 17 cm (7 inches) long, with a wingspread of about 38 cm (15 inches) (Palmer 1967). On January 10, 1986, the piping plover was listed as endangered and threatened pursuant to the ESA. Protection of the species under the ESA reflects the species precarious status range-wide. Three distinct populations were identified and listed separately: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). The Atlantic Coast population breeds on sandy, coastal beaches from Newfoundland to North Carolina, and winters along the Atlantic Coast from North Carolina south, along the Gulf Coast to Texas, and in the Caribbean (USFWS 1985). On July 10, 2001, the Service designated critical habitat for wintering piping plovers, including southern areas used by wintering plovers from the Atlantic Coast population. Critical habitat was also designated in the Great Lakes breeding area on May 7, 2001, and proposed for the Northern Great Plains breeding area on June 12, 2001 (USFWS 2001). No critical habitat has been designated or proposed in the Atlantic Coast breeding area.

The recovery plan for the Atlantic Coast population of the piping plover (USFWS 1996a) delineates four recovery units or geographic subpopulations within the population: Atlantic Canada, New England, New York-New Jersey, and Southern (Delaware, Maryland, Virginia, and North Carolina). Recovery criteria established within the recovery plan define population and productivity goals for each recovery unit, as well as for the population as a whole. Recovery benchmarks for the piping plover include criteria for the number and distribution of breeding pairs in the Atlantic Coast population. These criteria will be attained when 2,000 breeding pairs are observed and maintained for five consecutive years. The New York-New Jersey recovery unit must account for 575 of these 2,000 breeding pairs. Attainment of the goals for each recovery unit is an integral part of a piping plover recovery strategy that seeks to reduce the probability of extinction for the entire population by: (1) contributing to the population total, (2) reducing vulnerability to environmental variation (including catastrophes such as hurricanes, oil spills, or disease), (3) increasing likelihood of genetic interchange among subpopulations, and (4) promoting re-colonization of any sites that experiences declines or local extirpations due to low productivity or temporary habitat succession. In accordance with the Endangered Species Consultation Handbook (USFWS and NMFS 1998), since recovery units have been established in an approved recovery plan, this EA considers the effects of the proposed project on piping plovers in the New York–New Jersey Recovery Unit, as well as the Atlantic Coast population as a whole.

In 1989, the Atlantic Coast population consisted of 957 pairs with 319 pairs located in the New York-New Jersey region (USFWS, 2004a). Management efforts have resulted in significant gains in the Atlantic Coast population which, in 2006, consisted of 1749 plover pairs with 538 pairs located in New York State (USFWS, 2006). The distribution of Atlantic Coast piping plovers remains heavily concentrated in New England; however, the New York-New Jersey recovery unit has made recent gains and has accounted for 26.4-36.0% of the coastwide total since 2004 (USFWS, 2004a; USFWS, 2004b; USFWS, 2005; USFWS, 2006).

Piping plovers return to their Atlantic Coast nesting beaches in mid-March (Coutu *et al*. 1990; Cross 1990; Goldin 1990; MacIvor 1990; Hake 1993). Males establish and defend territories and court females (Cairns 1982). Piping plovers are monogamous, but usually shift mates between years (Wilcox 1959, Haig and Oring 1988, MacIvor 1990), and less frequently between nesting attempts in a given year (Haig and Oring 1988, MacIvor 1990, Strauss 1990). Plovers are known to begin breeding as early as one year of age (MacIvor 1990, Haig 1992); however, the percentage of birds that breed in their first adult year is unknown.

Piping plover nests can be found above the high tide line on coastal beaches, on sand flats at the ends of sand spits and barrier islands, on gently sloping foredunes, in blowout areas behind primary dunes, and in washover areas cut into or between dunes. Nest sites are shallow, scraped depressions in substrates ranging from fine-grained sand to mixtures of sand and pebbles, shells or cobble (Bent 1929, Burger 1987, Cairns 1982, Patterson 1988, Flemming *et al*. 1990, MacIvor 1990, Strauss 1990). Nests are usually found in areas with little or no vegetation, although, on occasion, piping plovers will nest under stands of American beachgrass *(Ammophila breviligulat*a) or other vegetation (Patterson 1988, Flemming *et al*. 1990, MacIvor 1990). Plover nests may be very difficult to detect, especially during the 6-7 day egg-laying phase when the birds generally do not incubate (Goldin 1994).

Eggs may be present on the beach from early April through late July. Clutch size for an initial nest attempt is usually four eggs, one laid every other day. Eggs are pyriform in shape, and variable buff to greenish brown in color, marked with black or brown spots. The incubation period usually lasts 27-28 days. Full-time incubation usually begins with the completion of the clutch and is shared equally by both sexes (Wilcox 1959, Cairns 1977, MacIvor 1990). Eggs in a clutch usually hatch within 4 to 8 hours of each other. Reasons for egg losses typically include tidal flooding, human disturbance, and predation (Lauro and Tanacredi 2002).

Piping plovers generally fledge only a single brood per season, but may re-nest several times if previous nests are lost. Chicks are precocial (Wilcox 1959, Cairns 1982). They may move hundreds of meters from the nest site during their first week of life (USFWS 1994), and chicks may increase their foraging range up to 1,000 m before they fledge (are able to fly) (Loegering 1992). Chicks remain together with one or both parents until they fledge at 25-35 days of age. Depending on date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988, Goldin 1990, MacIvor 1990, Howard *et al*. 1993).

Cryptic coloration is a primary defense mechanism for this species; nests, adults, and chicks all blend in with their typical beach surroundings. Chicks sometimes respond to vehicles and/or pedestrians by crouching and remaining motionless (Cairns 1977, Tull 1984, Goldin 1993, Hoopes 1993). Adult piping plovers also respond to intruders (avian and mammalian) in their territories by displaying a variety of distraction behaviors, including squatting, false brooding, running, and injury feigning. Distraction displays may occur at any time during the breeding season, but are most frequent and intense around the time of hatching (Cairns 1977).

Plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929, Cairns 1977, Nicholls 1989). Important feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sand flats, wrack lines, sparse vegetation, and shorelines of coastal ponds, lagoons or salt marshes (Gibbs 1986, Coutu *et al*. 1990, Hoopes *et al*. 1992, Loegering 1992, Goldin 1993, Elias-Gerken 1994). Studies have shown that the relative importance of various feeding habitat types may vary by site (Gibbs 1986, Coutu, *et al.* 1990, McConnaughey *et al*. 1990, Loegering 1992, Goldin 1993; Hoopes 1993, Elias-Gerken 1994), and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin 1990). Feeding activities of chicks are particularly important to their survival. Most time budget studies reveal that chicks spend a high proportion of their time feeding.

Cairns (1977) found that piping plover chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight gain by the twelfth day were unlikely to survive. During courtship, nesting, and brood rearing, feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances where brood-rearing areas are widely separated from nesting territories are not uncommon. Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1993), and at all stages in the tidal cycle (Goldin 1993, Hoopes 1993). Plovers generally forage on the beach, but also in dune swales or on the bay shore if there is access through the primary dunes for flightless chicks (NPS 2001b).

Piping plovers arrive on Fire Island in March; egg-laying and incubation occurs from April through June, with chicks typically hatching from May through August. Plovers begin leaving Fire Island in August and are almost completely gone by September (NPS 2001b). Adult piping plovers returning to FIIS in spring can be found almost anywhere along the beaches. Nesting in recent years occurs primarily on the beaches in front of the Otis Pike Wilderness Area (OPWA). In 2007, plover nests in the OPWA accounted for 84% of the observed nests (FIIS 2007). Plovers have also been documented in other areas of the park sporadically over the past 12-17 years.

Piping plover counts have been conducted on Long Island since 1985, with an average of 9.5 pairs per year on Fire Island from 1985 to 2007 (ranging from a low of 1 to a high of 25, Table 22). Piping plover nesting productivity on FIIS has been inadequate, with about 1.4 fledglings per pair since 1993 (FIIS 2007). Since 2002, the number of breeding pairs has been higher than previous years with 18.3 pairs per year and 22.0 nests per year. However, productivity has not shown similar increased numbers in recent years. Plover productivity was high, between 2.8 and 3.0 fledged chicks per pair, in 2000-2002. Since 2002, plover productivity has been substantially less, 1.72 fledged chicks per pair, with very low productivity in 2007 (0.7 chicks per pair) (FIIS 2007). Low productivity in 2007 may be attributable to a variety of factors including poor weather conditions and storm events in the beginning of the breeding season, nest disturbance resulting from interactions with humans and wildlife, and the location of several nests within recreational areas and proximal to dune crossings (FIIS 2007).

In the western portion of FIIS, most observed plovers and nest occurrences have been recorded in the Sunken Forest/Sailors Haven area, which accounted for 8% of the 25 nests observed on FIIS in 2007 (FIIS 2007). Plover nests have been located in or around the communities of Cherry Grove in 2002 and 2007, Fire Island Pines in 2004, Lighthouse Beach in 2007, Talisman/Barrett Beach in 2007, and Water Island in 1997. Piping plovers are also known to breed on beaches located just east of FIIS in Smith Point and Cupsogue County Parks. Piping plover breeding activity at these parks has been fairly consistent since 2004. Smith Point County Park has averaged 17.2 pairs per year and 21.5 nests with a productivity of 1.6 fledged chicks per pair. Cupsogue County Park has averaged 7.2 pairs per year and 9.5 nests with a productivity of 1.1 fledged chicks per pair (D. Rodgers SCDP, pers. comm.)

Table 22. Historic Success of Piping Plover Breeding Activity on FIIS, NY. 1993-2007.[1]

Year	Breeding Pairs	Nest Attempts	Productive Pairs	Eggs Hatched	Hatchlings / Breeding Pair	Chicks Fledged	Chicks Fledged/ Nest Attempt	Chicks Fledged/ Pair
1993	7	7	0	0	0	0	0	0.0
1994	3	4	0	0	0	0	0	0.0
1995	9	2	1	N/A[2]	N/A	2	1	0.2
1996	2	1	1	N/A	N/A	1	1	0.5
1997	1	1	0	0	0	0	0	0.0
1998	1	1	1	N/A	N/A	1	1	1.0
1999	3	2	2	N/A	N/A	5	2.5	1.7
2000	3	3	3	N/A	N/A	9	3	3.0
2001	4	4	4	N/A	N/A	11	2.8	2.8
2002	10	11	9	33	3.3	28	2.6	2.8
2003	20	22	15	64	3.2	35	1.6	1.8
2004	17	18	15	57	3.4	37	2.1	2.2
2005	17	20	14	54	3.2	40	2	2.4
2006	21	26	15	46	2.2	32	1.23	1.5
2007	25	35	11	45	1.8	18	.5	.7
Mean	**9.5**	**10.5**	**6.1**	**N/A**	**N/A**	**14.6**	**1.4**	**1.4**

[1]FIIS (2007)
[2]Data from previous nesting seasons are incomplete= N/A

Intensive management measures to protect piping plovers from disturbance by beach recreationists and their pets have been implemented at many New York-New Jersey plover nesting sites in recent years, including Fire Island. In New York, 95.8% of piping plover pairs nested on non-Federal lands in 1999 (Rosenblatt 2000). Piping plover protection in this recovery unit is therefore highly dependent on the efforts of state and local government agencies, conservation organizations, and private landowners. Landowner efforts are often contingent on annual commitments. While many landowners are supportive and cooperative, others are not.

Recreational activities can be a source of both direct mortality and harassment of piping plovers. Pedestrians may flush incubating plovers from nests (Flemming *et al*. 1988, Cross 1990, Cross and Terwilliger 1993), exposing eggs to predators or excessive temperatures. Repeated exposure of shorebird eggs on hot days may cause overheating, killing the embryos (Bergstrom 1991); excessive cooling may kill embryos or retard their development, delaying hatching dates (Welty 1982). Pedestrians can also displace unfledged chicks (Strauss 1990, Burger 1991, Loegering 1992, Hoopes 1993, Goldin 1993), forcing them out of preferred habitats, decreasing available foraging time, and causing expenditure of energy.

Concentrations of beach-goers may deter piping plovers from using otherwise suitable habitat. On Jones Beach Island, New York, Elias-Gerkin (1994) found less pedestrian disturbance in areas selected by nesting piping plovers than areas unoccupied by plovers. Burger (1991, 1994) found that presence of people at several New Jersey sites caused plovers to shift their habitat use away from the ocean front to interior and bayside habitats, and that the time plovers devoted to foraging decreased and the time spent alert increased when more people were present. Burger (1991) also found that when plover chicks and adults were exposed to the same number of people, chicks spent less time foraging and more time crouching, running away from people, and being alert then did adult birds.

Motorized vehicle use on beaches is also a threat to piping plovers. Vehicles can crush eggs, adults, and chicks (Wilcox 1959, Tull 1984, Burger 1987, Patterson *et. al*. 1991). In Massachusetts and New York, 18 piping plover chicks and 2 adults were killed by off-road vehicles (ORVs) in 14 documented incidents (Melvin *et a*l. 1994). Goldin (1993) compiled records of 34 chick mortalities (30 on the Atlantic Coast and 4 on the Northern Great Plains) due to vehicles. Biologists that monitor and manage piping plovers believe that vehicles kill many more chicks than are found and reported (Melvin *et al*. 1994).

Beaches used by recreational vehicles during nesting and brood-rearing periods generally have fewer breeding plovers than available nesting and feeding habitat can support. In contrast, plover abundance and productivity has increased on beaches where recreational vehicle restrictions during chick-rearing periods have been combined with protection of nests from predators (Goldin 1993). Beginning in 1999 at the North Brigantine Natural Area, Atlantic County, New Jersey, a seasonal closure to all motorized vehicles was imposed during the period when unfledged chicks are present. The number of nesting pairs of piping plovers at this site rose from 8 pairs in 1998 to 11 pairs in 2000; productivity rose from 1.50 chicks per pair in 1998 to a state record of 3.17 chicks per pair in 1999, with 2.45 chicks fledged per pair in 2000 (Jenkins *et al*. 1998, Jenkins *et al*. 1999b, Jenkins 2000).

Once hatched, piping plover broods are mobile and may not remain near the nesting area. Wire fencing placed around nests to deter predators (Rimmer and Deblinger 1990, Melvin *et al*. 1992) is ineffective in protecting chicks from vehicles because chicks typically leave the nest within a day after hatching and move extensively along the beach to feed. Typical behaviors of piping plover chicks increase their vulnerability to vehicles. Chicks frequently move between the upper berm or foredune and feeding habitat within the wrack line and intertidal zone. These movements place chicks in the paths of vehicles driving along the berm or through the intertidal zone. Chicks stand, walk, and run along tire ruts, and sometimes have difficulty crossing deep ruts or climbing out of them (Eddings *et al*. 1991, Strauss 1990, Howard *et al*. 1993). Chicks sometimes stand motionless or crouch as vehicles pass by, or do not move quickly enough to get out of the way (Tull 1984, Hoopes *et al*. 1992, Goldin 1993).

Vehicles can also degrade piping plover habitat or disrupt normal behavior patterns by crushing or burying wrack, making it unavailable for shelter or foraging. (Hoopes, *et al.* 1992, Goldin 1993). Additionally, vehicles create ruts that can trap or impede movements of chicks and may prevent plovers from using habitat that is otherwise suitable (MacIvor 1990, Strauss 1990, Hoopes *et al,* 1992, Goldin 1993, Hoopes 1994). Vehicles that are driven too close to the toe of the dune may destroy vegetation that may also serve as piping plover habitat (Elias-Gerken 1994, Allen 2001).

While trash and debris removal is desirable to reduce predation threats on the beach, the indiscriminate nature of mechanized beach-cleaning adversely affects piping plovers and their habitat. In addition to the danger of directly crushing piping plover nests and chicks and the prolonged disturbance from the machine's noise, this method of beach-cleaning removes the birds' natural wrack line feeding habitat (Eddings and Melvin 1991, Howard *et al*. 1993), and shell fragments, a preferred feature of nesting habitat.

While loss and degradation of habitat have been major contributors to the range wide decline of the piping plover (USFWS 1996a), this threat is especially prominent in the New York-New Jersey Recovery Unit. Within the New York Bight, which includes the species entire range in New Jersey and the southern Long Island shoreline, more than half the beaches are classified as “developed” (USFWS 1997). The remaining beaches in the New York Bight, classified as “natural and undeveloped,” enjoy some protection from development through the Coastal Barrier Resources Act's (96 Stat. 1653; 16 U.S.C. 3501 *et se*q.) limitations on Federal assistance and flood insurance. However, many of these areas are also subject to extensive stabilization activities that promote the formation of mature dunes, thus preventing overwash, inlet migration, and other natural coastal processes that create and maintain optimal plover habitat.

The beaches on the south shore of Long Island are affected by a variety of Federal and non-Federal management activities including inlet management, beach nourishment, dune construction, and dune stabilization. There are six inlets stabilized by hard structures along the barrier chain system from Montauk Point west to East Rockaway Inlet. Within this stretch, multiple groin fields also exist. Gilgo Beach and Jones Beach on Jones Island and Robert Moses State Park on Fire Island have been artificially nourished during the course of several Corps projects. Dune construction and beach nourishment are implemented almost entirely to protect development on the barrier island or mainland by reducing the potential for breaches and overwashes. Over the last 40 years, all major barrier island breaches have been artificially closed. Artificial plantings of American beachgrass and other species such as Japanese black pine (*Pinus thunbergii*), as well as erection of snow fencing, are used to promote the formation of large, heavily vegetated dunes, thus reducing the potential for breaches and overwashes.

Peregrine Falcon

The state endangered peregrine falcon is observed frequently at FIIS foraging and resting during the fall migration (USACE 2003). An average of 146 peregrine falcons were counted during fall migrations each year between 1986 and 1995 (NY Audubon Society 2002). This species is presented here because of its potential occurrence in the general area, but is not addressed further as it is a transient that should not be impacted by project activities.

Roseate Tern

The northeast breeding population of roseate terns has been listed as endangered since 1987. The roseate tern is exclusively a coastal bird that breeds on small islands or occasionally on barrier beaches. It arrives in coastal areas around Fire Island in April, with egg-laying, incubation, and rearing of chicks from May through August. Most roseate terns leave the coastal areas around Fire Island by the end of September. Roseate terns forage in shallow coastal waters around breeding colonies. The only roseate tern breeding colony on FIIS is on West Inlet Island (NYNHP, 2000), which means roseate terns forage in Great South Bay, off the ocean beach around Smith Point County Park, and probably into the eastern portions of the wilderness area.

The data source for roseate terns on Fire Island is NYSDEC (1994, 1998a) and the roseate tern recovery plan (USFWS 1998). At one time approximately 200 pairs were recorded on Fire Island. No roseate terns were observed on West Inlet Island between 1987 and 1996, and in 1996, 36 pairs of roseate terns were documented on West Inlet Island (NPS 2001b). A roseate tern was observed at Democrat Point in 2003 (USACE 2003). No roseate terns were observed on FIIS during the Long Island Colonial Waterbird Survey in 2007 (FIIS, 2007).

Roseate tern nesting sites continue to be associated with common tern colonies in New York (USFWS 1998). As mentioned above, the only roseate tern breeding colony within the boundaries of FIIS is on West Inlet Island. Roseate terns are occasionally observed within large flocks of other terns on the Fire Island beaches. The major threat to roseate terns is the loss of breeding colonies due to erosion, predation, and displacement by gulls. However, disturbance is also an issue. Terns regularly rest on beaches between foraging bouts. While on beaches, terns are subject to disturbance by vehicles, people, and pets.

Common Tern

The common tern arrives on Fire Island in April and May and remains until September or October. It nests from late May through July, and most young are fledged by September. Common terns typically nest in sand, gravel, or seaweed along ocean and backbay beaches and on the small islands in the Great South Bay. Based on observations documented between 1985 and 1998, with the exception of a ternery at Long Cove, most breeding occurs on the small backbay islands within FIIS. Common terns typically rest on beaches during and after foraging in the ocean and back bays (NPS 2001b). An average of 760 pairs of common terns per year have been counted on FIIS from 1985 through 1998. Bird surveys conducted by the Audubon Society counted 1207 pairs of common terns within FIIS in 1996 (Audubon 2003). Over 200 common terns were observed during surveys performed by the USACOE in 2002 and 2003 (USACOE 2003). Seven common terns were observed on FIIS during the Long Island Colonial Waterbird Survey in 2007 (FIIS, 2007). The NY Natural Heritage Program database indicates 11 common tern records: 2 points on the oceanside, 3 points on the bay beaches, and 6 points on smaller backbay islands including East Fire Island, West Fire Island, New Made Island, Sexton Island, and West Inlet Island. The most abundant terneries occur on New Made Island and West Inlet Island. Most breeding occurs on the small backbay islands. In most years observed (1985–1998), more than 98% of the tern pairs are found on the small islands in the Great South Bay. The only consistent ternery on Fire Island is at Long Cove (NPS 2001b).

Least Tern

The least tern arrives on Fire Island in April and remains through September. Egg laying, incubation, and rearing typically occur from May through August. Breeding habitat consists of flat, open sand, gravel, or dredge spoils with little vegetation. Nesting sites are typically associated with piping plover nesting sites (NPS 2001b). Least terns forage in the Great South Bay or on the ocean when the water is calm, with the most active foraging time in the early morning, and they commonly rest on beaches during and after foraging (NPS 2001b). An average of 40 pairs of least terns per year have been counted on FIIS from 1994 through 1999, predominantly at Watch Hill and Long Cove. Bird surveys conducted by the Audubon Society counted 67 pairs of least terns within FIIS in 1996 (Audubon 2003). Thirty-two least terns were observed on FIIS during the Long Island Colonial Waterbird Survey in 2007 (FIIS, 2007).

Seabeach Amaranth

Seabeach amaranth was added to the List of Endangered and Threatened Wildlife and Plants as a threatened species in 1993. The listing was based upon the loss of seabeach amaranth from two-thirds of its historic range, and continuing threats to the 55 populations that remained at the time (USFWS 1993).

Seabeach amaranth was rediscovered in New York State in 1990 after an absence of nearly 30 years (Mangels 1991). Prior to this, seabeach amaranth was only known to occur in North Carolina and South Carolina, although it historically ranged from the Carolinas to

Massachusetts. Seabeach amaranth was rediscovered on Assateague Island in Maryland in 1998 and 1999, Delaware and New Jersey in 2000, and Virginia in 2002 (Lamont and Young 2004).

Since the rediscovery of ~330 plants on Long Island in 1990, seabeach amaranth has dramatically increased in abundance. The number of observed plants on Long Island has averaged 106,382 plants from 2002-2006 (S. Young, pers. comm.). Populations of plants located on the beaches of Westhampton and Jones Beach Island have typically accounted for nearly 60% of observed amaranth plants. Record numbers of amaranth plants were observed between 2000 and 2002 when between 138,000 and 191,000 plants were observed annually (Young 2000; S. Young, pers. comm.). Since 2002, annual amaranth counts have been lower ranging between 21,000 and 35,000 (S. Young, pers. comm.). Due to the large numbers and wide distribution of seabeach amaranth on Long Island, this population now serves as an important stronghold for this species, as southern populations of this species in the Carolinas are at greater risk from hurricanes (Young, 2000).

On Fire Island, the number of observed amaranth plants has averaged 440 plants from 1990-2006 with a maximum of 2089 plants observed in 2003 and a minimum of 0 plants observed in 1998. The largest concentrations of amaranth have been recorded at Democrat Point and Smith Point (NPS 2001b). Seabeach amaranth was not observed in the western communities of Fire Island (Kismet to Point o'Woods) until 2001. Seabeach amaranth was observed slightly earlier (1999) in Fire Island Pines. The western communities exhibited peak amaranth occurrences in 2004 with 62 plants (S. Young, pers. comm.). This peak occurred one-year after maximum amaranth numbers were observed on Westhampton and Jones Island beaches and may reflect seed dispersal in longshore currents from Westhampton. Fire Island Pines peaked in 2005, with 188 plants observed (LUES, 2005). Similar to other beaches on Long Island, the number of amaranth plants in the western Fire Island communities and Fire Island Pines has declined since 2003 (S. Young, pers. comm.). Seabeach amaranth observations between Saltaire and Lonelyville ranged between 6-8 plants annually between 2005 and 2007. Seabeach amaranth observations in Fire Island Pines were high in 2005 (188 plants), but lower in 2006 and 2007 (28 and 2 plants, respectively) (LUES 2005, 2006, and 2007).

Seabeach amaranth is an annual plant of the Amaranth family (Amaranthaceae). Upon germination, the plant initially forms a small, unbranched sprig, but soon begins to branch profusely, forming a low-growing mat. Seabeach amaranth's fleshy stems are prostrate at the base, erect or somewhat reclining at the tips, and pink, red, or reddish in color. The leaves of seabeach amaranth are small, rounded, and fleshy, spinach-green in color, with a characteristic notch at the rounded tip. Leaves are approximately 1.3-2.5 cm in diameter, and clustered towards the tip of the stem (Weakley and Bucher, 1992). The foliage of seabeach amaranth turns deep red in the fall (Snyder, 1996). Plants often grow to 30 cm in diameter, consisting of 5-20 branches, but occasionally reach 90 cm in diameter, with 100 or more branches. Flowers and fruits are inconspicuous, borne in clusters along the stems. Seeds are 2.5 mm in diameter, dark reddish-brown, and glossy, borne in low density, fleshy, indehiscent utricles (bladder-like seed capsules or fruits), 4 to 6 mm long (Weakley and Bucher, 1992). The seed does not fill the utricle, leaving an air-filled space (USFWS 1996b).

The species' primary habitat consists of overwash flats at accreting ends of barrier islands, and lower foredunes and upper strands of non-eroding beaches. This species occasionally establishes small, temporary, and casual populations in secondary habitats including sound side beaches, blowouts in foredunes, and sand or shell dredge spoil or beach nourishment material (Weakley and Bucher, 1992).

Seabeach amaranth occupies a narrow beach zone that lies at elevations from 0.2 to 1.5 m above mean high tide, the lowest elevations at which vascular plants regularly occur. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season. Landward, seabeach amaranth does not occur more than a meter or so above the beach elevation on the foredune, or anywhere behind it, except in overwash areas. Therefore, this species is dependent on a terrestrial, upper beach habitat that is not flooded during the growing season. This zone is absent on beaches that are experiencing high rates of erosion. Seabeach amaranth is never found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher, 1992).

Seabeach amaranth usually occurs on a pure silica sand substrate, occasionally containing shell fragments. The U.S. Natural Resources Conservation Service classifies the habitat of seabeach amaranth as either Beach-Foredune Association or Beach (occasionally flooded). The habitat of seabeach amaranth is sparsely vegetated with annual herbs and, less commonly, perennial herbs (mostly grasses) and scattered shrubs.

Seabeach amaranth does not occur on well-vegetated sites, particularly where perennials have become strongly established (Weakley and Bucher, 1992). Seabeach amaranth seems to be incapable of competing with other plants and is typically found in areas with little or no vegetation.

Except where suitable habitat has persisted long enough for perennials to become established, the primary limiting factors of seabeach amaranth under natural conditions are abiotic. Abiotic limiting factors are expected for a fugitive species that occupies dynamic, early successional habitats. Weather is an important limiting factor, given the relatively narrow temperature and rainfall requirements for germination and seedling establishment. Flooding, drought, or unseasonable temperatures may impair seabeach amaranth survival and reproduction. Weather also limits abundance of the species through its effects on winds, which may cause burial of seeds and plants by sand. In addition to decreasing germination and seedling establishment, burial may also impact reproduction by covering adult plants prior to seed set.

Coastal storms are probably the single most important natural limitation on the abundance of seabeach amaranth. Storms erode habitat and curtail the reproductive season due to flooding and overwash. However, storm events also permit the species to survive by creating new habitat, and by providing long-distance seed transport. Through these combined effects, storms largely determine the distribution of the species in the landscape. A patchy distribution may itself limit the abundance of seabeach amaranth; colonization of suitable habitats is hampered by long distances to the nearest seed source (Weakley and Bucher, 1992).

The primary threats to seabeach amaranth are the adverse alterations of habitat caused by beach erosion and shoreline stabilization. Although seabeach amaranth does not persist on eroding beaches, erosion is not a threat to the continued existence of the species under natural conditions. Erosion in some areas is balanced with habitat formation elsewhere, such as accreting inlets and overwash areas, resulting in an equilibrium that allows the plant to survive by moving around in the landscape. In the geologic past, seabeach amaranth has persisted through even relatively rapid episodes of sea level rise and barrier island retreat. A natural barrier island landscape, even a retreating one, contains localized accreting areas, especially in the vicinity of inlets (USFWS 1996b).

Human alteration of the barrier island ecosystem generally tips the equilibrium between habitat destruction and creation in favor of destructive erosional forces. Erosion is accelerated in many areas by human-induced factors such as reduced sediment loads reaching coastal areas due to damming of rivers, and beach stabilization structures. When the shoreline is "hardened" by artificial structures *(e.g.* seawalls, bulkheads), overwash and inlet formation are curbed. Erosion may also be increasing due to sea level rise and increased storm activity caused by global climate change (USFWS 1993).

Although storms and erosion threaten seabeach amaranth, attempts to stabilize beaches against these natural processes are generally more destructive to the species and to the beaches themselves in the long term (USFWS 1993). Any stabilization of the shoreline is generally detrimental to a pioneer, upper beach annual, whose niche or "life strategy" is the colonization of unstable, unvegetated, new land, and which is unable to compete with perennial grasses (USFWS 1996b). However, where beaches are severely eroded and no habitat exists for seabeach amaranth, beach stabilization projects such as nourishment create habitat for the species.

Attempts to halt beach erosion through hard structures *(i.e.*, sea walls, jetties, groins, bulkheads) appear invariably to destroy habitat for seabeach amaranth. Even minor structures and non-structural beach stabilization techniques, such as sand fencing and beach grass planting, are generally detrimental to seabeach amaranth (USFWS 1993). Seabeach amaranth only very rarely occurs when sand fences and vegetative stabilization have taken place and, in these situations, is present only as rare, scattered individuals or short-lived populations (Weakley and Bucher, 1992).

Seabeach knotweed

Seabeach knotweed is listed as rare by the State of New York. It is an herb with prostrate to erect branching stems having alternate whitish leaves up to 3 cm long, crowded along branches with axillary clusters of small inconspicuous flowers. Seabeach knotweed begins flowering and seed dispersal during July and continues through October when the plants die. It is often found on sandy beaches, brackish swales, and the edge of salt marshes.

In 2002, more than 100 seabeach knotweed specimens were found on Fire Island. The majority of seabeach knotweed were discovered in a washover east of Old Inlet (n>100); other knotweed plants were found in front of Sailor's Haven (n=6) (NPS 2003a unpublished). They were generally located between the toe of the dune and the mean high tide line. Because seabeach knotweed often occurs with seabeach amaranth, it is expected to be similarly affected by beach renourishment.

3.4 Aquatic Ecology

3.4.1 Intertidal Zone

Intertidal and nearshore (from the surf zone to 18 ft below mean low water) environments of ocean beaches feature a diverse, yet inconspicuous, community of organisms. The species present are most often small organisms that avoid the turbulent waters of the nearshore and intertidal areas by burrowing into the sediment or residing in the water located in the interstices between sand grains.

The U.S. Army Corps of Engineers, as part of the Fire Island Inlet to Montauk Point (FIMP) Reformulation Study and Draft Environmental Impact Statement (DEIS), conducted invertebrate sampling of the beach and intertidal zones in the project area (USACOE, 2005). Sampling was conducted in May and October 2003. Species observed were identified to the lowest possible taxa. Species composition on the ocean side of Fire Island was dominated by oligochaete worms, nematode worms, *Turbellaria* flatworms, and to a lesser extent the bivalve *Mytilus edulis* (USACOE, 2005). Other observed taxa included various polychaeate worms including *Nereis arenceodonta*, *Scolelepis squamata*, *Capitella sp.*, *Scolopus sp.*, dipteran insects, *Haustoriidae* and *Neohaustorius* amphipods, *Polyciadida* flatworms, and various bivalve shells including *Astarte candensis*, *Donax sp.*, and *Tellina sp.* In addition, the amphipods *Talorchestia longicornus* and *T. megalophthalma,* ground beetles (*Clivinia* sp.), shore flies (*Ephydridae*), and nematomorpha worms were observed in the wrack lines of ocean beaches. In general, the study concluded that species density and richness is greater in the spring than the fall, and that species density and richness is highly variable in a random manner along the length of Fire Island.

3.4.2 Nearshore Waters

Nearshore waters of the ocean shoreline of Fire Island are expected to support large numbers of bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), weakfish (*Cynoscian regalis*), summer flounder (*Paralichthys dentatus*), northern puffer (*Spheroides maculatus*), northern kingfish (*Mentricirrhus saxatilus*) from April to November (NPS, 2003) with northern sea robin (*Prionotus carolinus*), clearnose skate (*Raja eglenteria*), windowpane flounder (*Scophthalmus aquosus*), Atlantic silversides (*Menidia menidia*), and sand lance (*Ammodytes sp.*) also expected to be common. Blueback herring (*Alosa aestivalus*), hickory shad (*Alosa mediocris*), alewife (*Alosa peudoharengus*), American shad (*Alosa sapidissima*), and butterfish (*Peprilus canthus*) expected to be abundant in the surf (USACE, 1999). In addition, crustaceans such as *Ovalipes ocellatus*, rock crab (*Cancer irrooratus*), spider crab (*Libinia emarginata*), and flat-clawed hermit crab (*Pagurus pollicarus*) are expected to be present in nearshore waters.

3.4.3 Offshore Borrow Site

Finfish

Finfish expected to be common in Long Island's offshore waters include winter flounder (*Pleuronectes americanus*), summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scophthalmus aquosus*), little skate (*Raja erinacea*), bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), weakfish (*Cynoscian regalis*), Atlantic mackerel (*Scomber scombrus*), black sea bass (*Centropristis striata*), butterfish (*Peprilus canthus*), Atlantic menhaden (*Brevoorita tyrannus*), scup (*Stenotomus chrysops*), northern sea robin (*Prionotus carolinus*), Atlantic silversides (*Menidia menidia*), and sand lance (*Ammodytes sp.*) (USACOE, 1999). These listed finfish species are expected to differ in their seasonal patterns of abundance at the project's proposed borrow and depositional sites. For instance, a USACOE (2001) study utilizing otter trawls to sample the finfish assemblage of the offshore and nearshore waters of coastal New Jersey found that spring trawl samples were dominated by blueback herring (*Alosa aestivalus*), skates *(Raja sp.*), anchovies (*Anchoa sp.*), windowpane flounder, and scup. In contrast, fall sampling trawls revealed mostly of butterfish, northern and striped (*P. evolans*) sea robins, skates, and windowpane flounder.

More site-specific information on the finfish community of the proposed borrow site was obtained from finfish sampling conducted in 2005 and 2006 as part of the NYSDEC 2003 permit conditions. Sampling was conducted 5/3/2005, 7/25/2005, 5/25/2006, and 8/8/2006 aboard the Research Vessel Seawolf. Surveys were performed using the U.S. Army Corps of Engineers protocol as described below:

> Bottom trawls were conducted offshore in Borrow Area 2E and Borrow Area 2W (Figure 1). A 30-foot otter trawl fitted with ½ inch mesh cod end was used for the trawls. As the borrow areas

exhibit depths with a range less than ten feet, transects lines were chosen randomly within each. Each transect was 0.25 nautical miles (nm) in length (+/- 0.03 nm) and was performed at a speed of 3.0 knots (+/- 0.3 knot). Four transects were sampled in each borrow area, and an additional four transects were conducted outside of borrow areas for control purposes. In total, twelve transects were sampled.

Catch was processed on board the vessel. It was first separated by species and then identified down to the lowest practical taxa. Total length (TL) measurements were taken for all species. When large numbers of a species were encountered, a random sub-sample of 30 was used for length measurements.

Results from the trawls are presented below (Table 23). Butterfish, long-finned squid, scup, and skates (various species) were the most common species found. Summer flounder and windowpane flounder were collected during all months sampled.

DRAFT

Table 23. Abundance of finfish species for demersal trawls conducted in USACOE Borrow Areas 2E and 2W following the 2003/04 nourishment project. Survey dates: 5/3/2005, 7/25/2005, 5/25/2006, 8/8/2006.

Species	Scientific Name	2E May Catch ('05/'06)	2W May Catch ('05/'06)	Control May Catch ('05/'06)	2E July/Aug Catch ('05/'06)	2W July/Aug Catch ('05/'06)	Control Jul/Aug. Catch ('05/'06)
Atlantic butterfish	*Peprilus* sp.	0/116	0/2	0/370	3474/1338	3348/601	2339/1077
Long finned squid	*Loligo forbesii*	5/3	13/6	105/18	60/994	285/797	178/631
Scup	*Stenotomus chrysops*	1/69	0/18	0/55	23/12	133/25	33/25
Skate	*Raja* sp.	148/81	103/57	144/98	258/47	116/110	341/157
Winter skate	*Raja ocellata*	4/0	11/0	15/0	0/0	0/0	0/0
Clearnose skate	*Raja eglanteria*	0/1	0/1	0/0	0/0	0/0	1/0
Northern searobin	*Prionotus carolinus*	0/2	0/7	0/8	2/1	6/2	3/3
Striped searobin	*Prionotus evolans*	0/1	0/2	0/0	0/0	8/1	4/1
Winter flounder	*Pseudopleuronectes americanus*	2/8	3/39	3/37	0/0	0/0	1/0
Summer flounder	*Paralichthys dentatus*	1/24	0/51	1/33	6/11	9/9	9/22
Smallmouth flounder	*Etropus microstomus*	5/1	3/3	2/4	1/1	2/1	5/1
Windowpane flounder	*Scophthalmus aquosus*	5/9	4/10	1/6	4/3	5/3	7/7
Fourspot flounder	*Paralichthys oblongus*	0/1	0/5	0/2	0/0	6/0	2/0
Red hake	*Urophycis chuss*	0/0	0/1	0/0	0/0	0/0	0/0
Spotted hake	*Urophycis regia*	1/2	0/4	0/5	0/0	1/0	0/0
White hake	*Urophycis tenuis*	0/0	0/0	1/0	0/0	0/0	0/0
Silver hake	*Merluccius billinearis*	0/1	5/0	1/0	0/0	0/3	0/0
Atlantic mackerel	*Scomber scombrus*	1/0	1/0	0/0	0/0	2/0	0/0
Black sea bass	*Centropristis philadelphica*	0/0	0/7	0/4	0/0	0/1	0/0
Scad		0/4	0/0	0/2	0/0	0/0	0/0
Bigeye scad	*Selar crumenophthalamus*	0/0	0/0	0/0	2/0	17/0	10/0
Round scad	*Decapterus punctatus*	0/0	0/0	0/0	15/6	5/0	11/1
Sand lance	*Ammodytes hexapterus*	0/0	0/2	0/0	0/0	0/0	0/0
Atlantic surf clam	*Spisula solidissima*	0/0	0/0	1/7	0/0	0/0	0/0
Dwarf goatfish	*Upeneus parvus*	0/0	0/0	0/0	1/0	1/0	0/0
Smooth dogfish	*Mustelus canis*	0/0	0/0	0/0	8/2	1/4	15/2
Planehead filefish	*Monacanthus hispidus*	0/0	0/0	0/0	1/1	0/0	0/0
Striped bass	*Morone saxatilis*	0/0	0/0	0/0	1/0	0/0	0/0
Atlantic moonfish	*Selene setapinnis*	0/0	0/0	0/0	1/0	0/0	0/0
Atlantic cod	*Gadus morhua*	0/0	0/0	0/0	0/0	1/0	0/0
Atlantic herring	*Clupea harengus*	0/0	0/0	0/0	0/0	3/0	2/0
Bigeye	*Priacanthus arenatus*	0/0	0/0	0/0	0/0	0/0	0/2
Short bigeye	*Prisigenys alta*	0/0	0/0	0/0	0/0	1/0	0/0
Coronet fish	*Fistularia commersoni*	0/0	0/0	0/0	0/0	0/1	0/0
Northern pipefish	*Syngnathus fuscus*	0/0	0/0	0/0	0/0	0/1	0/0

Essential Fish Habitat Designation:

In accordance with the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, an Essential Fish Habitat (EFH) consultation is required for the proposed beach nourishment projects. The Atlantic Ocean in the project area has been identified as an EFH for 37 species of finfish and 4 species of commercially important invertebrates (Table 24).

Table 24. Species for which an essential fish habitat (EFH) has been designated by NMFS.
(*From* http://www.nero.noaa.gov/hcd/STATES4/ConnNYNJ.htm)

Species	Eggs	Larvae	Juveniles	Adults
American plaice (*Hippoglossoides platessoides*)				
Atlantic butterfish (*Peprilus triacanthus*)	X	X	X	X
Atlantic cod (*Gadus morhua*)				
Atlantic mackerel (*Scomber scombrus*)	X	X	X	X
Atlantic salmon (*Salmo salar*)				X
Atlantic sea herring (*Clupea harengus*)			X	X
Atlantic sea scallop (*Placopecten magellanicus*)				
Black sea bass (*Centropristus striata*)	N/A	X	X	X
Bluefin tuna (*Thunnus thynnus*)			X	X
Bluefish (*Pomatomus saltatrix*)			X	X
Blue shark (*Prionace glauca*)		X	X	X
Cobia (*Rachycentron canadum*)	X	X	X	X
Common thresher shark (*Alopius vulpinus*)		X	X	X
Dusky shark (*Carcharhinus obscurus*)		X	X	
Haddock (*Melanogrammus aeglefinus*)				
King mackerel *(Scomberomorus cavalla*)	X	X	X	X
Long-finned squid (*Loligo pealei*)	N/A	N/A	X	
Monkfish (*Lophius americanus*)	X	X		
Ocean pout (*Macrozoarces americanus*)	X	X		X
Pollack (*Pollachius virens*)			X	
Redfish (*Sebastes fasciatus*)	N/A			
Red hake (*Urophycis chuss*)	X	X	X	
Sand tiger shark (*Odontaspis taurus*)		X		
Sandbar shark (*Carcharhinus plumbeus*)		X	X	X
Scup (*Stenotomus chrysops*)	N/A	N/A	X	X
Shortfin mako shark (*Isurus oxyrinchus*)		X	X	X
Skipjack tuna (*Euthynnus pelamis*)				X
Spanish mackerel (*Scomberomorus maculates*)	X	X	X	X
Spiny dogfish (*Squalus acanthias*)	N/A	N/A		
Summer flounder (*Paralicthys dentatus*)		X	X	X
Tiger shark (*Galeocerdo cuvieri*)		X	X	
Tilefish (*Lopholatilus chamaeleonticeps*)				
White hake (*Urophycis tenuis*)				
White shark (*Charcharodon carcharius*)			X	
Whiting (*Meriuccius bilinearis*)	X	X	X	
Windowpane flounder (*Scopthalmus aquosus*)	X	X	X	X
Winter flounder (*Pleuronectes americanus*)	X	X	X	X
Witch flounder (*Glyptocephalus cynoglossus*)				
Yellowtail flounder (*Limanda ferruginea*)	X			X
Quahog (*Mercenaria mercenaria*)	N/A	N/A	X	X
Surf Clam (*Spisula solidissima*)	N/A	N/A	X	X

Marine Mammals and Sea Turtles

Nearshore and offshore waters are also inhabited by several species of marine mammals and sea turtles, all of which are protected under Federal environmental regulatory statutes (Endangered Species Act of 1973, Marine Mammal Protection Act of 1972). Approximately two dozen cetacean species are found in the New York Bight. Four species of endangered whales—finback (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*) and right whale (*Balaena glacialis*)—have the potential to pass through the waters above the borrow area. All four species are state and Federally listed endangered species. They are typically found significantly farther offshore, but have the (limited) potential to enter the area during spring and fall migration periods. No records, present or past, indicate that the New York Bight is a high use foraging area for large cetaceans.

The finback whale is the most abundant of these species and occurs year round in the New York area, although it peaks in the spring and summer months. Finbacks occur in both deep and shallow water (Blaylock, et. al. 1995, NMFS 1995).

In addition, smaller cetaceans including harbor porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*) and common dolphin (*Delphinus delphis*) are also found in the New York Bight. Furthermore, five species of pinnipeds are found in these waters, the harbor seal (*Phoca vitulina*), harp seal (*P. groenlandica*), gray seal (*Halichoerus grypus*), hooded seal (*Cystophora cristata*), and rarely, ringed seal (*P. hispida*). Seals are usually observed November through May in Long Island's waters. However, seals, particularly harbor seals, may be observed year round in certain local waters, including Fire Island.

<u>Northern Right Whale</u>

Right whales have an exceptionally large head (28-33% of their body) and are generally broad for their length. Young of the year average 9 m and adults reach lengths of up to 17 m and can weigh up to 40 tons. The Northern right whale is considered the most endangered of the large whales; the North Atlantic population had been estimated at only 300-350 individuals. However, the most recent estimate, based on photo identification representing a nearly complete census, indicates a population size of about 395 individuals (Blaylock et al. 1995). The population growth rate is slow and well below the 6-7% growth rate seen in the South Atlantic population during the same period. The most recent data (1994) shows a current population growth rate estimated at 2.5% (Blaylock et al. 1995). It is thought that the slow recovery is due to human interaction (net entanglement, ship strikes), habitat degradation, and inbreeding.

Hamilton et al. (1994) report that interactions with fishing gear and boats are increasing; 27 of the animals sighted in the southeast during the winter of 1993 showed signs of previously undocumented entanglements. In addition, 3 more animals were documented carrying lines in the fall of 1994.

Right whales found in the New York Bight are primarily transiting the area on their way to more northerly feeding grounds in Great South Channel, Cape Cod Bay, and Browns/Baccarro Banks. During late winter and early spring they begin moving north along the coast past Cape Hatteras and near the Long Island coast before passing through the Great South Channel. Individuals are sighted along the south shore of Long Island and occasionally within Long Island Sound, Block Island Sound, Gardiners Bay, and south shore inlets and bays, but individuals and cow/calf pairs do not remain in the area for an extended period of time (Sadove and Cardinale 1993).

The right whale is planktivorous, feeding primarily on calanoid copepods (Wishner et. al. 1988). Right whale distribution is generally patchy and is probably due to the patchy distribution of their preferred forage, *Calanus finmarchicus*.

Humpback Whale

Humpback whales can reach up to 18 m in length and have a small, variably shaped dorsal fin, long distinctive pectoral fins, and a deeply notched fluke with an irregular saw-toothed edge. The NMFS/Northeast Region entanglement database reports 64 records of entangled humpback whales from 1975-1992. Of 20 stranded individuals examined for cause of death, Wiley (1995) reports that 6 had major injuries attributable to ship strikes and 5 of the 6 were indicative of entanglement in fishing gear.

The distribution of humpback whales in the northwestern Atlantic is changeable, and probably a response to changing distributions of preferred food sources. Both humpback and finback whales have been confirmed in the Hudson (NMFS 1995). However, these records cluster in spring and early summer and probably represent young or dispersing individuals, transient in the area. Historic records do not show the New York Bight to be a high use foraging area for large cetaceans.

Sadove and Cardinale (1993) report that humpback whales aggregate in New York in various years, but with no regularity of occurrence. They have been sighted in Long Island Sound, Gardiners Bay, and Block Island Sound, and some individuals have remained in these areas for more than a week. They are present in the greatest numbers June through September. For the most part, humpbacks are in transit through the area on their northward migration to summering areas in the Gulf of Maine.

Humpback whales are primarily piscivorous and seem to select prey opportunistically. Humpback whales have not used New York waters historically as a feeding area, but are concentrated in Gulf of Maine waters most years opportunistically exploiting prey species such as sand lance, herring, and mackerel.

Finback Whale

Finback whales are the second largest whale, reaching lengths of up to 24 m. They are characterized by a white “chevron” along their right side that may play a role in their feeding strategy. Finbacks occupy both deep and shallow waters and are probably the most abundant large cetacean in New York waters. They are most abundant in New York waters in spring and summer, but do have some presence during the winter months.

Finback whales feed on a variety of schooling fish, euphasids, and copepods both at the surface and at depth. They have often been observed turning on their side when opening their mouths and circling through or around a school of fish with their right side facing downward. A major area of feeding was sighted directly east of Montauk Point during spring and summer. The drift patterns of their preferred forage explains the concentration of fin whales east of Montauk Point in summer.

Sei Whale

Although similar in appearance, sei whales are smaller than finback whales and rarely exceed 15 m in length. Sei whales are rare in the New York Bight and are likely to be present only during the summer months. Very little is know about the ecology of sei whales in the North Atlantic although they feed in a manner similar to right whales by skim feeding along the surface to filter small planktonic crustaceans such as copepods and several species of krill (Katona et al. 1993).

Four species of sea turtles have been documented around FIIS, although none nest in the area. All species of sea turtles are currently listed as threatened or endangered by the Endangered Species Act of 1973. The loggerhead sea turtle (*Caretta caretta*) is Federally threatened and the Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and green sea turtles (*Chelonia mydas*) are Federally endangered. Sea turtles occurring in nearshore waters are typically small juveniles; the most abundant is the loggerhead turtle, followed by the Kemp's ridley. Waters off Long Island are also warm enough to support green sea turtles from June through October. The leatherback turtle, which is the most commonly observed turtle from May through October, utilizes offshore areas and is not found in the estuaries or backbay areas.

Sea turtles begin arriving in the waters around Fire Island in June and July and remain for several weeks, using the shallow coastal waters to forage. Kemp's ridley and loggerheads feed primarily on benthic crustaceans, and green sea turtles feed primarily on eelgrass and algae. The leatherback sea turtle remains offshore of the barrier island and commonly feeds on jellyfish and ctenophores. Sea turtles leave the area by late fall as water temperatures decrease.

Loggerhead Sea Turtle

Of all the sea turtles, the loggerhead is the most temperate and subtropical in its nesting habits, which makes it the best candidate for use of more northerly waters in general. Loggerhead adults have shells ranging in size from 84-101.6 cm and weigh between 68-182 kg. The shell is reddish brown and composed of horn covered bony plates. Although the precise reasons why young sea turtles enter northeastern waters are not known, it is thought that these waters provide important developmental habitat for a number of chelonid turtles (Morreale and Standora 1994). Loggerhead turtles were the most frequently sighted species of turtle during the CeTAP surveys of 1982. The peak average abundance in the study area was 7702 (+/-1748). Most of the sightings were concentrated on the continental shelf and in estuaries from Long Island to Chesapeake Bay.

Sadove and Cardinale (1993) report that loggerheads are the earliest species to appear in New York waters, arriving as early as May. During tagging and telemetry studies conducted from 1987-1992, 337 sea turtles were captured; loggerheads represented 65% of the total. Results show that sea turtles occur with regularity in New York waters from June through the first week of November. All of the turtles tagged during Morreale and Standora's study (1994) showed a steady southward movement along the coastline after leaving the inshore New York waters.

Loggerheads consume a wide variety of benthic organisms including gastropod and pelecypod mollusks, decapod crustaceans, jellyfish, sea urchins, sponges, squids, basket stars, and fishes (Nelson 1988, NMFS and USFWS 1991, Morreale and Standora 1994). In Long Island waters, crabs made up 80% of loggerhead diets.

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle is the smallest of the sea turtles. Adults do not exceed shell lengths of 76 cm and range in weight from 36-45 kg. Kemp's ridley sea turtle populations have suffered one of the most dramatic declines in population numbers observed for any animal (USFWS and NMFS 1992). Like the loggerhead, Kemp's ridleys use northeastern waters as developmental habitat, foraging throughout the summer until decreasing temperatures send them southward in the fall. Morreale and Standora's (1994) study of New York waters represent the highest concentrations of this species outside of the Gulf of Mexico.

Morreale and Standora (1992) found Kemp's ridley turtles feeding primarily on crabs in NY waters. In their tracking studies, they determined that Kemp's ridleys are sub-surface animals that frequently swim to the bottom while diving. Analysis of stomach contents in Cape Cod Bay indicates that they are feeding on fish, sand dollars, bay scallops, and blue mussels.

Green Sea Turtle

Green sea turtles are a medium to large sized turtle with the shells of adults ranging in length from 91-110 cm and weighing between 91-136 kg. This species is primarily herbivorous and has a serrated edge on the lower jaw. It is most commonly found in tropical waters and usually does not migrate from its regular habitat except to visit nesting beaches. The major threats to green sea turtles are trawls and gillnet fisheries. In addition, extensive trade in the animals and their products still exists in some areas, and effectively wiped out the population around the Bermuda Islands.

Immature turtles go through an omnivorous stage (1-3 years) and may be feeding on different food items than the preferred vegetation consumed by adults. This may explain the use of New York waters by juveniles. Data from dietary studies in New York indicated that juveniles were feeding primarily on algae (Burke et al. 1992).

A 38 cm green sea turtle captured, tagged, and released in New York was recaptured almost 1 year later only 13 km from the original capture site (Morreale and Standora 1994), suggesting that during the developmental stages, these turtles may return for a number of years before becoming an adult and taking up residence in more tropical seagrass beds. Growth rates for green turtles were higher in New York than in both Florida and Hawaii, but lower than in the Bahamas. This suggests that New York waters provide significant foraging opportunities.

Leatherback Sea Turtle

Leatherback sea turtles are the largest of the sea turtles, with curved carapace length of 137-183 cm and weights of 204-696 kg. The estimated worldwide population of leatherbacks is about 115,000 adult females. CeTAP (1982) provides conservative estimates of peak average abundance at 361 (+/-181) for Mid and North Atlantic regions of the continental shelf. In New York waters, leatherbacks are the primary species entangled in fishing gear and struck by boats; they do not seem to suffer from the same causes of mortality as chelonid sea turtles (trawls, gill nets, and cold stunning) (Morreale and Standora 1994). Although this species is known to occur in the action area, they are only present as occasional transients.

The main component of the leatherbacks' diet consists of arctic jellyfish. It is thought that leatherbacks follow their prey north along the western Atlantic to the Gulf of Maine, Georges and Brown Banks in summer, then traveling south through the bays and sounds in the fall (Lazell 1980).

Benthic Macroinvertebrates

The faunal communities of offshore habitats typically feature a diverse assemblage of benthic invertebrates which may exhibit important variations across seasons and sites (RMC Environmental Services, 1996; USACOE, 2000). These invertebrates provide the primary food source for many predatory finfish. In general, benthic species expected to be found include decapod crustaceans such as lady crab (*Ovalipes ocellatus*), flat-clawed hermit crab (*Pagurus pollicaris*), rock crab (*Cancer irroratus*), long-clawed hermit crab (*Pagurus longicarpus*), spider crab (*Libinia emarginata*), sand shrimp (*Crangon septemspinosa*), and American lobster (*Homarus americanus*). Echinoderms such as Forbes' sea star (*Asterias forbesii*) and the sand dollar (*Echinarachinus parma*), and mollusks including the northern moon snail (*Lunatia heros*) and dwarf tellin (*Tellina agillis*) are expected to be found. Other crustaceans inhabiting offshore benthic habitats are the horseshoe crab (*Limulus polyphemus*) and various amphipods such as *Pseudouniola obliquua*, *Acanthohaustorius millsi*, *Psammonyx nobillis*, *Gammarus annulatus*, *Protohaustorius wigleyi*, *Pseudoleptocuma minor*, and *Diaastylis polita*. In addition, archiannelid worms (*Polygordius sp*.) and polychaete worms, including the fringed worm (*Tharyx acutus*), mudworm (*Spiophanes bombyx*), ampharetid worm (*Asabellides oculator*), and *Magelona papillcornis*, are important members of the benthic community.

More specifically, the USACOE conducted a rigorous benthic invertebrate survey of offshore habitats during the months of July and August, 1999 (USACOE, 2000). The investigators collected 240 benthic samples from 10 sites between Fire Island Inlet and Montauk Point. The samples were collected with a modified Young grab sampler (0.025 m^2 in area). The samples were then analyzed to determine the species composition, abundance, and biomass typical of offshore sites in Long Island's coastal areas. In three USACOE study sites proximal to the borrow sites proposed for this nourishment effort, Borrow Area 2-East and Borrow Area 2-West, the dominant species was the polychaete worm (*Polygordius triestinus*). *P. triestinus* accounted for 26-46% of the organisms sampled, depending on the study site. The sand dollar *E. parma* was also commonly found and represented 8-27% of the organisms sampled. Other important species in these benthic communities included the amphipod species (*P. oblique*, 5-16%), the polychaete worm (*S. bombyx*, 0-7%), and the amphipod species (*P. wigleyi*, 1-4%).

Additionally, the USACOE (2000) did a comparison of infaunal abundance with water depth among the 10 study sites. They considered depths less than 16 m (≈52 ft) to be shallow; depths greater than 16 m were considered deep. Results indicated that lower abundances appear to occur at shallower borrow areas. The average infaunal abundance (organisms per sample per square meter) was 4030 ± 909 at study sites with water depths of less than 16 m and 6526 ± 2479 at study sites with water depths greater than 16 m. The proposed offshore borrow sites for this beach nourishment project, Borrow Area 2-East and Borrow Area 2-West, are considered to be shallow as they occur at depths of 16m or less.

Studies conducted by RMC Environmental Services (Greeley-Polhemus Group, Inc. 1997) and BVA (Barry A. Vittor & Associates, Inc. 1999) in Fire Island borrow sites have similar findings in that the macroinvertebrate assemblage was dominated by polychaete worms. However, the dominant species varied with season and study site. Observed species included polychaetes such as *Tharyx acutus*, *Magelona papillicornis*, *Ascabellides oculata*, and *Brania spp.*; the archiannelid worm *Polygordius spp.*; amphipods such as *Protohaustorius wigelyi* and *Gammarus annulatus*; bivalves such as *Spisula solidissima* and *Tellina agilis*; oligochaete worms; and rhynochocoels.

Species such as digger amphipods (*Acanthohaustoris millsi* and *Protohaustorius wigelyi*), the scud amphipod (*Gammarus annulatus*), sharp-tailed cumacean (*Diasylis polita*), archiannelid worms (*Polygordius spp*), polychaete worms (*Magelona papillicornis*, *Asabellides oculator*, *Spiophanes bombyx*, and *Tharyx acutus*), surf clam (*Spisula solidissima*), dwarf tellin (*Tellina agilis*), and sand dollar (*Echinarachinus parma*) are expected to be dominant in offshore areas with medium-grained sands required for beach nourishment (NPS, 2003).

Offshore benthic invertebrate species of special concern in this assessment are the ocean quahog (*Arctica islandica*) and the surf clam (*Spisula solidissima*), as these species support important commercial harvesting operations in the Mid-Atlantic Bight. A detailed description of life cycles and ecological characteristics of these species, their abundance at areas proximal to the proposed site, and the risk of impacts to commercial harvests are presented in Sections 3.4.3 and 4.4.

Nearshore benthic invertebrates in the USACOE borrow areas were sampled in July and August 1999 for the FIMP Reformulation Study (USACOE, 2000). Results indicated that the dominant invertebrate was the archiannelid worm *Polygordius triestinus*. Other taxa observed included Rhynchocoela, Nematoda, Archiannelid, Annedlida, Mollusca, Arthropoda, Echinodermata, and Chordata. Dominant species observed were the sand dollar *Echinarachinius parma* (9%), amphipods *Protohaustorius wigleyi* (8%), *Pseudunciola oblique* (6%), and the polychaete *Spiophanes bombyx* (5%). Surf clams (*Spisula solidissima*), while present in each borrow area, were not abundant, and accounted for less than 1% of organisms identified.

Organisms in the Water Column (Planktonic Forms)

The water column contains several marine species from different trophic levels throughout the year. Most of these species are transient, and are not dependent on the presence of the borrow sites. Both zooplankton and ichthyoplankton will be present in the water column above the borrow sites in varying degrees of abundance and diversity as the seasons change. The zooplankton population consists primarily of several copepod species, such as *Acartia hudsonica*, *A. tonsa*, *Temora longicornis*, *Labidocera aestive*, and *Pseudocalanus* spp. Zooplankton densities can approach levels in excess of 100,000 individuals per 100 cubic meters of water at certain times of the year, particularly in March and April, when zooplankton abundance typically peaks (USACOE 1999a, 1999b).

Along with seasonal concentrations of adult finfish that occur in the study area, eggs and larva (ichthyoplankton) will also be present, mainly from April through July. Although ichthyoplankton surveys are not being conducted in the field program, it is reasonable to assume that species spawning both offshore and in Shinnecock Bay will be transported through the study area. Fish larvae feed primarily on zooplankton, so the abundance and diversity of fish larvae are strongly influenced by the zooplankton population. Species expected to be observed include both bluefish and summer flounder, which spawn offshore. Developing larvae drift inshore into the bays. Atlantic herring (*Clupea harengus*), red hake (*Urophycis chuss*), spotted hake (*Urophycis regia*), and striped and northern searobins (*Prionotus evolans* and *carolinus*, respectively) are all nearshore spawners. American sandlance (*Ammodytes americanus*), an offshore and important baitfish species to many piscivorous fish, spawns throughout the winter months, and occurs in the study area (USACOE 2001).

3.5 Transportation

The majority of visitors to Fire Island arrive via ferry or boat to one of several locations throughout the island. Visitors to Saltaire, Fair Harbor, Dunewood, Lonelyville, Fire Island Summer Club, Corneille Estates, Ocean Beach, Seaview, and Ocean Bay Park utilize Fire Island Ferries from Bayshore. Visitors to Fire Island Pines utilize the Sayville Ferry Service, which departs from Sayville. Visitors to Davis Park utilize the Davis Park Ferry, departing from Patchogue.

Once on the island, visitors typically walk or ride bicycles to their destination. During summer months, walkways and beaches are crowded with visitors to Fire Island. Approximately two million people visit the island annually, most during summer months.

Fire Island does not feature a network of highly developed roadways for transportation between communities. Dozens of wide walkways can accommodate vehicles when necessary, but the majority of transport on Fire Island is conducted along the beaches, including emergency response, essential services (utilities, garbage collection), residents, and contractors. Emergency response and essential service vehicles are permitted to drive year-round on the beach, although time of day restrictions are in place for all but emergency vehicles. Residents, contractors, and essential services are issued oversand vehicle permits for restricted driving on Fire Island. According to FIIS (J. Mahoney, pers.comm.), 145 residential permits, 80 contractor permits, and 30 essential services permits are issued annually. Transportation along the beaches is restricted for contractors and residents as follows:

- Driving permitted in lieu of alternate transportation from the day after Columbus Day to the Thursday before Memorial Day weekend.
  - Driving is permitted on weekdays only in May.
- Driving is not permitted from the Friday of Memorial Day weekend through Columbus Day.
- Smith Point access is not permitted from mid-March through Columbus Day.

3.6 Community Services

There are seventeen (17) developed communities on Fire Island. Visitors utilize the natural environment within the communities for a variety of recreational purposes, including swimming, surfing, sunbathing, beach-combing, clamming, nature viewing, hiking and fishing. Thirteen communities, including Saltaire, Fair Harbor, Dunewood, Lonelyville, Ocean Beach, Seaview, and Davis Park, have lifeguard-protected ocean beaches for summer recreation. All of these recreational activities require adequate beach, intertidal, and nearshore ecosystems.

All Fire Island communities have facilities for public enjoyment of their resources. These facilities include marinas for ferry dockage and slips for residents and/or transient use, restaurants, snack bars, public restrooms, souvenir shops, and overnight accommodations. Fire Island is home to approximately 400 year-round residents, swelling to over 20,000 summer residents.

In addition to the communities, there are public recreation areas within FIIS, including Sailor’s Haven, Watch Hill, and Smith’s Point. Sailor’s Haven is a 300-year old preserve that features elevated boardwalks for hikers and nature viewing, and is accessible by ferry or boat. Public facilities at Sailor’s Haven include a 47-slip marina, lifeguard protection, snack bar, picnic area, and souvenir shop. Watch Hill is the largest FIIS public recreation area, and is accessible by ferry or boat. Watch Hill features a 183-slip marina, lifeguard protection, camping facilities (May-October), restaurant, grocery, and souvenir shop. Smith’s Point is the third public recreation area within the boundaries of FIIS, although it is managed by the Suffolk County Parks Department. Smith’s Point County Park is a 6-mile stretch featuring public parking and beach access, a visitor center with restrooms and snack bar, the TWA Flight 800 Memorial, and camping facilities.

3.7 Socioeconomic Environment

Fire Island is a seasonal recreation area, with a seasonal economy from April through October. Peak economic activity occurs during summer months of June, July, and August. The majority of economic activity occurs in the retail sector, which accounts for more than 75% of Fire Island employment. There are approximately 135 businesses within the communities of Fire Island; these account for 800 jobs, the majority of which are seasonal. Public recreation areas including Sailor's Haven, Watch Hill, and Smith's Point add an additional 75 jobs to the Fire Island economy.

In addition to retail, economic activity centers largely around the ferry terminals and marinas on the island, as these are the only access points during summer months for residents and day visitors.

3.8 Cultural Resources

History of Human Settlement

Native Americans first travelled to Fire Island for fishing, shellfishing, and hunting. These and other early uses, such as whaling and harvesting of salt hay, did not require settlements.

Controversy over land ownership also discouraged formation of settlements on Fire Island. Fire Island was not included in the Patent of 1686, which conveyed shore lands and lands under water to the Towns. Instead, William Tangier Smith claimed ownership of Fire Island, Great South Bay, and Moriches Bay in 1693 (USACOE, 1999). In 1845, David Sammis purchased land to build a hotel on Fire Island, which led to controversy over land ownership and eventual litigation (USACOE, 1999).

The Great Partition of 1878 provided a mechanism to settle lawsuits and controversy over land ownership. It allowed secure purchase and ownership of land, which opened land along the west end of Fire Island for development and creation of communities (USACOE, 1999). Point O' Woods was the first community developed in 1894, and Dunewood the last in 1958. In 1928, approximately 950 structures were found in the communities, which quickly grew to 1,260 in 1955, 2,400 in 1962, 3,500 in the 1970's and approximately 4,150 in 1999 (USACOE, 1999).

Ethnographic Resources

Native Americans travelled to Fire Island some 8,000 - 10,000 years ago seasonally for fishing, shellfishing, hunting, and whaling. To date, no archeological sites from the pre-contact period have been discovered.

There are two Native American entities within the project vicinity. The Shinnecock Nation and the Unkechaug Nation are NY State recognized tribes, but neither are federally recognized tribes. The park's approved Ethnographic Overview and Assessment (Ethnographic Overview and Assessment, Fire Island National Seashore, Public Space Research Group of the Center of Human Environments, 2006) provides detailed information on the Unkechaug's areas of current interest and concerns within the park's boundaries. Specifically, Chief Harry Wallace stated that the Unkechaug were interested in "Fireplace" (an area in Brookhaven Hamlet), the Carmans River and Pattersquash Island. The Shinnecock Nation is traditionally associated with the Town of Southampton. Based on information in, "We Are Still Here! The Algonquian Peoples of Long Island Today", there is no evidence of the project areas being associated with the Shinnecock.

Archeological Resources

Based on recent cultural resource investigations by Watts (2001), John Milner & Associates (2000 & 1998), Tuttle (1999), and others, there are no known cultural resources located in the dunes, beach, or nearshore within the project areas. Furthermore, the studies indicated that placement of fill would have no significant impact on potential resources which may exist beneath the barrier island.

Potential for resources in offshore areas may be higher than on the beach. Historical research confirmed that the coastal waters of New York have been an important center for maritime activity since colonial times (Watts, 2001). Shipwrecks along Fire Island date back to the mid-1600s and have become a source of cultural interest and merit, although only one potential shipwreck has been found near the project area during recent investigations.

Terrestrial Sites

Analysis of historical records and environmental data indicated that Fire Island was sparsely inhabited during the prehistoric and pre-modern eras (Barber, 1980). Furthermore, modern impacts from natural and man-made sources have altered much of the existing landform. As a result, researchers (Barber, 1980) determined that the archaeological potential of the beach and dune areas were very low and recommended no further investigation.

In all, thirteen historic-period sites have been identified on Fire Island, including remnants of life-saving stations, refuse middens and stratified deposits, a farm boundary, and the remains of recreational facilities and residences (USACE, 1999). However, only portions of two are located on the ocean side of the barrier island and are situated in the dunes bordering Great South Beach (JMA, 2000). Site A103-05-000605 is the remains of a recreational facility built for handicapped children in the early 20th century, which was destroyed by the Hurricane of 1938. The site is located in the dunes of Robert Moses State Park, west of Kismet and outside of the project area. Site A103-02-1579 consists of remains of structures used by the Coast Guard dating back to the mid-19th century and is situated in the dunes near Whalehouse Point in the Otis G. Pike Wilderness Area. Both sites are outside the project area and will not be affected by the proposed project.

The potential is low for other preserved archaeological deposits within the beaches or dunes of Fire Island (JMA, 1998). The lack of stable surfaces in the coastal zone makes it difficult for archaeological deposits to be preserved in good context.

Drowned Terrestrial Sites

Prehistoric archaeological sites may have been buried and preserved beneath the barrier island. The potential for these sites along Fire Island is relatively high and are at risk of exposure due to coastal erosion.

As part of the interim project, the Corps commissioned a remote sensing study of the tidal zone and nearshore area of Fire Island that included magnetometer, side-scan sonar, and fathometer surveys (Tuttle, 1999). Results indicated 26 anomalies with signature characteristics of possible cultural resources. Due to the nature of the proposed project, the study concluded that the placement of fill would not impact any of the anomalies and no further investigation was recommended.

Maritime Resources

There been over 450 documented shipwrecks in the waters off the south shore of Long Island (JMA, 1998). Although many wrecks have not been located or identified, there is a high potential for remains along the Fire Island Coast. Side-scan sonar and magnetometer investigations have identified seven PCRs in the vicinity of the Corps borrow areas off of Fire Island (Ocean Surveys, 1996). No PCRs have been identified in Borrow Areas 2-East or 2-West.

Further investigations by remote sensing were conducted in eleven offshore borrow areas, three of which were located in Corps Borrow Area 2 region (Watts, 2001). The area surveyed did not include the entire borrow area region, but was significantly larger than the borrow areas proposed for this project. Only one anomaly was identified in the vicinity of Borrow Area 2A, and was located outside the proposed borrow area limits. This result suggests that the probability of an anomaly in Borrow Areas 2-East and 2-West is very low. The study recommended additional investigation if the target could not be avoided.

The Cultural Resource requirements for Borrow Areas 2-East and 2-West were completed in 2003. The New York State Office of Parks, Recreation and Historic Preservation listed the pre-requisites for dredging these borrow areas in a letter dated September 11, 2003 addressed to the FIIS superintendent. In fulfillment of this requirement, Tidewater Atlantic Research, Inc. conducted a remote sensing archaeological survey of the two borrow areas between October 22 and 27, 2003 using magnetometer and side scan sonar survey equipment. No magnetic or acoustic anomalies were identified in either borrow area, which cleared the areas for dredging based on the criteria in the September 11, 2003 letter. Results of the investigation were described in a report dated November 5, 2003. A copy of the report was provided to the State Historic Preservation Field Services Bureau in Pebbles Island in November 2003.

CHAPTER 4—Impacts of Each Alternative on Affected Environment

This chapter provides an analysis of potential impacts of the alternatives presented in Chapter 2. Each alternative is analyzed for impacts to a resource, as follows:

4.1 Geology
4.2 Water Quality
4.3 Terrestrial Ecology
4.4 Aquatic Ecology
4.5 Transportation
4.6 Community Services
4.7 Socioeconomic Environment
4.8 Cultural Resources

As required by NEPA, potential impacts are described in terms of type, context, duration, and level of intensity. These terms are defined below. Overall, these impact analyses and conclusions were based on the review of the existing literature and Park studies, information provided by on-site experts and other agencies, professional judgment and park staff knowledge and insight.

• ***Type of Impact***: Impacts can be beneficial or adverse. Beneficial impacts would improve resource conditions while adverse impacts would deplete or negatively alter resources.

• ***Context:*** Context is the setting within which an impact occurs and can be site specific, local, parkwide, or regionwide. Site-specific impacts would occur at the location of the action, local impacts would occur within the general vicinity of the project area, parkwide impacts would affect a greater portion of the Park and regionwide impacts would extend beyond Park boundaries.

• ***Intensity:*** Impact intensity is the degree to which a resource would be adversely affected. Because level of intensity definitions (negligible, minor, moderate, major) varies by resource, separate definitions are provided for each impact topic analyzed. The criteria that were used to rate the intensity of the impacts for each resource topic is presented below under “impact thresholds”. Beneficial impacts do not receive intensity definitions.

- Negligible: Impacts would be at the lowest levels of detection and would have no perceptible effect on resources, values, or processes.

- Minor: Impacts would be perceptible but slight and localized. If mitigation were needed to offset any adverse effects, it would be relatively simple to implement and would likely be successful.

- Moderate: Impacts would be readily apparent and measurable. The resource might deviate from normal levels but would remain viable. Mitigation measures would probably be necessary to offset adverse effects and would likely be successful.

- Major: Impacts would be readily apparent and widespread, and would result in a substantial alteration or loss of resources, values, or processes and would likely be permanent. Mitigation measures to offset adverse effects would be necessary, extensive, and their success could not be guaranteed.

• ***Duration:*** Depending on the resource, impacts would last as long as construction was taking place, for a single year or growing season, or longer. Impacts can be either short term or long term. A short-term impact would be temporary in duration and would be associated with construction. Long-term impacts last beyond the construction period, and the resources may not resume their pre-construction conditions for a longer period of time following construction. Impact duration for each resource is unique to that resource and is presented for each resource topic.

Direct and Indirect Impacts

DO-12 requires that direct and indirect impacts be considered, but not specifically identified. A direct impact is caused by an action and occurs at the same time and place. An indirect impact is caused by an action later in time, but still reasonably foreseeable and farther removed in distance.

Cumulative Impacts

The Council on Environmental Quality regulations, which implement NEPA, requires assessment of cumulative impacts in the decision-making process for Federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are analyzed for all of the alternatives, including the no-action alternative.

Cumulative impacts were determined by combining the impacts of the alternatives with the impacts of other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects at the Park and, if applicable, the surrounding region. These projects include the beach nourishment project and Smith's Point and Cupsogue County Parks, potential reach projects associated with FIMP, and additional projects encompassing Shinnecock and Westhampton Dunes. Section 1.3 provides a description of the currently proposed projects (p. 9).

Impairment of Park Resources and Values

NPS Management Policies 2006 requires analysis of potential effects to determine whether or not actions would impair park resources. The fundamental purpose of the national park system, established by the Organic Act (16 USC 1-4) and reaffirmed by the General Authorities Act of 1970, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adversely impacting park resources and values. However, the laws do give the NPS the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values.

Although Congress has given the NPS the management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values. An impact to any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major or severe adverse effect upon a resource or value whose conservation is:

1. necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;

2. key to the natural or cultural integrity of the park; or

3. identified as a goal in the park's GMP or other relevant NPS planning documents.

Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park. In this "Environmental Consequences" section, a determination on impairment is made in the Conclusion section of the impact analysis for each impact topic related to natural and cultural resources. Impairment determinations are not made for socioeconomic topics, or visitor use and experience (unless impacts are resource based) because impairment findings relate back to park resources and values, and these impact areas are not generally considered to be park resources or values and according to the Organic Act, cannot be impaired in the same way that an action can impair park resources and values.

4.1 Impacts on Geology

4.1.1 Impacts of Alternative 2.2, No Action Alternative

Direct and Indirect Impacts

If no action were taken by the communities for storm protection, there would be no immediate impacts to the geological characteristics of the project and borrow areas. The beach and dune systems of the community areas would continue to erode as described in Chapter 3.

Cumulative Impacts

Continued erosion from no action could result in cumulative impacts to geological processes of Fire Island. The shoreline will recede at its average pre-nourishment rate of 1.5 ft/yr and higher in the hot spot regions such as Davis Park, Ocean Bay Park and Western Fire Island. This would lead to progressive dune and shoreline retreat or degradation, which could lead to increased risk of overwash and breach in one or more of the community areas. Beach or overwash would have moderate to major impacts on littoral processes and beach and dune sediments. Impacts would be moderate if a breach were closed with emergency measures, or could be major if it were allowed to remain open. Discussion of the potential impacts associated with a breach, although significant, is outside the scope of this document.

Cumulative impacts must be considered for other projects that may affect geology on Fire Island. Potential beach management projects that could impact geology include the potential dredging of Moriches Inlet for beach nourishment at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. Impacts associated with these projects (except FIMP) are not synergistic, as the project areas are located approximately eight miles from the community project areas. FIMP may also contribute to cumulative impacts on geology, but that project is still in planning phase and therefore outside the scope of this document.

4.1.2 Impacts of Alternative 2.2, Beach Scraping

Direct and Indirect Impacts

Beach scraping would have only short-term, negligible effects on geology of the beach. Impacts would be localized, as only small volumes of sand are removed from the beach system. This sand will be replenished by littoral processes within a short time.

Scraping does result in impacts to the dune system. Dunes are enhanced or restored (following storm damage), which augments storm protection provided by the dunes. Rebuilt dunes do not function as well as natural dunes in storm protection, due largely to planted vegetation versus natural vegetative growth that typically occurs with aeolian dune formation. However, dunes have eroded and are not reforming naturally in the project areas. A rebuilt dune provides substantial storm protection compared to an eroded natural dune or no dune at all.

Cumulative Impacts

Five LIDAR data sets were analyzed to determine if repeated beach scraping is adversely affecting the coastal environment on Fire Island (Robertson, 2008). Changes in shoreline and dune position, along with beach width and volume change, were quantified at 686 locations adjacent to coastal communities and unaltered (control) areas. Results indicate shoreline and dune positions are migrating seaward over time, but their volumes are decreasing. Scraped areas fare better than control areas, and areas downdrift of scraping activities show less erosion than control areas. Although the evidence suggests that scraped areas and their adjacent downdrift sections benefit from scraping activities, as compared to control areas, the changes due to beach scraping are much smaller than the natural beach variability caused by shoreline undulation.

A second study by Kratzmann (*In Press*), found complementory results. Beach profile analysis reveals morphological differences in scraped areas vs. non-scraped areas of the beach. Dunes constructed via scraping contain a greater volume of material than the natural foredune. Along western Fire Island, scraped material moved downcoast as clearly shown by higher beach and dune volumes and wider beaches in undeveloped areas. In the vicinity of Davis Park, the scraped profile is the most erosional and dune elevations are lower than in adjacent non-scraped areas. Beach scraping appears to accelerate downcoast transport in accreting areas and is ineffective protection in eroding areas. The latter statement shows that scraping results are short term, especially in highly erosional areas, but the recipients (communities) still feel they are valuable for that period.

The above analysis confirms that no cumulative impacts to geology are anticipated with annual beach scraping, as long as no structures are built or enlarged landward of the created dunes.

In addition to annual scraping events, cumulative impacts must be considered for other projects that may affect geology on Fire Island. Potential beach management projects include the potential dredging of Moriches Inlet for beach nourishment at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. However, as stated above, impacts from these potential projects are not synergistic, and therefore, will not contribute to cumulative impacts within or adjacent to the community project areas.

4.1.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

Impacts on the Coastal Geological Framework

Updated shoreline change rates and subsequent volume and adjusted volume estimates indicate that Fire Island beaches are maintainable if a long-term nourishment project is implemented. Beach nourishment is keeping up with shoreline retreat by maintaining average shoreline position in its current or seaward position. USACOE suggested 6.8 million cubic yards (5.2 million m^3) to nourish and protect beaches within our study area. The majority of losses are found in Western Fire Island and Fire Island Pines, and this report shows that Western Fire Island (WFI) and Fire Island Pines (FIP) are in need of immediate nourishment. The entire study area can be maintained, however, by placing 97,800 cy (75,000 m^3) of sand each year. This can be done following storms or on a six-year interval depending on coastal conditions. This nourishment rate is based on using the Corps profile template along with standard beach nourishment design methods (USACE CEM 2001) which include building protective beach and dune systems with sufficient advanced nourishment.

The portion of the barrier island west of Watch Hill in the vicinity of FIIS is fronted by an extensive sand ridge field that covers about 1,154 km^2 and contains nearly 18 billion cubic yards (14 billion m^3) of sand in the ridges. These sand ridges constitute a significant sand resource that can be exploited for beach nourishment. Only a small portion needs to be beach-compatible sediment to nourish the project area for decades to come. Removal of less than 1.1 million cubic yards (1 million cubic meters) of sand from Borrow Area 2-West is minor in comparison to the Ridge 1 volume of 40 million cubic yards (31 million cubic meters) of sediment. Removal of about 0.8 million cubic yards (0.6 million cubic meters) of sand in Borrow Area 2 East is also minor (< 1%) in comparison to the Ridge 2 volume of 134 million cubic yards (103 million cubic meters) of sediment. Based on impacts from existing Fire Island borrow pits and similar projects around the US, transfer of sand from a shoreface-attached ridge to the beach involves minimal disturbance to the natural environment and should have negligible impacts on the morphodynamic system where the borrow areas occur. Sand is not lost to the Fire Island system, but is conserved within the near shore and beach region after being transported from the ridges. This conclusion is based on bathymetric data described above and utilized by several studies cited by Lentz (2008) to support her findings rely on this same bathymetric data set.

Coastal studies are always confronted with limited data on which decisions must be made. The USACOE (USAERC 2008, Gravens 1999) and CPE have used the available data to develop a good understanding of the coastal processes sufficient to design a project that addresses the erosion on Fire Island and avoids or minimizes impacts to coastal geology. The decisions made to support a project formulation are not based on the available data alone, but also the experience gained on many similar projects throughout the U.S. that provide the engineers or scientists the insight needed to design a project that meets expectations.

Impacts on Beach and Dune Sediments

Sand fill placed in the project area will temporarily cover existing sediments, but not disturb them. Natural alongshore and cross-shore transport will mix fill sand with adjacent native sands relatively quickly. The fill sand has similar characteristics as the beach sand and any difference will soon migrate towards pre-project conditions.

This nourishment alternative includes reconstruction or repair of the sand dunes in the project area, to provide an increased level of protection to the subject communities from erosion caused by severe storms and tidal action. The beach area will also be increased, providing an elevated level of erosion protection for the dune. Sand fencing will be utilized in conjunction with American beach grass (*Ammophila breviligulata*) to help stabilize the newly constructed dune system.

Impacts to Borrow Areas

The proposed borrow pits have previously been dredged, so any impact and magnitude through wave refraction or interception of onshore transport is largely already present. In addition, previous refraction analysis conducted by the USACOE (1999) along with the analysis described below indicates that any impact would be small to negligible. Although there are indications that onshore or cross shore exchange of sediment may have existed or still exists (Batten, 2003; Lentz *et. al*., 2008), the magnitude of this transport and its potential impacts are not settled science among professional geologists and engineers. The USACOE (1999) shows offshore losses are needed to balance their latest sediment budget, which is supported by Kana (2007) and CPE. There has been no noticeable impact from the 1993-4, 1997 or 2003 project borrow areas on the Fire Island shoreline.

It has been stated at project scoping meetings that surveys of the existing borrow areas should be undertaken before they are dredged for the 2008 project as well as after construction, to directly assess potential impacts of dredging on the borrow areas. Monitoring of the borrow areas will be based on a proven protocol that will be developed for incorporation as special condition(s) in the NPS Special Use Permit, if the project is approved.

Cumulative Impacts

Coastal Geology

Numerous prior actions have incrementally affected the geomorphology of Fire Island. The construction of groins and the stabilization of inlets have greatly influenced the natural littoral drift along Fire Island. Softer anthropological influences in the project area include past beach nourishment and scraping projects. Previous projects show that the placement of sand fill has negligible and neutral cumulative effects on littoral processes and has substantially fewer effects on littoral processes than harder methods of erosion control. Beach nourishment will add sand back into the longshore drift and help to mitigate the cumulative effects of previous impacts. In addition, fill placed in the project areas will act as feeder beaches to downdrift areas, such as Cherry Grove, Kismet, and the lighthouse area.

Beach and Dune Sediments

The combined effect of erosion and impediments to landward migration of the dune has led to formation of a narrow primary dune system without sufficient volume or secondary dunes to absorb storm impacts and prevent flooding and overwash. In many locations in the communities, dune conditions are below the minimum level of protection recommended by FEMA for dune protection, which is protection from a 5-year storm. The current protection is at the 2-year storm level in these areas. This alternative aims to maintain at least a 10-year level of protection in the project areas for a period of at least six years. However, affected areas will not be elevated above historic natural dune conditions.

Borrow Area Volumes

The two borrow areas proposed for the community project were developed in 2001 when the USACOE was still finalizing their borrow areas for the FIMP project. Borrow areas were selected to be within the Borrow Area 2 region designated at that time for use with Fire Island project reach. The borrow areas were first used in 2003, and were selected for use again since they have the quantity and quality of sand need for the proposed 2008 project. The USACOE New York District had no objection to the communities' use of the borrow areas (Frank Santomauro, NY Dist. USACOE Planning Division Chief, 2007). Based on studies conducted by the USACOE and described in this EA, dredging the borrow areas will have negligible impacts on Fire Island shoreline. Borrow areas located in 40-55 feet of water, which is at least double the closure depth, are not normally considered a serious threat to adjacent shorelines at the moderate volume size being considerd. The sand needed for the project only constitutes 1.1% of the volume of the ridges in which they are located (Table 26). Past dredging increases this by approximately another percentage point. The proposed borrow areas are within USACOE borrow area 2-F and 2 A-D regions as defined today.

Table 26: Borrow Area Volume versus Ridge Volume

Item	Borrow Area 2-West	Borrow Area 2-East
Ridge Volume (cy)	41,079,000	133,840,000
2003 Borrow Area Volume (cy)	3,500,000	1,500,000
Existing Borrow Area Volume (cy)	1,905,000	942,000
Proposed Fill Volume (cy)	1,070,000	805,000
Proposed to Ridge Volume (%)	2.6%	0.6%

Volumes, size and location of the two proposed borrow areas are typical for beach nourishment projects, and should not increase risk to the short and long term geological conditions of Fire Island. The project is self liquidating, in that the sand is being used on its adjacent island, so there is no net loss of sand. The ridges are not being leveled by the dredging, so they retain most their previous profile in line with on shore wave advance. This will be the final project for both borrow areas, since most of the dredgeable sand will be exhausted.

Smith Point County Park and Cupsogue County Park, 2008 Beach Nourishment Projects

The Suffolk County Departments of Public Works and Parks are proposing a project related to beach nourishment resulting from the April 2007 nor'easter and other recent storms. In the winter of 2006-2007, the County implemented a Phase I nourishment project, dredging 225,000 cubic yards of sand from an offshore borrow area and placing it on the beaches and dunes at Smith Point. The April 2007 nor'easter removed approximately one-third of this sand, but the Phase I nourishment probably prevented serious damage to the park facilities and infrastructure.

Phase II involved the excavation of up to 250,000 cubic yards of sand from an accretional dune field in the park, centered 1.3 miles west of Moriches Inlet. This alternatve was tabled during the scoping process.

Phase III, the current proposed project, entails dredging of approximately 250,000 cubic yards of sand from the Federal navigation channel in Moriches Inlet, which will be placed on the beaches and dunes in the middle portion of Smith Point Park and the western portion of Cupsogue Park.

Suffolk County is in the process of preparing a NEPA EA for Phase III as required by the NPS, which will examine potential impacts of Phase III on all relevant environmental resources. Resources include endangered and threatened species, essential fish habitat, coastal processes, water quality, mitigation and monitoring. Suffolk County's EA will be reviewed by a host of State and Federal agencies prior to project implementation, with NPS/FIIS taking lead in the Federal review. The project is located in eastern Fire Island, approximately eight miles from the community project locations in the western portion of the Island. The County project will dredge material trapped in the inlet thalweg (channel) and place it downdrift outside the inlet's area of influence, mimicking natural by-passing that would occur if the inlet was unimproved. Dredging will contribute to maintaining navigation in the inlet. The cumulative impact of the project is to reduce the sediment deficit on Fire Island due to the improved inlet at Moriches, although it will prevent the inlet from returning to its natural configuration that may promote a more natural bypassing, but with reduced navigiblity.

4.1.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

Impacts to coastal geology and and beach and dune sediments are similar to those described for alternative 2.3 above, and will not be reiterated. This alternative addresses the design refinements needed to improve Alternative 2.3. The proposed increase in cut depth for Borrow Area 2-East has the potential to impact geological resources differently. The potential impacts of dredging the east end of Borrow Area 2-East a few feet deeper was assessed using a wave refraction model. The analysis compares the borrrow area depth approved and permitted in 2003 with the proposed change of a few feet of depth. The model, as described below, shows a negligable impact potential. An additional 210,000 cy will be dredged with the proposed increased cut depth, which is needed to nourish Davis Park in addition to Fire Island Pines.

Wave refraction analysis conducted on Borrow Area 2-East conclude that dredging 1-3' deeper in portions of this borrow area will have negligible impacts on wave height, direction, and/or velocity (see below). The proposed 2008 nourishment projects will utilize all of the available sand in Borrow Area 2-East, so that no further dredging of this borrow site will occur after this project. This wave modeling was conducted as a supplement to the Corps of Engineers wave refraction analysis conducted for the entire Borrow Area 2 region.

Wave Simulation

Simulating Waves Nearshore (SWAN) is a non-stationary third-generation wave model (*e.g.* Holthuijsen *et al.*, 1993; Ris, 1997). SWAN incorporates an extensive list of physical phenomena of wave transformation, including wave propagation in time and space, shoaling, refraction due to current and depth, frequency shifting due to currents and non-stationary depth, wave generation by wind, nonlinear wave-wave interactions (both quadruplets and triads), white-capping, bottom friction, and depth-induced breaking, blocking of waves by current *etc*. Diffraction is not explicitly modeled in SWAN but diffraction effects are simulated by applying directional spreading of the waves.

Numerical wave modeling using SWAN was conducted to evaluate the effects of modifying Fire Island Borrow Area 2-East by increasing depth of cut from 1-3 ft from the originally 2003 permitted design. Modern models were designed to use the metric system. The SWAN model grid extended 7.5 miles alongshore (~3.5 miles to each side of the borrow area) and 6.25 miles cross-shore. The offshore limit was located approximately at the WIS wave station where wave data were aquired. WIS is the wave information study created by the USACOE, which has time series wave data sets for every coastal location in the U.S., spaced at some close interval.

Model parameters were set at default values. Physical processes simulated included bottom friction, refraction, diffraction, wind growth, whitecapping and wave-wave interactions. The results of the change in cut depth were very small changes in wave height, on the order of 0.3 ft or less. A 3D simulation of wave induced flow was also conducted to observe the magnitude of wave-induced currents at the borrow area using the Delft3D-Flow model. Velocities at the borrow area were similar to the velocities on the adjacent seabed, indicating that mixing would occur at the bottom of the borrow pit, an important factor for habitat considerations.

Four wave cases were simulated. Wave data were obtained from WIS station 111, located offshore of the center of Fire Island. A ten year period of WIS data was analyzed to obtain statistically representative wave cases. Four wave conditions were selected from the record (Table 27). These corresponded to low and high waves 3.3 to 9.8 ft, and greater than 9.8 ft, from the two most frequently occurring direction quadrants (90^o to 180^o and 180^o to 270^o). Shore normal is approximately 160 degrees. The four wave condition results from the analysis are shown in Table 27. A JONSWAP spectra was assigned to each wave condition with a peak enhancement factor of 3.3, and a direction spreading of 20 degrees. JONSWAP represents non-linear waves with variability in wave height, period and direction experienced during a three hour wave record.

Wind conditions were included with the similar direction of incoming waves and a higher velocity associated with more severe wave events. Figure 17 is a wave rose showing direction and height statistics for the study area.

Table 27. Wave cases simulated using SWAN

Wave Case	Hsig* (ft)	Tp** (s)	Direction (degrees)	Wind velocity (ft/sec)
Case 1	5.2	6.93	135	19.7
Case 2	12.2	8.84	137	39.4
Case 3	5.2	6.45	182	19.7
Case 4	12.0	8.52	180	39.4

* significant wave height

** peak period, which is not the average, but characteristics that define the larger waves in a wave train of 3 hours.

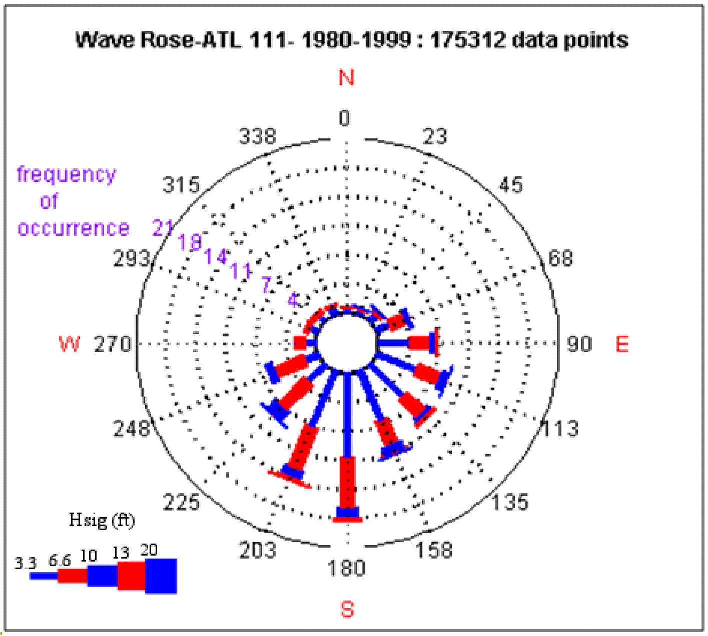


Figure 17. Wave Rose showing statistical distribution of the 20 year wave records at WIS station #111, offshore of Fire Island.

Results from SWAN simulations are shown in Figures 18-21. These figures clearly show that waves interact with large sand ridges resulting in zones of wave focusing and shadowing along the coast. Simulations were conducted using the 2003 permitted borrow area design cuts, versus the 2008 proposed cuts (which are deepened by 1 to 3 ft). The wave height and direction are indicated by the length and orientation of the vectors in the charts, with the larger wave height changes taking palce nearshore.

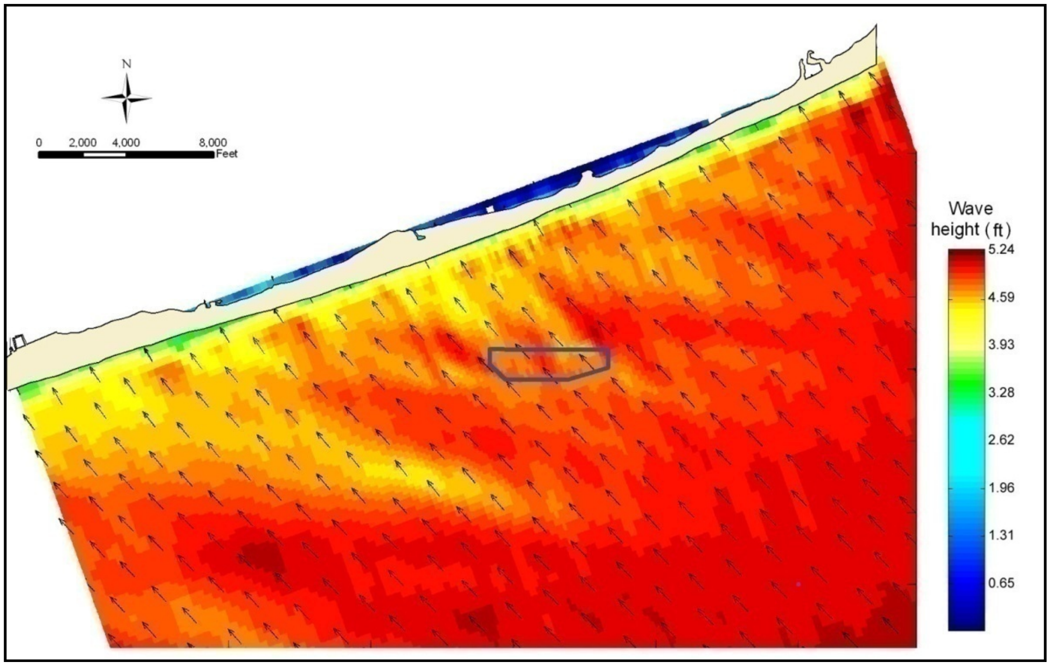


Figure 18. SWAN output, wave case 1 (Hsig 5.2 ft, 6.93 s Tp, and 135 direction).

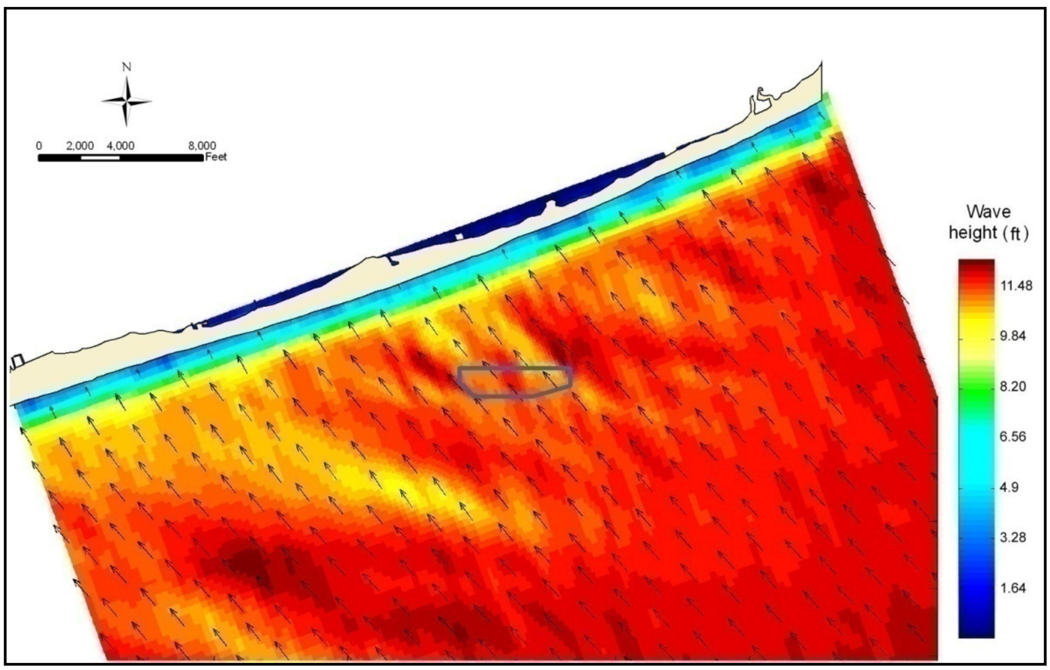


Figure 19. SWAN output, wave case 2 (Hsig 12.2 ft, 8.84 s Tp, and 137 direction).

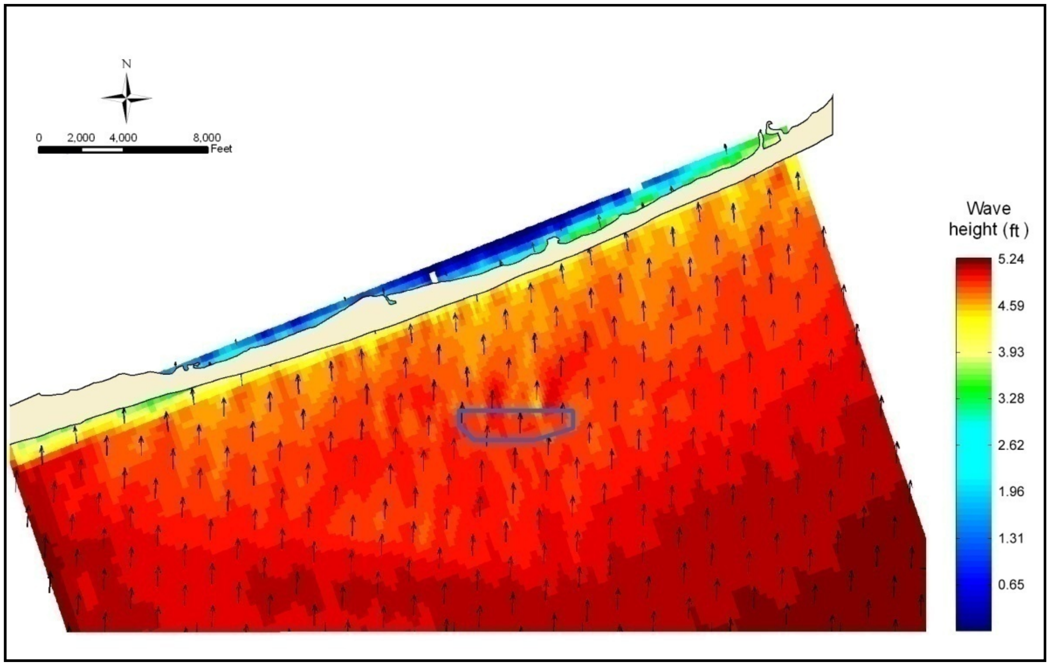


Figure 20. SWAN output, wave case 3 (Hsig 5.2 ft, 6.45 s Tp, and 182 direction).

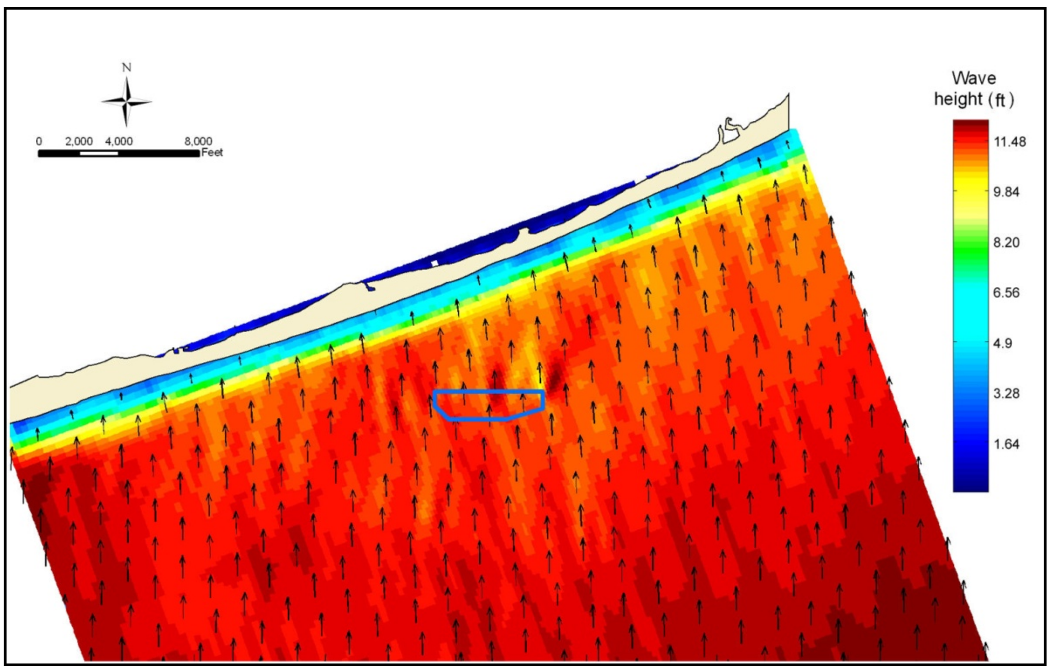


Figure 21. SWAN output, wave case 4 (Hsig 12 ft, 8.52 s Tp, and 180 direction).

Results from the SWAN model were compared for existing (2003) and proposed (2008) cut conditions to obtain an assessment of the changes in wave height due to proposed modifications in cut depth. Results of changes in wave height are shown in Figures 22-25. In order to make the results visible, the scale of the plot had to be reduced significantly, so that regions colored red and green would be within the visible scale. In fact, many regions of Borrow

Area 2-East were not deepened. Changes in wave height reached a maximum of 0.32 ft for the high wave cases. This value is less than 2.7% of the input conditions (12.2 ft) and is considered negligible. The 2% range of change falls within the accuracy of SWAN (90% accurate, or 2% margin of error) and it is significantly less than the accuracy of the WIS hindcast wave records. The reason for such small changes in wave height due to borrow area cut modification is because the cut increments were too small (1 to 3 ft) to cause a greater change in the patterns of propagation in the incident waves. Figures 22-25 below shows the difference in feet between the deepened wave conditions vs the undeepened wave conditions.

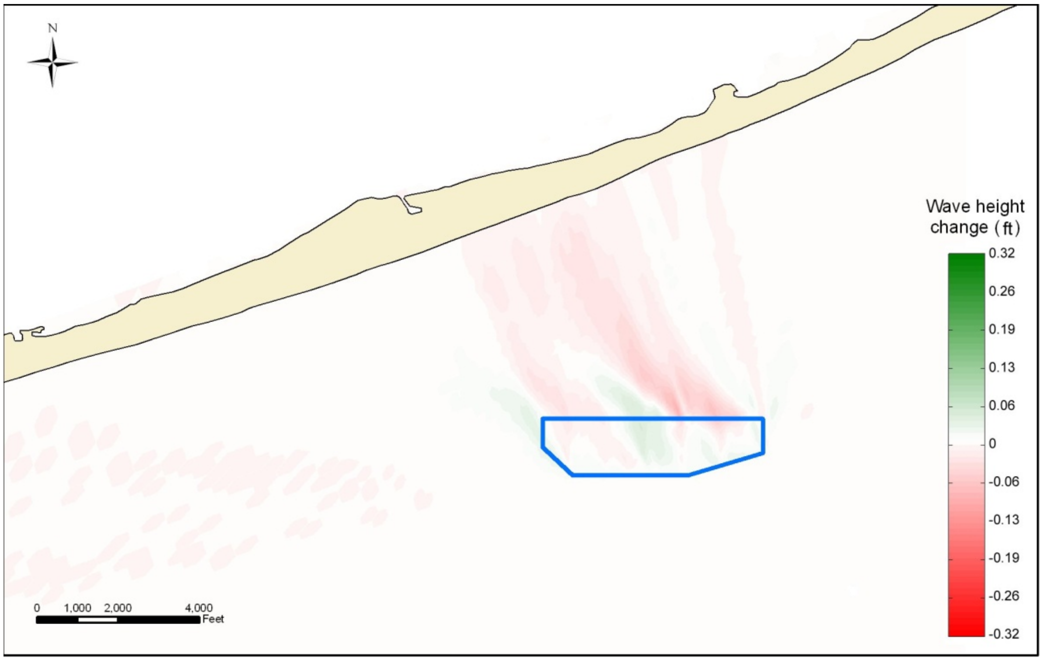


Figure 22. Relative wave height change between existing and proposed borrows area for wave case 1. The relative change was calculating by subtracting the waves predicted using the new borrow area design cuts by the waves predicted using the 2003 borrow area design cut. Maximum changes are within less than 2% of the input wave height.

DRAFT

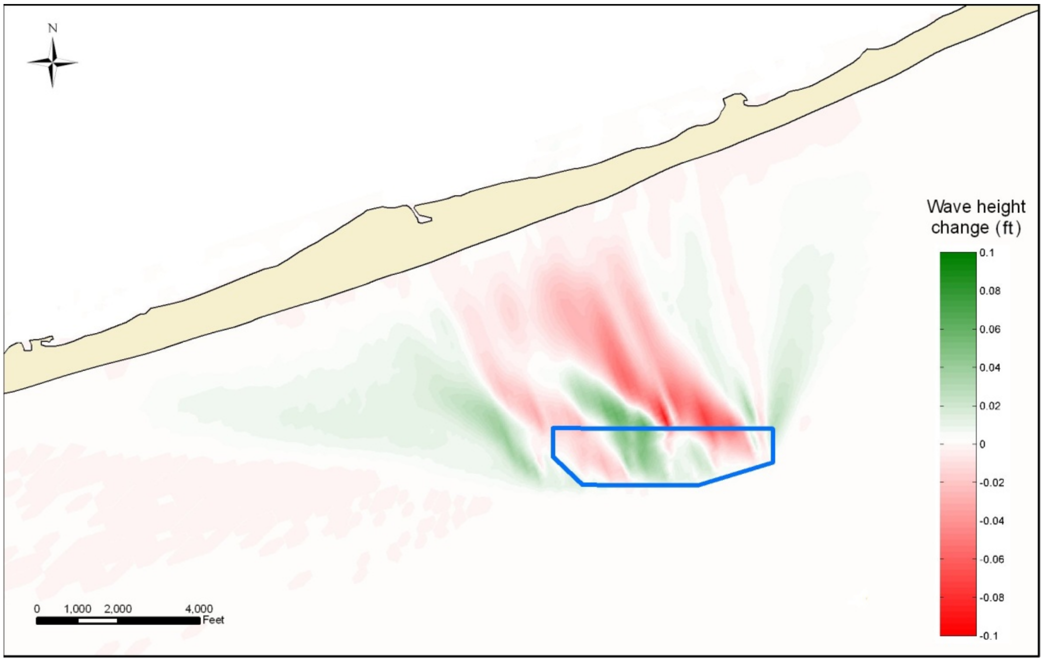


Figure 23. Relative wave height change between existing and proposed borrows area cuts for wave case 2. Maximum changes are within less than 2.6% of the input wave height.

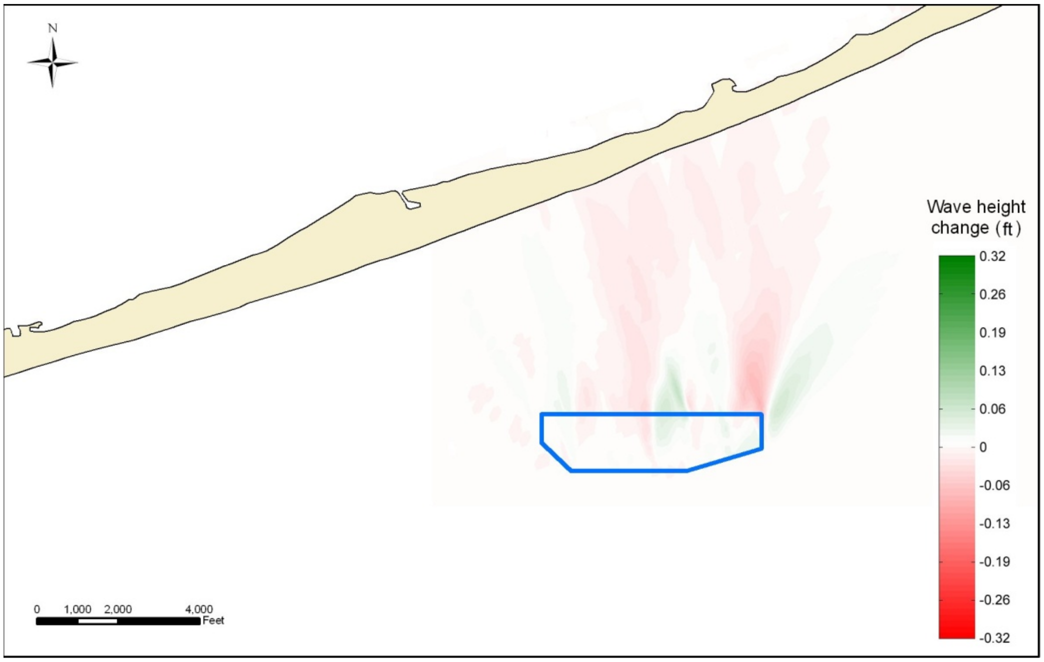


Figure 24. Relative wave height change between new and old borrows area for wave case 3. Maximum changes are within less than 2.0% of the input wave height.

Figure 25. Relative wave height change between new and old borrows areas for wave case 4. Maximum changes are within less than 2.7% of the input wave height.

Flow Simulation

A 3D simulation of wave induced flow was also conducted to observe the magnitude of wave-induced currents at Borrow Area 2-East. The 3D flow simulation used default parameters in Delft3D-Flow in 10 vertical layers. Flow was forced by the output of SWAN and by wind conditions (Table 27). A cross-shore profile of flow velocities during wave event #4 (Hsig 12 ft, 8.52 s Tp, and 180˚ direction) is shown in Figure 26. Flow velocities are greater at the surfzone and reduce to between 0.33 ft/s to 0.66 ft/s near the borrow area. Velocities at the borrow area are similar to the velocities on the adjacent seabed landward and seaward of it. This illustrates that circulation is occurring at the bottom of the dredge pit, which will prevent anoxic conditions from occuring.

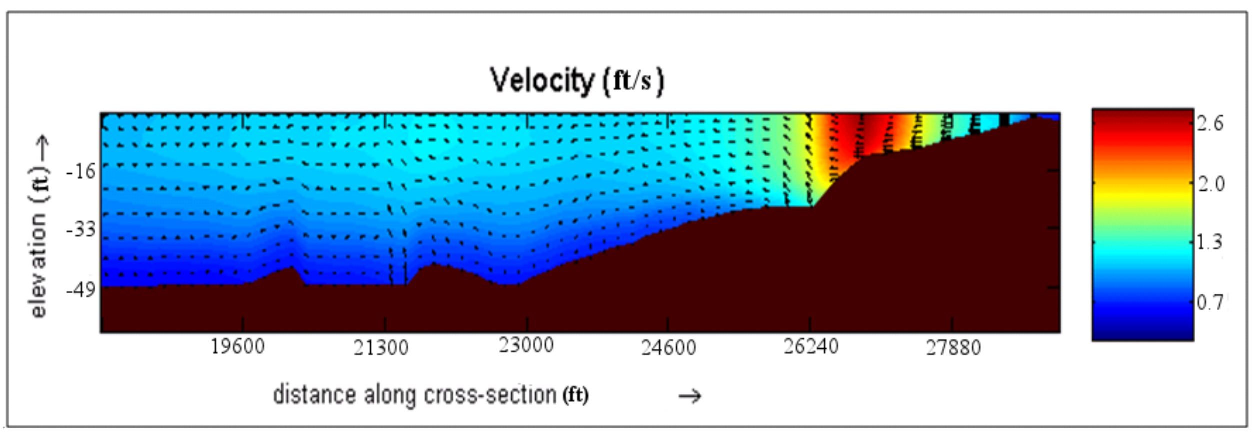


Figure 26. A Cross-shore Profile of Flow Velocities During Wave Case #4

Cumulative Impacts

Cumulative impacts for this alternative are similar to those described for alternative 2.3, and as such, will not be reiterated here.

4.1.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

Impacts from this alternative are very similar to alternative 2.4 discussed above. The only difference between the two alternatives is that this alternative does not propose tapers on Federal property; however, tapers are still proposed on Town of Islip and Town of Brookhaven (Point O'Woods) lands with this alternative, based on permission from the towns.

Tapers increase the durability and life of a project; the lack of tapers in 2003 resulted in additional losses of 20,000-30,000 cy/yr, according to monitoring results. To provide storm protection for the project duration of 5-6 years without tapers, advanced nourishment would be required in the design.

Cumulative Impacts

Cumulative impacts from this alternative are very similar to cumulative impacts for alternative 2.4 discussed above. The exception is that the lack of tapers would increase the volumetric need duing future nourishment events, leading cumaltively to a larger need for offshore sand.

4.1.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

This alternative would decrease the allowable fill volume by approximately 50% in the three western reaches, but would allow more than the desired fill amount in Davis Park. Given erosion rates described above, the reduced fill volume would lead to a shorter project life of 3-4 years in the western reaches, and offer a lower level of protection. To provide community storm protection, more frequent nourishment events would be required with this alternative.

Fill distribution for this alternative is not based on engineering principals, leading to some very narrow fill sections which are not economic to build, thereby leaving sections of the project area with insufficient protection for upland development and houses.

Cumulative Impacts

The 2008 dune center line was created by a procedure of mapping the existing location of the dune crest using aerial photography. The cumulative and long term impact will be a northward migration of dunes without regard to structures and infrastructure within the communities. Discussion of impacts associated with northward migration of the dune line is beyond the scope of this document.

4.1.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

The impacts of this alternative are expected to be a combination of the impacts discussed above for alternatives 2.2 (beach scraping) and 2.5 (beach nourishment).

4.2 Impacts on Water Quality

4.2.1 Impacts of Alternative 2.1: No Action Alternative

Direct and Indirect Impacts

The proposed no-action alternative is unlikely to have any greater than negligible adverse or beneficial impacts to the water quality of either the Atlantic Ocean or the Great South Bay.

Cumulative Impacts

A potential cumulative impact under the no-action alternative would result from the increased likelihood of a breach event. A breach would be likely to result in increased salinity and decreased residence time of water in the Great South Bay. It has been estimated that a breach would be expected to raise the average salinity of the Great South Bay from 25.9 to 29.5 ppt and residence time would be reduced by approximately half, from 96 to 40-52, days depending on the location of the breach (Conley 2000).

It is difficult to assess the effect of a breach on water quality indicators, such as bacterial contaminants, chemical contaminants, and nutrient concentrations. For example, the large influx of ocean waters that are less impacted by runoff from suburban watersheds and decreased residence time may reduce contaminant concentrations in the Great South Bay. However, this reduction may be confounded by the large flux of surface runoff, stream/creek discharge, and floodwaters into the Great South Bay that are likely to occur result from the heavy precipitation and storm surge that would be associated with a large storm. Furthermore, likely impacts on water quality resulting from a breach are difficult to assess due to the potential implementation of emergency actions which would likely repair areas in front of communities (NPS, 2003).

With the exception of increased risk of a breach discussed above, the no-action alternative is unlikely to have any greater than negligible adverse or beneficial impacts to the water quality of either the Atlantic Ocean or the Great South Bay. Similarly, it is unlikely that other potential beach management projects would have any moderate to major impacts in water quality. Potential beach management projects include the potential dredging of Moriches Inlet for beach nourishment at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. Accordingly, it is unlikely that the no-action alternative would contribute measureably to the cumulative impacts on water quality in the Atlantic Ocean and Great South Bay which include residential and commercial development in watersheds; contributions of non-point source pollution including excess nutrients, sediments, chemicals, and pathogens; maintenance dredging of marinas and navigational channels; contributions of wet- and dry-atmospheric deposition of pollutants; brown tides; recreational and commercial boat traffic; and discharge of stormwater runoff.

4.2.2 Impacts of Alternative 2.2: Beach Scraping

Direct and Indirect Impacts

Beach scraping is unlikely to result in any greater than negligible impacts to water quality in the nearshore waters of the Atlantic Ocean. The use of heavy equipment on the beaches during beach scraping may result in the potential for fugitive discharge and run-off of petroleum products from the equipment to the supratidal beach. However, due to the limited spatial scope and duration of construction activities associated with beach scraping, the impact of any trace discharge of pollutants is considered to be negligible. Disturbance to sediments resulting from beach scraping is not likely to result in an increase in the suspended sediments in adjacent nearshore waters as scraping only occurs on high and wide beaches that are typically not subject to inundation during high tides.

Cumulative Impacts

Beach scraping is unlikely to result in a greater than negligible contribution to the cumulative impacts to water quality resulting from the petroleum product discharge from the hundreds of vehicles that utilize Fire Island beaches. Other potential beach management projects are also unlikely to have a greater than negligible cumulative impacts on water quality due to the low likelihood that these projects will occur simultaneously and due to the temporary nature of the impacts associated with these potential projects. Potential beach management projects include dredging of Moriches Inlet for beach nourishment at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. Accordingly, it is unlikely that beach scraping would contribute to the cumulative impacts on water quality in the Atlantic Ocean and Great South Bay which include residential and commercial development in watersheds; contributions of non-point source pollution including excess nutrients, sediments, chemicals, and pathogens; maintenance dredging of marinas and navigational channels; contributions of wet- and dry-atmospheric deposition of pollutants; brown tides; recreational and commercial boat traffic; and discharge of stormwater runoff.

4.2.3 Impacts of Alternative 2.3: Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

This beach nourishment alternative would have short-term, minor adverse direct impacts on water quality during construction. Dredging and sand placement would lead to increased turbidity and sedimentation impacts in the immediate vicinity of the beach and borrow areas. Large grain sizes would keep impacts localized, and sediments would settle shortly after construction ends. Turbidity and sedimentation impacts would not significantly impact water quality in the borrow areas (Naqvi & Pullen, 1982). Water quality in sand placement areas will also not be measureably impacted, as these high-energy areas already exhibit high turbidity levels.

Naqvi and Pullen (1982) also concluded that problems with anoxic sediments and nutrient release in the nearshore zone of a high-energy beach as a result of beach nourishment do not appear to be significant for the following reasons: (1) fine materials that are high in organics are generally moved offshore, (2) sulfides are rapidly oxidized, and (3) fine sediments are rapidly diluted by the high-energy mixing process.

Runoff or discharge of scant amounts of fugitive petroleum products is possible from dredging equipment and heavy machinery; however, due to the large volume of ocean waters, it is unlikely to cause any direct adverse impacts to water quality.

Cumulative Impacts

Due to the lack of permanent impacts to water quality, the proposed nourishment is not likely to contribute to cumulative effects on the quality of water in the project areas or surrounding areas of the Atlantic Ocean or the Great South Bay. Similarly, it is unlikely that other potential beach management projects would have greater than negligible cumulative impacts impacts on water quality due to the low likelihood that these projects will occur simulataneously and due to the temporary nature of the impacts associated with these potential projects. Potential beach management projects include the potential beach nourishment project at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. Accordingly, it is unlikely that Alternative 2 would contribute to the cumulative impacts on water quality in the Atlantic Ocean and Great South Bay which include residential and commercial development in watersheds; contributions of non-point source pollution including excess nutrients, sediments, chemicals, and pathogens; contributions of wet- and dry-atmospheric deposition of pollutants; brown tides; recreational and commercial boat traffic; and discharge of stormwater runoff.

4.2.4 Impacts of Alternative 2.4: Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

Impacts from this alternative are similar to alternative 2.3 discussed above. The only difference between the two alternatives is distribution of sand within the communities and tapers on Federal property. However, distribution of sand will not impact water quality differently, and tapers are still proposed on Town of Islip and Town of Brookhaven (Point O'Woods) lands with this alternative. As such, impacts are the same.

Cumulative Impacts

Cumulative impacts from this alternative are similar to alternative 2.3 discussed above. The only difference between the two alternatives is the distribution of sand in the communities and tapers on Federal property. However, location of sand placement will not impact water quality any differently for this alternative than alternative 2.3. As such, impacts are the same.

4.2.5 Impacts of Alternative 2.5: Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

Impacts from this alternative are similar to alternative 2.3 discussed above. The only difference between the two alternatives is distribution of sand within the communities, which will not impact water quality any differently for this alternative than alternative 2.3. As such, impacts are the same.

Cumulative Impacts

Cumulative impacts from this alternative are similar to alternative 2.3 discussed above. The only difference between these alternatives is the distribution of sand in the communities. However, location of sand placement will not impact water quality any differently for this alternative than alternative 2.3. As such, impacts are the same.

4.2.6 Impacts of Alternative 2.6: Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

Impacts from this alternative are similar to alternative 2.3 discussed above. The only difference between the two alternatives is distribution of sand within the communities, which will not impact water quality any differently for this alternative than alternative 2.3. As such, direct and indirect impacts are the same.

Cumulative Impacts

Cumulative impacts from this alternative are similar to alternative 2.3 discussed above. The only difference between these alternatives is the distribution of sand in the communities. However, location of sand placement will not impact water quality any differently for this alternative than alternative 2.3. As such, impacts are the same.

4.2.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

Impacts are expected to be the same as those discussed above for alternatives 2.2 (beach scraping) and 2.3, 2.4, 2.5, and 2.6 (beach nourishment).

4.3 Impacts on Terrestrial Ecology

4.3.1 Impacts of Alternative 2.1: No Action Alternative

Direct and Indirect Impacts

The no-action alternative may potentially result in both beneficial and adverse impacts to the Federally- or state-protected species in the project area that are dependent on beach and dune habitats (piping plover, roseate tern, least tern, common tern, and seabeach amaranth).

No impacts are anticipated to the maritime beach and dune plant communities, birds and wildlife, or beach and intertidal communities from the no action alternative. Only in the unlikely event of a breach would these biological assemblages be impacted. However, the short and long-term effects of a breach would be unpredictable regarding the positive or negative impacts on these assemblages due to the potential implementation of the FIIS Breach Contingency Plan and/or emergency actions which would likely repair areas in front of communities (NPS, 2003).

Protection of terrestrial special status species would be maintained by the NPS through continued implementation of its Endangered Species Habitat Management Plan. This would include driving restrictions on specified beaches during nesting season and fencing areas that support nesting birds.

Potential Beneficial Effects of No Action on Threatened and Endangered Species (TES)

The no-action alternative increases the likelihood of dune overwashes, breaches, and new inlet formation. Temporary overwash conditions may provide additional temporary breeding habitat for protected birds and germination of seabeach amaranth until natural revegetation of these areas by *Ammophila breviligulata* and other beach plants. The unlikely event of a breach and new inlet formation might also provide temporary additional breeding and foraging habitats on the shores of this new inlet. Numerous studies of Atlantic coast populations of piping plovers have documented the importance of beaches with bayside access, overwash, and tidal bay flats on piping plover distribution and reproductive success (Coutu et. al. 1990, Goldin 1990, Loegering 1992, Hoopes 1993, Howard et. al. 1993, Elias-Gerken 1994, Houghton et. al. 1995-2002, Jones 1997, NPS and MD DNR 1993- 1997, Goldin and Regosin 1998, NPS 1998, Elias, et. al. 2000). Wide east-west facing beaches with the potential for tidal flat and ephemeral pool development would provide high-quality foraging habitat for plovers as well as potentially more sheltered beach conditions and higher nesting productivity. These newly formed overwash areas could support large numbers of nesting piping plovers, as observed on beaches in Westhampton after the barrier breach and formations of Pikes and Little Pikes Inlets (Houghton et. al. 1995-2000). These wide overwash beaches are also likely to support large numbers of seabeach amaranth.

Enforcement and education would be critical in protecting these sites from the pressures of high public use at these highly visible and accessible community areas. The longevity of such breach conditions is uncertain and, accordingly, is the duration of the benefit afforded to piping plovers with regards to enhanced foraging and nesting habitat as the Breach Contingency Plan and other emergency actions could be implemented to quickly repair the beaches in front of communities (NPS, 2003).

Potential Adverse Effects of No Action on TES

If an overwash or breach were to occur in front of the Fire Island communities, the additional foraging and nesting habitat would likely be sub-optimal, as overwashes would be in close proximity to or under community structures and debris from damaged structures (NPS, 2003). Human activity associated with debris removal and beach repair would likely be high resulting in disturbance to protected bird species. Furthermore, the abundance of nest predators would also be high in the overwash or breach beaches due to the proximity of the communities.

Attracting healthy, adult birds to sub-optimal, heavily-disturbed community areas could result in a population sink, where productivity and nesting/fledging success could be lower than in more natural, undisturbed habitats.

In addition, more frequent overwashes or breaches could also adversely impact plovers due to more flooding and resulting adult and chick mortality or loss of eggs and habitat. If an overwash or breach occurred during the nesting season, the construction activities associated with beach/dune repair and restoration could result in direct impacts to breeding adults or chicks.

Similar beneficial and adverse effects are anticipated for seabeach amaranth as it also favors early successional beach habitats including overwash flats and lower foredunes of non-eroding beaches and even secondary habitats like dune blowouts (Weakley and Boucher 1992). The no-action alternative could create new, additional habitat in overwash areas and result in a temporary proliferation of amaranth.

This potential positive effect would also be associated with the adverse potential of flooding of the existing beach habitat as well as newly formed habitats. Therefore, it is possible that any proliferation of amaranth in an overwash or breach may result in low productivity (loss or burial of seed bank) or mortality in active overwash or breach conditions due to the intolerance of amaranth to flooding.

Summary of Potential Impacts to TES

In summary, the potential beneficial and adverse impacts of the no-action alternative to piping plovers and seabeach amaranth include and depend largely on the timing and extent of an overwash and/or breach and severity of storm and weather conditions (NPS, 2003):

Potential Beneficial Impacts

- Temporary increase in suitable habitat for plover foraging/nesting and amaranth germination.
- Enhanced habitat diversity through creation of preferred overwash, backbay and inlet beaches.
- Perpetuation of natural, early-successional habitat formation and barrier island dynamics.

Potential Adverse Impacts

- Creation of sub-optimal and functionally unsuitable overwash habitat within community areas due to high human activity and abundance of predators.
- Increase in human disturbance within community areas due to clean-up of debris and beach repair.
- Increase in predation associated with human presence/pets within community areas.
- Increase in potential mortality and decreased productivity of plovers and amaranth due to flooding in overwash and breach habitats.

- Creation of population sink conditions leading to reduced productivity for the Fire Island piping plover population.

As stated previously, impacts of the no-action alternative are anticipated to be negligible to non-existant for maritime beach and dune plant communities, birds and wildlife, and beach and intertidal invertebrates.

Cumulative Impacts

Although the no-action alternative could affect listed species either positively or negatively, a variety of historic, on-going and planned activities will continue to affect these species (NPS, 2003). Residential development and recreational use facilities in areas throughout the park have resulted in degradation and loss of habitat for threatened and endangered species. Associated human disturbance, including driving, pedestrian traffic, and presence of pets, adversely affects protected species by interfering with reproductive and foraging behavior and may result in direct mortality when plants and animals are crushed by beach-driven vehicles or killed by unrestrained pets.

Impacts to the terrestrial ecology of Fire Island may result from the potential impacts of other projects, including the potential beach nourishment project at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.3.2 Impacts of Alternative 2.2: Beach Scraping

Direct and Indirect Impacts

The potential impacts of beach scraping to terrestrial wildlife include direct mortality resulting from physical disturbance associated with sand excavation and placement. Direct mortality is only expected to slow-moving or burrowing organisms including small mammals, terrestrial herpetiles, and invertebrates. For example, wildlife that may be adversely impacted by beach scraping include white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), and cottontail rabbit (*Sylvilagus floridanus*). However, the negligible adverse impacts of beach scraping to these species are not expected to translate to the population-level due to 1) the sporadic or transient occurrence of individuals of these species in beach and dune habitats due to limited vegetative cover, 2) the tendency of these species to utilize a wide variety of suitable and widespread habitats, and 3) the lack of dependence of any of these species on beach and dune habitats for breeding, foraging, or nesting.

Physical disturbance of beach and dune habitats, increased human activity, operation of heavy equipment, and increased noise levels may also result in temporary loss of foraging and resting habitat for various avian and mammal species. For example, the disturbance and noise associated with beach scraping is likely to discourage shorebirds from foraging in nearby intertidal areas, gulls and terns from loafing in adjacent supratidal areas, and various birds and mammals from foraging in the swales of dunes. This loss of habitat is expected to be temporary as the affected avian and mammal species are highly motile and would re-locate to surrounding habitats during beach scraping. Accordingly, this displacement will likely have negligible impacts on the populations of these species, as foraging and loafing activities would resume in the project site after the completion of construction activities (for intertidal and beach species) or revegetation of the dune and swale (for upland species).

Placement of sand and use of heavy equipment on the beach and near the dunes has the potential for minor to moderate adverse impacts on beach and dune vegetation. Although permitting conditions prohibit the placement of sand on heavily vegetated dunes, vegetation on the seaward slope of the dune may be buried by sand. In addition, studies have shown that rhizomes may be sheared by vehicle passage, resulting in a loss of vegetation and its benefits to dune integrity (Tanksi, 2007).

The use of heavy equipment on the beaches during beach scraping also results in the potential for fugitive discharge and run-off of petroleum products from the equipment to the supratidal beach. Considering the heavy use of Fire Island beaches for ORV traffic, the additional discharge of petroleum products expected occur from beach scraping for two to three weeks in the summer months is expected to result in a negligible increase in impact intensity relative to the baseline level of petroleum product discharge from the hundreds of vehicles that utilize Fire Island beaches.

Since beach scraping occurs during the summer months, it has the potential for minor to moderate adverse impacts to the nesting and reproduction of special concern species that are dependent on beach habitats (piping plover, least tern, and common tern). Potential adverse impacts could include disruption, harm, or harassment of nesting adults; destruction of nesting habitat, nests, or eggs; mortality of chicks, and disturbance and harassment of chicks. Beach scraping has been undertaken by various Fire Island communities since 1993 as a method of providing temporary protection for residences against storm events. As described in Section 3.4.3, beaches located within the Fire Island communities have not historically been well-utilized by these species for nesting due to narrow beach width, high levels of pedestrian and vehicle traffic, and abundance of nest predators including gulls, crows, foxes, and feral cats. Plover and least tern nests have occasionally occurred in Fire Island communities; most of these nests occur in the Sailors Haven/Sunken Forest area. In 2007, four plover nests were located in western Fire Island. Nesting plovers were observed at Talisman/Barrett Beach, Sailors Haven/Sunken Forest, and Lighthouse Beach. In 2004, a plover nest was located in Fire Island Pines. In 1997, a plover nest was located in Water Island. In addition, least terns have attempted to nest in Sunken Forest, Point o’ Woods, and Atlantique.

Impacts of beach scraping on piping plover and least tern are not anticipated for several reasons. First, as stated previously, beach habitat present within the Fire Island communities is, for the most part, unsuitable for nesting and breeding due to the narrow beach width and frequent human disturbance. Second, beach scraping is typically conducted after July 15th and subsequent to the most active months of plover and tern nesting activity. Third, a requirement prior to commencement of beach scraping is to conduct surveys (per USFWS conservation measures protocol) prior to and during beach scraping. If piping plovers are present, then no beach scraping will be conducted. Similarly, beach scraping would not be conducted within the vicinity of nesting least terns. Fourth, beach scraping is prohibited within 1,000 ft of an established plover or tern nest. Lastly, certified plover monitors are present during beach scraping to avoid impacts to any transient adult plovers or terns that may utilize the project area.

Impacts of beach scraping on seabeach amaranth include direct mortality during excavation or sand placement and disturbance and burial of its seed bank. However, these direct impacts will be avoided by conducting surveys for seabeach amaranth prior to commencement of beach scraping. If amaranth is present, fencing would be installed as a protective buffer and the plant(s) would be monitored until natural annual mortality occurs. In the event that beach scraping activities are unable to avoid disturbance to a plant, the plant would be transplanted to a suitable and nearby site, protected through the installation of fencing, and monitored until senescence. An additional measure to minimize and compensate for any mortality of amaranth would be the collection of seeds and germination/replanting of seedlings in the project area and protection through senescence, in accordance with USFWS protocol (USFWS 2002). Due to the implementation of these avoidance and mitigation measures, direct impacts of beach scraping on seabeach amaranth are expected to be negligible to minor.

Cumulative Impacts

There is the unlikely potential for all Fire Island communities to beach scrape annually along the entire widths of their communities during the project timeframe. However, if this did occur, it would result in the impacts described above. Furthermore, the Suffolk County Department of Parks may be undertaking a beach nourishment of the middle portion of Smith Point Park and western portion of Cupsogue Park. Piping plovers are known to breed on beaches located just east of FIIS in Smith Point and Cupsogue County Parks. Piping plover breeding activity at these parks has been fairly consistent since 2004 with an average of 17.2 pairs per year at Smith Point County Park and 7.2 pairs per year at Cupsogue County Park (D. Rodgers SCDP, pers. comm.). Furthermore, Smith Point County Park and the beaches of Westhampton have typically exhibited high abundances of seabeach amaranth. Implementation of similar mitigation measures by Suffolk County to avoid impacts to piping plovers and seabeach amaranth will serve to mitigate for cumulative impacts to these species. FIIS would continue to operate under its Endangered Species Management Plan to avoid adverse impacts to protected species and would continue to report the results of inventory and monitoring programs established for the beach scraping and nourishment projects to the USFWS and NYSDEC. In addition, planning for the USACOE FIMP project and its associated reach project are on-going as are additional projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.4.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

Maritime Beach and Dune Plant Communities

Construction of the proposed community beach nourishment projects would result in the burial and destruction of existing beach and dune vegetation communities throughout the project area. For the dominant floral species, this should be considered a moderate adverse impact; however, this impact is not permanent and, therefore, not considered to be a major adverse impact as beach-dwelling plant communities are composed of pioneer species and adapted to disturbance and dynamic substrate and environmental conditions. These plant communities typically revegetate areas of open sand created during natural overwash events within one to three years (USACOE, 1999). Similarly, prompt natural revegetation of the deposited sand after the completion of the nourishment project is expected. In addition, some slight changes in vegetation distribution may be expected in the backdune and swale areas due to the increase in primary dune height resulting from this project. Primary dunes act to shelter vegetation in backdune and swale areas from wind-blown salt and sand. Therefore, by increasing the height of the dune, backdune habitats would become more favorable for woody plant species, such as beach plum and rugosa rose, and an increase in abundance of these species is plausible.

The proposed nourishment project is expected to have only negligible adverse impacts to seabeach amaranth for several reasons. First, there is limited habitat available in the applicant communities, and this limited habitat is not optimal for the growth and survivorship of amaranth. Seabeach amaranth is most common in recent storm washouts and in rapidly, accreting or eroding shorelines, and are less common on highly stable beaches. Furthermore, recreational use of beach habitats is a primary cause for declines in the populations of these plant species. Off-road vehicle and pedestrian traffic can crush or break individual specimens resulting in mortality or reduced seed production. Thus, the intense recreational use of the beaches in the applicant communities, limited habitat currently available, and the absence of large washout habitats indicate that seabeach amaranth is not expected to be numerous in these communities. This prediction is supported by observational data from the Fire Island communities, which have had consistently low numbers of seabeach amaranth in recent years. Seabeach amaranth observations between Saltaire and Lonelyville ranged between 6-8 plants annually between 2005 and 2007. Seabeach amaranth observations in Fire Island Pines were high in 2005 (188 plants), but lower in 2006 and 2007 (28 and 2 plants, respectively) (Appendix G).

Wildlife

The potential impacts of beach nourishment to terrestrial wildlife include direct mortality resulting from the burial of wildlife and beach invertebrates during sand placement. This direct mortality is expected to impact slow-moving, small, or burrowing organisms including small mammals, terrestrial herpetiles, and invertebrates. For example, wildlife that have the potential to be adversely impacted by beach nourishment include white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), and cottontail rabbit (*Sylvilagus floridanus*). However, these are not expected to be major, permanent adverse impacts at the population-level due to the sporadic or transient occurrence of individuals of these species in beach and dune habitats, which is due to limited vegetative cover and the tendency of these species to utilize a wide variety of suitable and widespread habitats. Accordingly, it is expected that these species would disperse into the nourished beach/dune from surrounding habitats after completion of the project and re-colonization of beach and dune vegetation.

The extensive physical disturbance of beach and dune habitats, operation of heavy equipment, increased noise levels, and human activity during beach nourishment would also result in negligible adverse impact due to the temporary loss of foraging and resting habitat for various avian and mammal species. This would negatively impact wildlife foraging in the swales of dunes of the Fire Island communities during the fall and winter months. Mammals expected to be present include white-tailed deer (*Odocoileus virginicus*), red fox (*Vulpes vulpes*), and the small mammals described above. Songbird and raptors which utilize the beaches, dunes, and swales, described in Section 3.3.3, are also expected to be temporarily displaced from the project area. The disturbance and noise associated with beach nourishment is also expected to discourage overwintering gulls and terns from loafing in adjacent supratidal areas. These adverse impacts are not expected to rise to the level of moderate or major intensity due to the mobile nature of the organisms, the abundance of suitable, proximal undisturbed habitats, and the lack of dependence of these species on beach and dune habitats.

Another potential adverse impact of beach nourishment is the temporary loss of intertidal foraging habitat for migratory and resident shorebirds in the project area due to increased turbidity in intertidal surface waters during construction. Beach nourishment activities conducted between September and December would coincide with the fall migration of shorebirds on Fire Island. The shorelines of Fire Island provide an essential source of intertidal invertebrates for the migrating birds. Disturbance resulting from beach nourishment is not expected to have a moderate or major adverse impact on the migration of shorebirds as 1) abundant intertidal foraging area in adjacent ocean beaches and the nearby bay shoreline would be undisturbed by beach nourishment and 2) migratory shorebirds are highly mobile and capable of avoiding disturbed beaches.

Beach Invertebrates

Beach nourishment would also have a short-term moderate adverse impact on beach invertebrate communities, which serve as prey for many species of birds, including piping plovers. Beach invertebrate communities would be buried with sand placement activities. However, studies have shown that beach invertebrate populations recolonize within 2 to 7 months of disturbance (Nelson, 1985, Hackney et al., 1996). Studies conducted in nearby similar habitats indicate that fauna in the swash and intertidal zone showed no significant difference in abundance, diversity, composition, or total biomass between samples collected before and after nourishment in New Jersey study areas (ACOE 1999a, 1999b, 2001).

Threatened and Endangered Species

Potential direct impacts to listed terrestrial wildlife and plants (piping plover and seabeach amaranth) from construction associated with beach nourishment includes harm and harassment of adult or juvenile plovers, destruction of plover nests or nesting habitat, and destruction of seabeach amaranth individuals and/or seed banks.

Beach nourishment is proposed during fall and winter months when piping plovers are overwintering in their southern habitats. Therefore, direct adverse impacts including harm and harassment of plovers and destruction of nests are not anticipated.

Plover nesting habitat may be directly impacted by beach nourishment activities. However, the Fire Island communities proposing beach nourishment are not typically utilized by plovers for nesting. Historically, no plovers have been observed nesting in the Western, Central, or Davis Park reaches. In Fire Island Pines, a single nest in 2004 is the only occurrence on record. As such, destruction of productive plover nesting habitat is not anticipated and is not expected to result in adverse impacts to the piping plover population on Fire Island.

Beach nourishment can have positive site-specific impacts on seabeach amaranth. Although more study is needed before the long-term impacts can be accurately assessed, seabeach amaranth has colonized several nourished beaches, and has thrived in some sites through subsequent re-applications of fill material (USFWS 1993). However, on the landscape level, beach nourishment is similar to other beach stabilization efforts in that it stabilizes the shoreline and curtails the geophysical processes of barrier islands. These effects are detrimental to the range-wide persistence of the species. In addition, beach nourishment may cause site-specific minor to moderate adverse effects by crushing or burying seeds or plants, or by altering the beach profile or upper beach micro-habitats in ways not conducive to seabeach amaranth colonization or survival. Deeply burying seeds during any season can have serious effects on populations; this also applies to the placement of dredge spoil (USFWS 1996b). Burial of the seed bank may be particularly detrimental to isolated populations, as no nearby seed sources are available to re-colonize the nourished site. Adverse effects of beach nourishment may be compounded if accompanied by artificial dune construction and stabilization with sand fencing and/or beach grass, or if followed by high levels of erosion and scarping of the upper beach.

Prior to the 2003 nourishment projects in Western Fire Island and Fire Island Pines, there were no amaranth plants observed within the communities. Following the beach nourishment projects, 62 seabeach amaranth plants were observed in western Fire Island communities during the 2004 growing season (S. Young, pers. comm.) and 45 plants were observed in Fire Island Pines (Appendix G). Amaranth occurrence peaked in 2004 in the western Fire Island communities and in 2005 in Fire Island Pines, when 188 plants were observed. Large numbers of amaranth in these areas in 2004 and 2005 indicate that seabeach amaranth is able to rapidly recolonize new habitats and that nourished beaches provide suitable habitat for amaranth. Therefore, it seems that the beneficial effects of beach nourishment for amaranth, *i.e.* creation of suitable beach habitat, has offset the adverse impact of seed bank burial in past nourishment projects.

Indirect impacts of beach nourishment may be anticipated to piping plovers, least terns, and seabeach amaranth from changes in the beach profile expected within and adjacent to the project area. These indirect impacts from beach nourishment could have both beneficial and adverse impacts to these species. Beach nourishment would produce a higher, wider beach and, potentially, greater availability of suitable habitat for plovers, terns, and amaranth. The higher, wider beach may reduce flooding of upper beach habitat, which would provide more favorable amaranth and plover nesting habitat and reduce mortality of plover eggs, plover chicks, amaranth plants, and amaranth seedlings from flooding. These beneficial affects are likely to be negligible to minor in intensity for piping plovers as the use of beaches in the communities for ORV traffic and recreational activities would continue to adversely impact the habitat quality of these beaches. The beneficial effects of beach nourishment on seabeach amaranth may rise to the level of moderate, as indicated by the large numbers of plants observed in western Fire Island communities and Fire Island Pines after nourishment projects.

Potential adverse indirect impacts from beach nourishment to piping plovers include the creation of additional sub-optimal or non-functional habitat in the heavily-disturbed community areas, which could result in a population sink. In this case, a population sink could occur if adult plovers invest time and resources in attempting to nest and raise chicks in an area with a high risk of nest failure or chick mortality due to human disturbance, pedestrian traffics, or nest predators. Numerous studies have documented the direct and indirect adverse impacts of human disturbance on piping plovers (Burger 1987, Melvin et al. 1992, Howard et al. 1993, Elias-Gerken and Fraser 1994, and Strauss 1990). Since ocean beaches in the Fire Island communities already have high levels of public use, these potential adverse impacts are expected to be negligible to minor in intensity as no noticeable shift or change in existing use of these beaches by plovers and terns is expected. This is also the case with impacts from nest and chick predators, including crows, gulls, grackles, feral cats, and foxes, which tend to be more abundant in the communities.

Beach nourishment also decreases the likelihood of natural overwash processes and early successional habitat formation which are preferred habitats by plovers, terns, and amaranth. However, it would seem that overwash habitats located within the existing communities have the potential to be population sinks for the same reasons (high levels of human activity and nest predators) as the beaches created by beach nourishment.

Sand placement during beach nourishment would bury established beach vegetation and temporarily inhibit vegetative growth. However, the community areas exhibit very little vegetation, much of which was destroyed in the April 2007 nor'easter. Loss of the beach and dune system from the nor'easter and other storms has precluded recolonization of these areas by beach vegetation.

Nourishment could also bury or temporarily remove the wrack line, an important source of prey for piping plovers. The wrack line is expected to re-accumulate quickly after the completion of beach nourishment, and should be reestablished prior to the arrival of plovers in the spring. Accordingly, burial of the wrackline during beach nourishment is expected to have a negligible impact on piping plovers.

Summary of Beach Nourishment Impacts on Terrestrial Ecology

In summary, the potential direct and indirect impacts of beach nourishment on terrestrial ecology include adverse and beneficial impacts listed below. The realization of these impacts would depend on the timing and extent of the projects and the severity of storm and weather conditions. NPS and NYSDEC criteria require surveys, monitoring, and other conservation measures as permit conditions, and would not allow projects to occur if these species are present. As such, no direct impacts are anticipated. The indirect impacts could adversely or positively affect piping plover and seabeach amaranth. Nourishment may also affect species habitat up to one mile downdraft of the project area due to sediment transport. FIIS would continue to operate under its Endangered Species Management Plan, which incorporates measures to protect these species, and would continue to report the results of its inventory and monitoring program to the USFWS and NYSDEC.

Potential Adverse Impacts

- Direct impacts
  - Burial and destruction of existing beach and dune vegetation communities.
  - Direct mortality of slow-moving, small, or burrowing organisms including small mammals, terrestrial herpetiles, and invertebrates.
  - Displacement of wildlife which utilize beaches, dunes, and swales for foraging, breeding, or resting habitat.
  - Disturbance to prey base (beach invertebrates and wrack line) and temporarily reduced prey availability.
  - Direct mortality to plovers or amaranth if present during project activities (not anticipated).
  - Creation of sub-optimal habitat due to high-levels of human activity and predator abundance in nourished area leading to a population sink.
  - Changes to existing plover and amaranth habitat on FIIS due to sediment transport (could be a positive or negative impact).

- Indirect impacts
  - Reduction of potential formation and maintenance of optimal overwash piping plover breeding and foraging habitat.

Potential beneficial impacts:

- Direct impacts

- Potential significant increase in beach profile height and width and creation of increased nesting, colonization, germination, and foraging habitat.
- Potential for ephemeral pool creation and less scarping.
- Decreased likelihood of mortality and loss of productivity due to flooding.

Cumulative Impacts

Suffolk County Department of Parks may be undertaking a beach nourishment of the middle portion of Smith Point Park and western portion of Cupsogue Park. Piping plovers are known to breed on beaches located just east of FIIS in Smith Point and Cupsogue County Parks. Piping plover breeding activity at these parks has been fairly consistent since 2004 with an average of 17.2 pairs per year at Smith Point County Park and 7.2 pairs per year at Cupsogue County Park (D. Rodgers SCDP, pers. comm.). Furthermore, Smith Point County Park and the beaches of Westhampton have typically exhibited high abundances of seabeach amaranth. Implementation of similar mitigation measures by Suffolk County to avoid impacts to piping plovers and seabeach amaranth would serve to avoid mitigate for cumulative impacts to these species. FIIS would continue to operate under its Endangered Species Management Plan to avoid adverse impacts to protected species and would continue to report the results of inventory and monitoring programs established for beach nourishment projects to the USFWS and NYSDEC. In addition, planning for the USACOE FIMP project and its associated reach project are on-going as are additional projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area or surrounding areas, but cannot be predicted at this time.

4.3.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

The potential direct and indirect impacts, both beneficial and adverse, to terrestrial ecological resources under this nourishment alternative are largely identical to those described for alternative 2.3 and, accordingly, identical impacts will not be reiterated. However, the following section will describe the potential for nourishment design modifications included in this alternative to result in increased impacts relative to alternative 2.3 above.

The proposed variation in the cross-section of project design would not result in any additional adverse impacts to terrestrial ecological resources as the total volume of placed sand in dune, beach, and intertidal habitats would not be altered.

The proposed placement of 400-500’ taper sections on Federal property would result in a slight increase in the size of the project area and, consequently, the areas of dune, beach, intertidal, and nearshore habitats impacted by the project. Accordingly, due to the inclusion of tapers, the potential adverse and beneficial impacts of this nourishment alternative to terrestrial ecological resources are likely to show a negligible increase in intensity relative to the impacts expected from alternative 2.3 above.

The proposed modification to the borrow area cut depth would not result in any additional adverse or beneficial impacts to terrestrial ecological resources.

The proposed modification of the construction timeline has the potential to result in a negligible increase in the magnitude of the potential adverse impact to shorebirds. For example, beach nourishment would result in a temporary loss of intertidal foraging habitat for migratory and resident shorebirds in the project area due to increased turbidity in intertidal surface waters during construction. Commencement of the nourishment activities earlier in the fall would result in the project timeframe coinciding with a greater proportion of the fall migration. However, the earlier commencement date proposed in this alternative is not expected to result in greater adverse impacts relative to alternative 2.3 due to 1) the abundant intertidal foraging area in adjacent ocean beaches and the nearby bay shoreline would be undisturbed by beach nourishment and 2) migratory shorebirds are highly mobile and capable of avoiding disturbed beaches.

Cumulative Impacts

The cumulative impacts impacts to terrestrial ecological resources under this alternative are identical to those described for alternative 2.3 and, accordingly, are not reiterated.

4.3.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Template, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

This alternative is similar to alternative 2.4 above, except that there are no tapers proposed on Federal property with this alternative. Tapers on Town of Islip and Town of Brookhaven (Point O' Woods) lands are still proposed. Accordingly, the expected direct and indirect impacts to terrestrial ecological resources in this alternative are identical to those described in the previous discussion for alternative 2.4, with the exception that the small decrease in the project area resulting from the elimination of taper sections on Federal property would result in a negligible decrease in the intensity of impacts relative to the impacts expected from alternative 2.4.

Cumulative Impacts

The cumulative impacts impacts to terrestrial ecological resources under this alternative are identical to those described for alternative 2.3 and, accordingly, are not reiterated.

4.3.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

The expected direct and indirect impacts to terrestrial ecological resources with this alternative are identical to those described for alternative 2.4 and, accordingly, are not reiterated.

Cumulative Impacts

The cumulative impacts impacts to terrestrial ecological resources under this alternative are identical to those described for alternative 2.3 and, accordingly, are not reiterated.

4.3.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

Direct and Indirect Impacts

The expected direct and indirect impacts to terrestrial ecological resources with this alternative would be a combination of impacts discussed in the above sections. Accordingly, they are not reiterated.

Cumulative Impacts

There is the realistic potential for several beach nourishment and beach scraping projects during the project timeframe. This could result in nearly 6 miles of beach manipulation with a combination of the direct and indirect impacts to the terrestrial ecology described in the above sections. As discussed, the effects of these impacts may be beneficial or adverse. In addition, beneficial and adverse indirect impacts resulting from littoral drift and sand movement of nourished sand may occur one-mile to the west and 1000' ft to the east of the project site. This could result in direct and indirect impacts from alternative 2.7 that may potentially occur from the Fire Island Lighthouse Visitor Center in the west to the Watch Hill Visitor Center in the East.

In addition to the likely combination of beach scraping and beach nourishment projects described above, the Suffolk County Department of Parks may be undertaking a beach nourishment of the middle portion of Smith Point Park and western portion of Cupsogue Park. Piping plovers are known to breed on beaches located just east of FIIS in Smith Point and Cupsogue County Parks. Piping plover breeding activity at these parks has been fairly consistent since 2004 with an average of 17.2 pairs per year at Smith Point County Park and 7.2 pairs per year at Cupsogue County Park (D. Rodgers SCDP, pers. comm.). Furthermore, Smith Point County Park and the beaches of Westhampton have typically exhibited high abundances of seabeach amaranth. Implementation of similar mitigation measures by Suffolk County to avoid impacts to piping plovers and seabeach amaranth will mitigate for direct and/or cumulative impacts to these species. FIIS would continue to operate under its Endangered Species Management Plan to avoid adverse impacts to protected species and would continue to report the results of inventory and monitoring programs established for the beach scraping and nourishment projects to the USFWS and NYSDEC. In addition, planning for the USACOE FIMP project and its associated reach project are on-going as are additional projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area or surrounding areas, but cannot be predicted at this time.

4.4 Impacts on Aquatic Ecology

4.4.1 Impacts of Alternative 2.1, No Action Alternative

Direct and Indirect Impacts

No direct or indirect effects of the no-action alternative are anticipated for the benthic invertebrate and finfish assemblages of the intertidal zone, nearshore areas, or offshore borrow site. Only in the unlikely event of a breach could the intertidal zone, nearshore areas, or the aquatic ecology of Great South Bay be impacted. For example, a breach could have beneficial direct effects, such as the creation of new intertidal habitats, and would potentially have adverse indirect impacts, such as changes in the finfish and invertebrates communities of the Great South Bay due to the changes in salinity that would result from a breach. However, the positive or negative impacts effects of a breach on these assemblages would be unpredictable, in terms of their duration and intensity, due to the potential implementation of the FIIS Breach Contingency Plan and/or emergency actions which would likely repair areas in front of communities (NPS, 2003).

Protection of aquatic special status species, such as marine mammals and sea turtles, would be maintained by the NPS through continued implementation of its Endangered Species Habitat Management Plan. However, as stated previously, the oceanic habitats of the protected marine mammals and sea turtles would not be affected by the no action alternative.

Cumulative Impacts

Cumulative impacts to the aquatic ecology of Fire Island may result from the potential impacts of other projects, including the potential dredging of Moriches Inlet for beach nourishment at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, and additional projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time. The aquatic ecological resources of the nearshore areas of Fire Island and the offshore borrow site would continue to be affected by variations in water quality resulting from residential and commercial development in watersheds; contributions of non-point source pollution including excess nutrients, sediments, chemicals, and pathogens; contributions of wet- and dry-atmospheric deposition of pollutants; recreational and commercial boat traffic; and discharge of stormwater runoff. In addition, aquatic ecological resources would continue to be impacted by commercial and recreational fisheries and regulations/quotas aimed at managing these resources. Considering the wide range of factors unrelated to the no-action alternative influencing the aquatic ecological resources of Fire Island, it is not likely that this alternative would contribute to the cumulative impacts on these resources.

4.4.2 Impacts of Alternative 2.2, Beach Scraping

Direct and Indirect Impacts

No direct or indirect impacts will occur to the aquatic ecology as all disturbance resulting from beach scraping occurs landward of the mean high water mark.

Cumulative Impacts

Potential cumulative impacts would result soley from other projects including the potential dredging of Moriches Inlet for beach nourishment at Smith Point and Cupsogue County Parks, potential reach projects associated with USACOE FIMP project, or projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this aquatic ecology of the project area of or surrounding areas, but cannot be predicted at this time

4.4.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

Direct impacts of beach nourishment may occur to aquatic ecology at both the borrow sites (USACOE Borrow Areas 2-West and 2-East) and a maximum of 6 miles of shoreline subject to sand placement, as well as the potential indirect impacts to an additional 6 miles of shoreline adjacent to the site of sand placement. The following section will discuss both direct and indirect impacts to intertidal and nearshore benthic communities, finfish and benthic invertebrate communities at the borrow site, and marine mammals and sea turtles.

Criteria imposed by NPS/FIIS and NYSDEC will serve to reduce the intensity of potential direct and indirect impacts of beach nourishment, particularly for Federally- and state-protected species. Such project conditions include 1) imposition of a time of year restriction for all construction activity that attempts to avoid and minimize any impacts to natural and cultural resources, 2) the requirement that all equipment transport occur by water or interior road transport to avoid and minimize impacts to beach habitats whenever possible, 3) the requirement of pre, during and post-project surveys and monitoring for the duration of the beach nourishment activities, and 4) the requirement that grain size and sediment characteristics of the material to be deposited will be consistent with the existing beach substrate.

Intertidal and Nearshore Benthic Community

Intertidal and nearshore benthic communities would sustain temporary moderate adverse impacts from the deposition of fill material, as sessile and slow-moving species would be subject to near complete mortality during sand placement. In addition, increased turbidity in the water column during construction may result in 1) negative impacts to filter feeding organisms due to clogging of gills and filter-feeding structures, 2) reduction of dissolved oxygen levels, 3) smothering of nearshore, intertidal, and beach invertebrates in the areas of sand placement, 4) altered benthic diversity following recolonization, and 5) altered behavior and reduced productivity due to increased stress levels (NPS, 2003).

Studies have reported that nearshore and intertidal infaunal communities can recolonize within 2 to 7 months of disturbance created by beach nourishment projects (Nelson, 1985; Hackney et al., 1996). This short recovery time is consistent with intertidal and coastal species being accustomed to responding to disturbance, as most species have larval stages capable of wide dispersal and, therefore, colonization of new habitats. However, it should be noted that a rapid recolonization may be contingent on the degree of similarity between the deposited dredged sediments and the original substrate. Similarity in sediment size and type may facilitate the recruitment and colonization of the newly placed sediments by infaunal organisms from adjacent areas. For example, studies in North Carolina (Reilly and Bellis, 1983) and Florida (Rakocinski, 1990) reported recovery times of greater than one year for some infaunal species on beaches that received a significant amount of anomalous silt and clay in the nourishment material.

Moderate negative impacts to the benthic intertidal and nearshore invertebrate communities due to burial and turbidity are inevitable during a beach nourishment project. However, permanent and major adverse effects of this project can be avoided by selecting nourishment material comprised of sediments similar to those of the beach substrate found at the project sites.

Invertebrate surveys performed following the 2003 nourishment project indicate that the invertebrate community of the intertidal and supratidal beach zones returned to levels consistent with unnourished areas within one year (Appendix G). USACOE methodologies were used for this study and are described below:

> Invertebrate surveys were conducted twice per year in 2004 and 2005, to determine species diversity and biomass and to compare nourished and reference sites.
>
> Sample Sites. There were two sample sites within the project areas. In the western communities, sampling was done south of Crest Walk (SFD11). In Fire Island Pines, sampling was done south of Harbor Walk (FIP7).
>
> Data from the renourishment areas was compared with two "control" studies, the USACOE Beach and Invertebrate Survey for the Reformulation Study, and a National Parks Service Technical Report on Ocean Beach Invertebrates.
>
> Sampling Methodology. Sampling methods were taken from the USACOE Placement Area Invertebrate Sampling for the Reformulation Study. Samples were taken using a transect method twice each year (spring and fall). Each transect ran from the base of the foredune to the edge of the wash zone. Physical characteristics were noted for each sample site. Each site required two days of sampling.
>
> Core Samples. Core samples were used to catch burrowing animals. To collect the sample, a 3" diameter, 8" long plastic corer was used. The samples were then sieved through a 0.5 mm stainless sieve and organisms identified where possible. Any organisms not identified were bottled and preserved in formalin for later analysis.
>
> On day one, core samples were taken from each site at the following locations along the transect line: (1) at the most recent high tide line (regardless of the presence of wrack), (2) at the low tide surf zone, and (3) in the middle of the tide lines. On day two, one core sample from the wrack line was taken following the sight sample, where insecticide was used to stun organisms.
>
> Sight Samples. Sight samples were taken within the wrackline on day two. One sight sample was taken along each transect. To sample, a 0.075 m^2 quadrat was placed over the wrack to designate the sampling area. A rectangular sieve was then placed over the quadrat, and a light, steady mist of insecticide was sprayed through the sieve mesh onto the wrack. The sieve was then removed and the wrack searched for five minutes for organisms. Organisms that were not identified in the field were bottled and preserved with formalin for later analysis. If the wrack was too thick to sort thoroughly within the allotted five minute period, the bucket-floatation method was used. With this method, the wrack sample is submerged in a white bucket of seawater to catch organisms that float to the surface.
>
> Pitfall Trap Sampling. Pitfall traps were set within the wrackline (1), supratidal (1) and beach grass areas (1) of each transect line for 24 hours. The traps consisted of 0.5 L (16 oz.) plastic solo or comparable cups buried level with the sand surface and partially filled with soapy water. After the sampling period, the contents within each trap were placed in Ziploc bags or comparable containers and placed in a cooler for analysis in the lab.
>
> The methods described above yielded eight (8) samples from each transect line in the spring, and another eight (8) samples in the fall, for a total of sixteen (16) samples per year for each transect.

The results of each invertebrate survey are discussed in the monitoring reports found in Appendix G. To compare the effects of beach nourishment on benthic invertebrates, the results from sampling conducted by Land Use Ecological Services (Appendix G) were compared to the USACOE study (2005) and a study conducted for NPS/FIIS as a master's thesis by a SUNY Stony Brook student. Table 28 compares the overall results of each study. Although sample sizes were too small for statistical comparison, it appears that nourished sites recovered to pre-construction conditions as early as 2004. High variability between sites and seasons was shown in the USACOE and NPS/FIIS studies, both of which demonstrated that the sites nearest the nourished areas have among the lowest abundances. This indicates that the project area was never a highly abundant area for benthic invertebrates.

However, the dominant groups—nematodes, oligochaetes, and amphipods—returned to the nourished areas within one season. Their abundances hold steady over the 2004-2005 sampling seasons, indicating a recovered benthic invertebrate base and providing evidence that the adverse impacts of the 2003 nourishment project on benthic invertebrates were only moderate in intensity.

Table 28. Comparison of four (4) invertebrate studies on Fire Island, Atlantic ocean side.

Invert Study		USACOE* (January 2005)	NPS** (June 1999)	LUES*** (December 2004)	LUES*** (December 2005)
***N* Sample Sites**		12	6	2	2
n samples		192	192	32	32
Core Samples	**Dominant Taxa**	Nematoda, Oligochaeta	Amphipoda	Bivalvia (*Mytilus edulis),* Nematoda	Nematoda, Oligochaeta
	# Organisms	4454	338	143	118
Pitfall Traps	**Dominant Taxa**	Amphipoda (*Talorchestia longicornus*)	Amphipoda (*T. longicornus*)	Hymenoptera (Formicidae)	Coleoptera (*Notoxus* spp.), Amphipoda (*T. longicornus*)
	# Organisms	527	4597	63	66
Wrack Sight Samples	**Dominant Taxa**	Amphipoda	Coleoptera (*Phaleria testacea*)	Bivalvia (*M. edulis*)	Decapoda (*Emerita talpoida*)
	# Organisms	71	887	1175	2

Finfish

Dredging and beach nourishment activities are expected to have short-term, negligible to minor impacts to finfish populations in the project area. The following adverse direct impacts may be expected to finfish: 1) burial of demersal eggs by settling sediments, 2) clogging of gills and filter-feeding structures by suspended sediments which result in increased mortality, reduced reproduction, or decreased ability to avoid predators (Sherk 1971), or (3) mortality of finfish of all life stages.

Turbidity and associated water quality parameters at the borrow areas and placement sites would rapidly return to preconstruction levels with no lingering adverse impacts expected (Naqvi and Pullen, 1982). Impacts will be negligible to minor due to 1) the abundant areas of adjacent waters that will be undisturbed by beach nourishment and 2) highly mobile adult life stages of finfish which are capable of avoiding disturbed beaches and intertidal areas. Furthermore, construction is proposed during late fall and winter months, when the project areas are sparsely inhabited by finfish. Finally, sand placement areas are high-energy zones with mixing and transport of sediment with each wave and tidal cycle (NPS, 2003). Therefore, impacts to finfish resulting from dredging and beach nourishment are expected to be negligible to minor in intensity and short-term in duration.

In accordance with the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, an Essential Fish Habitat (EFH) consultation is required for the proposed beach nourishment projects. The Atlantic Ocean in the project area has been identified as an EFH for 37 species of finfish and 4 species of commercially important invertebrates (Table 24). A detailed discussion of potential impacts of beach nourishment on EFH managed finfish species is provided below. Discussion of the potential impacts of beach nourishment on EFH managed invertebrate species is found in the following section on benthic macroinvertebrates. A summary of potential impacts to EFH managed finfish and invertebrate species is provided in Table 29.

Atlantic butterfish (*Peprilus triacanthus*)

All life stages of the Atlantic butterfish inhabit waters in the project area. The Atlantic butterfish inhabits waters of the project area during spring and summer months, moving inshore to feed and reproduce. Juveniles and adults are found in schools over sand and mud substrates, mainly near the surface of waters with a depth of 22-55m (Bigelow and Shroeder, 1953). Eggs and larvae appear in the area in May through October, indicating spawning occurs in spring and summer months. Studies have shown that spawning probably does not occur below 15 degrees Celsius (Colton, 1972).

Butterfish in the project area feed on planktonic prey, including thaliaceans, mollusks, crustaceans, coelenterates, polychaetes, small fishes, and ctenophores (Fritz, 1965). They, in turn, are preyed upon by haddock, whiting, monkfish, weakfish, bluefish, swordfish and sharks. Many of these species are also included in the EFH designation.

When temperatures fall below 15 degrees Celsius in the fall/winter, butterfish migrate offshore to the edge of the continental shelf. They are then found near the bottom over sand, mud and rock. Studies have shown that butterfish are absent from the inshore waters off New Jersey from January through late April (Cross et al., 1999).

Although a fishery for Atlantic butterfish has existed since the 1800's, the demand for the species has declined in recent years. The National Marine Fisheries Service has stated that the butterfish stock is neither overfished nor approaching overfished condition (NMFS, 1997).

Fall dredging may impact juvenile and adult butterfish prior to their winter offshore migration. However, this species is mobile and would likely avoid areas of dredging activity resulting in negligible to minor impacts to butterfish in the project area and negligible impacts to butterfish populations. Construction would be complete prior to the spring inshore migration and spawning of butterfish and would not result in adverse impacts to butterfish.

Atlantic mackerel (*Scomber scombrus*)

Atlantic mackerel inhabit waters of the project area throughout the year. Studies have shown that mackerel are intolerant of waters with temperatures below 5-6 degrees Celsius and above 15-16 degrees Celsius (Studholme et al., 1999). During winter months, mackerel migrate to deep water of the continental shelf from Sable Island Bank, Nova Scotia to Chesapeake Bay. In the spring, they move inshore and northeast, where they will spawn. Spawning occurs during spring and summer months, progressing form south to north as surface water temperatures increase. The most important spawning grounds for Atlantic mackerel appear to be southern New England and the Middle Atlantic Bight. Females spawn five to seven times per year.

Mackerel eggs are found in pelagic waters over 34 ppt, with depths of 10-325 m. They are found typically above the thermocline or in the upper 10-15 m of water, in temperatures ranging from 5-23 degrees Celsius. Surveys indicate that, although southern New England and the Mid-Atlantic Bight are productive spawning grounds, eggs are not found in the immediate project area (Studholme et al., 1999).

Larvae are found in waters with temperatures ranging from 6-22 degrees Celsius, at depths of 10-130 m. They are believed to migrate diurnally from the surface at night to the thermocline during the day. Surveys show that while larvae are abundant in southern New England and the Mid-Atlantic Bight, they are not found in the immediate project vicinity.

Juveniles and adults were found in Long Island waters during summer and winter months. Based on surveys, juveniles are most abundant during summer months, while adults were most abundant during the winter. However, survey results indicate that mackerel inhabit waters offshore of the project and borrow areas, and would not likely be found in the immediate project vicinity (Studholme et al., 1999).

Mackerel feed on a variety of invertebrates and fish, or by filter feeding. When filter feeding, mackerel swim through plankton with mouths agape, filtering food through their gill rakers. Prey selection includes copepods and fish larvae for larval mackerel, small crustaceans and mollusks for juveniles, and invertebrates and small fish for adults. As size increases, mackerel feed on a wider variety of prey that may also include squid, hake, sand lance, herring and sculpin (Studholme et al., 1999).

Atlantic mackerel are also prey species for several fish, including tuna, striped bass, and several species of elasmobranches. In addition, marine mammals such as pilot whales, common dolphins, porpoises and seals feed on mackerel.

The Atlantic mackerel is an important commercial fish. Regulations on the take of mackerel have enabled this species to thrive, with an estimated biomass of 3 million metric tons (Anderson, 1995). Atlantic mackerel stocks are therefore considered underexploited and at a high level of biomass.

Dredging and construction would have at most negligible impacts on Atlantic mackerel. Although all life stages are found in waters adjacent to the project areas, none were found in the immediate project area. Eggs and larvae occur predominately offshore during the spring and summer. Juveniles and adults may migrate into the project area during summer and winter months. However, this species is mobile and would likely avoid areas of dredging activity resulting in negligible to minor impacts to mackerel in the project area and negligible impacts to mackerel populations.

Atlantic salmon (*Salmo salar*)

Atlantic salmon are a highly commercial species that lives in ocean waters and migrates into freshwater rivers and streams to spawn in the fall. Atlantic salmon may not die after spawning as other salmon species do. They undergo a migration back out to sea, where they head for cold north Atlantic waters off northern Canada and Greenland.

Atlantic salmon used to range as far south as Connecticut, but overfishing and other factors now limit their southern range to Maine. Stocks have been so depleted that, in 1995, the National Marine Fisheries Service proposed a listing of endangered for the Atlantic salmon (www.nmfs.noaa.gov). As Atlantic salmon are not known to occur as far south as the project area, they would not be adversely impacted by dredging.

Atlantic sea herring (*Clupea harengus*)

Atlantic sea herring are a commercially important species with an EFH designation in the project area for juveniles and adults. Surveys show that both juveniles and adults inhabit nearshore waters in small numbers in the winter and high numbers in the spring, when they migrate from offshore areas. Juvenile herring prefer water with temperatures 8-12 degrees

Celsius, 26-32 ppt, and depths of 30-90 m. Adults prefer waters with temperatures 9-21 degrees Celsius, 25-28 ppt, and depths of 10-30 m. Juveniles and adults also migrate vertically in the water column, moving up to the surface at night and away from the surface during daylight (Brown, 1960; Blaxter, 1985).

Atlantic sea herring feed on a variety of invertebrates, including copepods, several types of invertebrate larvae, euphausiids and chaetognaths. Herring are preyed upon by several species of finfish, including sand lance, cod, and mackerel, as well as marine birds, seals, porpoises and whales (Reid et al., 1999).

Atlantic sea herring have been fished extensively in the past. The stock collapsed in the early 1970's and landings remained low for about 10 years (Atlantic States Marine Fisheries Commission, 1995). Spawning stock biomass recovered, with an estimated 1.4 million metric tons on 2001. According to the U.S. assessment, the resource is under-utilized, with the exception of the Gulf of Main inshore population, which may be overexploited (Stevenson & Scott, 2005).

This beach nourishment alternative is expected to have negligible to minor short-term impacts on Atlantic sea herring. Abundance of herring during fall/winter construction months is low, as this species prefers depths greater than found in the borrow sites. In addition, juveniles and adults are highly motile and would be temporarily displaced, but would avoid dredging activities. Construction is expected to be completed by spring and therefore, would not impact the spring migration of herring into nearshore waters in abundance.

Black sea bass (*Centropristis striata*)

Black sea bass are a warm water species that associate with structures such as reefs, shipwrecks and mussel beds. Black sea bass spawn during late spring and summer on the inner continental shelf between Chesapeake Bay and Montauk Point at depths of 20-50 m (Steimle et al., 1999a). Little is known of the egg stage of black sea bass. Larval sea bass settle and become demersal in coastal areas. Once settled, they grow to juvenile stage, wherein they migrate into estuarine nurseries. Entrance into estuaries in the Mid-Atlantic Bight occurs from July to September (Steimle et al., 1999). Once grown to adult size (>19 cm TL), black sea bass may migrate out into warm coastal waters associated with structures. There they associate with other finfish species, such as tautog (*Tautoga onitis*), hake (*Urophycis* sp.) and butterfish (*Peprilus triacanthus*). Trawls found that black sea bass were not common in open, unvegetated flats, beaches or deep, muddy bottoms.

The project area encompasses unvegetated flats and deepwater habitats. Magnetometer and side-scan sonar surveys indicate that there are no structures within the project or borrow areas. It is highly unlikely that black sea bass would be found to inhabit the project area, and therefore, would not be adversely impacted by dredging and construction operations.

Bluefin tuna (*Thunnus thynnus*)

Bluefin tuna are a highly important commercial species that occurs offshore in warm temperate waters throughout the Atlantic. They prefer water temperatures above 15 degrees Celsius, but have been observed in waters as low as 5 degrees Celsius. Bluefin tuna are a schooling fish, and prey on other species of finfish off the continental shelf. Bluefin tuna are highly migratory, making trans-Atlantic migrations in several tagging studies (Lutcavage et al., 2001).

As bluefin tuna prefer warmer waters and are highly migratory, they are not likely to be in the project area during construction. Therefore, no adverse impacts are expected to the species.

Bluefish (*Pomatomus saltatrix*)

Bluefish are a warm water species, and do not inhabit waters with temperatures less than 14-16 degrees Celsius. Recent surveys support this, as no bluefish have been found in the Mid-Atlantic Bight during winter months (Fahay et al., 1999).

Juvenile bluefish occur mainly in bays and estuaries of the Middle Atlantic Bight. They prey primarily on copepods, and begin eating finfish at 30 mm TL. Adults occur in the open ocean, large embayments, and estuaries. Studies suggest that bluefish are opportunistic feeders, eating whatever is most abundant in their habitat.

Bluefish are preyed upon by sharks, tuna and billfishes due to their size and speed. Mako sharks are the primary predator of bluefish, consuming 4.3-14.5% of the bluefish stock between Georges Bank and Cape Hatteras (Stillwell & Kohler, 1982).

Bluefish have experienced large population fluctuations since the 1600's (Bigelow & Shroeder, 1953). The proposed project is expected to have no adverse impact on bluefish, as construction would take place during late fall and winter months when water temperatures fall below the threshold for the species.

Blue shark (*Prionace glauca*)

Blue sharks are a fast moving, oceanic species. They are highly migratory, and have been documented migrating up to 3,716 miles across the Atlantic Ocean (Allen, 1999). However, little is known about migration; it is suspected that blues travel as water cools with seasonal change. Blue sharks are the most abundant oceanic shark species, and prey on squid and bluefish.

Blue sharks are an important commercial species. In addition, they are often caught on long lines and in drift nets set for other fast-moving finfish. It is estimated that 6.2-6.5 million blue sharks are caught annually; most of these are killed and thrown back or used for bait (Allen, 1999).

It is highly unlikely that blue sharks would be adversely affected by this beach nourishment alternative. Pups, juveniles and adults are found mainly in oceanic waters, but may also inhabit coastal waters where prey species are abundant. As prey species would be displaced due to construction, it is unlikely that blue sharks would be found in the project area, and would therefore not be adversely impacted.

Common thresher shark (*Alopius vulpinus*)

Thresher sharks are pelagic, fast moving species that migrate into coastal waters to feed on schooling fish. Threshers stay near the surface, following schools of mackerel, bluefish, shad, menhaden or herring into coastal waters, corralling them. They then feed on the school, mouth agape. Although the most abundant species of shark off Block Island during the porgy run in June, thresher sharks declined by about 67% in US Atlantic waters from 1976 to 1994 (Allen, 1999).

Beach nourishment is expected to have no effect on the common thresher shark. Threshers are found in inshore waters only when following prey species. As prey species would be displaced due to construction, threshers would not likely be found in the project vicinity and, accordingly, would not be adversely impacted.

King mackerel (*Scomberomorus cavalla*)

King mackerel eggs and larvae are not found in the project area. Juveniles and adults have been observed rarely during summer and winter months, but are more commonly found in oceanic waters offshore of the borrow areas. King mackerel are more common in warm temperate and tropical waters.

King mackerel are a commercially important species. However, dredging and construction would not adversely affect this species, due to their rare occurrence in the project area and the high mobility of juveniles and adults.

Monkfish (*Lophius americanus*)

Monkfish (also known as goosefish) eggs and larvae are listed in the EFH for the project area. Spawning occurs from spring through early fall; in southern New England it occurs May through June. Eggs are shed within veils that float freely at the surface. They are rare in the project area, and are not seen at all in southern New England after September; accordingly, they are not likely to be adversely impacted by the proposed project.

Larvae are pelagic, and are a common component of the summer ichtyoplankton community in the Mid-Atlantic Bight and southern New England. Monkfish larvae are rare inshore, preferring waters with depths of 30-90m.

This beach nourishment alternative would not adversely affect monkfish eggs or larvae, as neither are found in the project area during fall/winter months, and only rarely during the summer.

Ocean pout (*Macrozoarces americanus*)

Ocean pout spawn during the fall on sheltered, hard bottom areas such as shipwrecks and artificial reefs at depths <50 m. Eggs are demersal and laid in sheltered places on the bottom, such as rocky crevices. They are guarded by one or both parents until hatching, which occurs by mid-winter (Bigelow & Shroeder, 1953). Geographic distribution of eggs, however, is unavailable at this time.

Ocean pout have a brief larval stage. Larvae are thought to remain in their sheltered hatching grounds near the bottom (Bigelow & Shroeder, 1953). They are thought to occur across the continental shelf north and south of Cape Cod.

Adults are generally solitary, and continue to be demersal. They are commonly found from the intertidal zone to depths of 200 m along the continental slope. Ocean pout winter in inshore areas of the Mid-Atlantic Bight. Surveys showed common distribution in winter and spring across the project area (Steimle et al., 1999b).

Feeding habits of ocean pout are somewhat in debate. MacDonald (1983) reported that ocean pout are bottom feeders, sorting mouthfuls of sediments for prey. He stated that they do not use visual cues for hunting. However, Auster (1985) and Auster et al. (1995) stated that ocean pout were ambush predators, lying in wait within the sediment until prey approaches. Regardless of the method, ocean pout feed on a variety of invertebrates, most commonly the sand dollar. They also prey on bivalves, mollusks and crustaceans. Ocean pout are preyed upon by the sandbar shark.

Ocean pout abundance has fluctuated greatly over time. They were not a commercial species until the 1930's, and were heavily exploited in the 1960's and 1970's. The abundance of ocean pout has declined, and is considered overexploited by the National Marine Fisheries Service (1997).

Ocean pout eggs and larvae would not be affected by the proposed project, as they are not found in the project area. Adults are found in the project area during winter months. However, surveys of the borrow areas indicate that benthic infauna is sparse; no ocean pout were recovered during December 2001 and January 2002 surveys. Therefore, dredging and construction during fall/winter should not result in adverse affects to ocean pout that rise to the level of moderate. However, negligible to minor impacts could result due to the displacement of ocean pout to nearby unaffected waters.

Red hake (*Urophycis chuss*)

Red hake eggs, larvae and juveniles are listed in the EFH for the project area. Little is known of red hake eggs, as they co-occur with several species of hake. However, there is a major spawning area off of eastern Long Island. Spawning occurs at temperatures 5-10 degrees Celsius, usually during May-June off eastern Long Island (Steimle et al., 1999c).

Red hake larvae dominate the summer ichthyoplankton in the Mid-Atlantic Bight, mostly on the mid and outer continental shelf (Comyns & Grant, 1993). They have been collected in the upper water column from May through December (Collette & Klein-MacPhee, prep.). Larvae prey mainly on copepods and other invertebrates.

Juvenile red hake are distributed offshore (>100m) during the winter, and in coastal waters (<100m) of the project area during spring and summer. They remain pelagic until reaching a TL of 25-30mm (Methven, 1985). They then settle to the bottom, where they prefer sheltered habitats such as depressions in the sandy seabed or scallop beds. Juvenile red hake prey on several species of invertebrates, including amphipods and copepods. Juvenile red hake are also prey for several species of finfish, including other EFH species such as spiny dogfish, monkfish and whiting.

Dredging and construction is not likely to adversely impact red hake. Eggs are found in the project area during summer months, larvae are not found in the project area, and juveniles are found mainly during summer months. Although a few juveniles were observed during winter months, this number is insignificant when compared to the abundance in the area during summer, as most juveniles migrate offshore during the winter. Any juveniles remaining in the project area are likely to avoid construction activity. This is supported by survey data, in which no red hake were recovered during December 2001 and January 2002 surveys in the project area. Therefore, impacts to red hake juveniles in the project area are likely to be negligible to minor in intensity with negligible impacts to red hake populations.

Sand tiger shark (*Odontaspis taurus*)

The waters off Long Island are thought to be a major nursery for sand tiger sharks. This species is a warm water species. They are considered the most abundant shark species from Delaware Bay to Cape Cod during summer months. However, sand tigers migrate south when water temperatures fall below 19 degrees Celsius (Allen, 1999). As dredging and construction would occur during fall/winter months when water temperatures fall below 19 degrees Celsius, there is expected to be no adverse impact to the species.

Scup (*Stenotomus chrysops*)

Scup are typically found in the project area during warm summer and fall months. Once temperatures fall below 8-9 degrees Celsius, scup migrate from inshore waters south and offshore, at depths of 75-185m (Steimle et al., 1999d). Late fall dredging may impact this species; however, this species is mobile and is likely to avoid construction activities. Dredging during winter months would not impact the species, as they would be in their offshore winter habitats. Therefore, this beach nourishment alternative may result in negligible to minor impacts to scup in the project area while negligible impacts to scup populations are expected.

Spanish mackerel (*Scomberomorus maculates*)

Spanish mackerel are a commercially important species rarely found north of Chesapeake Bay. However, juveniles and adults have been observed off Long Island in small numbers in summer months. Dredging during fall/winter is not likely to adversely impact the species, as they are unlikely to be in the project area.

Summer flounder (*Paralichthys dentatus*)

Summer flounder, or fluke, are present in large numbers in the project area on a seasonal basis. Larvae, juveniles and adults are listed in the EFH for the project area.

Larvae of summer flounder are planktonic and most abundant 19-83 km from shore at depths of 10-70 m (Smith, 1973; Able et al, 1990). They are seen off eastern Long Island as early as September. In October, they are concentrated on the inner continental shelf between Chesapeake Bay and Georges Bank. They then spread evenly over the inner and outer portions of the shelf, before moving further offshore and southward to concentrate off North Carolina by April (Able & Kaiser, 1994).

Juvenile summer flounder are found inshore and in estuarine habitats during spring, summer and fall months (Able & Kaiser, 1994). During winter months, some juvenile summer flounder migrate to deeper waters offshore with adults, while others remain inshore and in estuaries (Able & Kaiser, 1994).

Summer flounder adults generally migrate from coastal and estuarine waters during warm months to deeper waters on the outer continental shelf during colder months (Bigelow & Schroeder, 1953; Grosslein & Azarovitz, 1982). Tagging studies off Long Island and southern New England have shown that summer flounder adults begin seaward migration in September and October, as water temperatures cool (Poole, 1962; Lux & Nichy, 1981). New York and New Jersey fish may move farther south during winter months (Poole, 1962). Studies indicate that during winter, summer flounder were mainly found at temperatures of 5-11 degrees Celsius and depths >70 m (Packer et al., 1999). Adult summer flounder generally feed on a variety of finfish species, including winter flounder, red and silver hake, scup and bluefish (Bigelow & Schroeder, 1953; Curran & Able, 1998).

Summer flounder are an important recreational fish in Great South Bay, particularly near Fire Island Inlet (Neville et al., 1939, Schreiber, 1973). They are also an important commercial species throughout Long Island waters, although in some years recreational landings exceeded commercial landings. The NMFS Northeast Fisheries Science Center (1997) considers the summer flounder to be at a medium level of abundance and over-exploited.

This beach nourishment alternative may adversely affect summer flounder juveniles and/or adults prior to their winter offshore migration. However, both juveniles and adults are highly motile and would likely avoid dredging activities. Surveys of the borrow areas conducted in December 2001 and January 2002 found no summer flounder individuals. Therefore, fall dredging may have minor to negligible adverse impacts to summer flounder as they would be displaced to nearby unaffected waters during their migration while winter dredging and construction would not result in more than negligible adverse impacts to this species.

Whiting (*Merluccius billinearis*)

Whiting, also known as silver hake, are listed in the EFH for the project area for eggs, larvae and juveniles. Whiting spawn throughout the year on the continental shelf. In southern New England spawning occurs in October; in the Mid-Atlantic Bight, spawning occurs in December and January. Eggs are pelagic, and are most commonly found in water depths of 50-150 m (Morse, 1999). They are found in deeper water in spring, and move into shallower water during summer months.

Whiting larvae are pelagic until they reach a TL of 17-20 mm, at which time they descend to the bottom as juveniles. Surveys indicate that larvae were rarely caught from January through April, and most of those were offshore in the Mid-Atlantic Bight (Morse, 1999).

Juvenile whiting undergo a seasonal migration. They inhabit inshore waters in the spring and summer months, then migrate offshore during winter. They prey on crustaceans such as euphausiids and shrimp, and graduate to fish as they grow.

This beach nourishment alternative is not likely to affect whiting, as the majority of individuals would have migrated offshore in winter habitats during construction. Although surveys indicate that small numbers of both juveniles and adults inhabit waters within or adjacent to the project area during fall/winter months, they are motile species and would avoid construction activities. Therefore, impacts to this species are expected to be negligible to minor for whiting in the project area while negligible impacts to whiting populations are expected.

Windowpane flounder (*Scophthalmus aquosus*)

Windowpane flounder of all age classes are listed within the EFH designation for the project area. Windowpanes spawn throughout the year. There is evidence for split spawning season off New York and New Jersey, with peaks in May and September (Wilk et al. 1990).

Eggs of windowpane flounder are found in the water column from February through November, with peaks in May and October. Larvae settle to the bottom at 10 mm TL (Bigelow & Shroeder, 1953). Settlement location depends on spawning time; spring spawned individuals settle in estuaries and on the continental shelf, while fall spawned individuals settle on the continental shelf.

Juvenile windowpanes are found inshore throughout the year. They prey on invertebrates, mainly mysiid shrimp and fish larvae.

Adults are found on sandy substrates in the project area, where they prey on crustaceans and fish larvae. Both adults and juveniles are prey for a number of species, including spiny dogfish, monkfish, black sea bass and summer flounder.

Windowpane flounder are not a commercially important species. However, they are often caught as bycatch for other benthic fisheries.

Dredging operations may have a negligible to minor impact on windowpane flounder eggs, due to an increase of suspended sediments during construction. Impacts are not expected to be moderate or major due to the short-term duration of the expected increase in turbidity and localized project area relative to the widespread occurrence of windowpane flounder.

Larvae, juveniles and adults may also be impacted, though this impact is expected to be negligible to minor. All three life stages occur in nearshore waters throughout the year, but may migrate to deeper offshore waters during winter months. December 2001 and January 2002 surveys of the borrow areas found only five individuals within the whole of the borrow sites sampled. Although dredging during fall/winter months may impact windowpane flounder individuals, construction activities would not have greater than negligible adverse impacts on populations of windowpane.

Winter flounder (*Pseudopleuronectes americanus*)

Winter flounder are a very important species commercially and recreationally, and occur in the designated EFH in all life stages. Typically, winter flounder are found in shallow waters during fall, winter and spring, and migrate to cooler deeper waters during summer months. They spawn during winter months in shallow habitats.

Winter flounder eggs are typically found in shallow bays and estuaries during winter months. They are demersal, and concentrated at depths of less 5 m, with temperatures less than 10 degrees Celsius and salinities of 10-30 ppt (Pereira et al., 1999). Typically, eggs are found in sandy bottom areas, although they have been reported in muddy sand and sand and gravel. Eggs are found clustered together and hatch after 2-3 weeks, depending on temperature.

Larvae of winter flounder are concentrated highly in Great South Bay, an area with low current speeds and turnover rates (Monteleone, 1992). This is consistent with Pearcy (1962), who stated that larvae would likely be found in spawning areas, as they are non-dispersive. Larvae feed in these areas on invertebrate eggs, nauplii, harpacticoids, calanoids, polychaetes and phytoplankton (Pearcy, 1962). They, in turn, are preyed upon primarily by the medusae, *Sarsia tubulosa*.

Young of the year winter flounder are found in very shallow inshore waters. Pearcy (1962) found that, while young of the year remain in estuaries during spring, summer and fall, they may migrate out to inshore areas during winter months. They are driven out of the shallow estuarine habitats by temperature and photoresponse preferences (Pereira et al., 1999). These conditions are thought to keep older juveniles in deeper, cooler waters throughout much of the year. Young of the year and juveniles feed on copepods, harpaticoids, amphipods and polychaetes (Pearcy, 1962). They are preyed upon by bluefish, gulls and cormorants.

Winter flounder adults undergo an annual migration between inshore and offshore waters. In the fall and early winter, they migrate inshore to spawn in bays and estuaries in winter and early spring. Once water temperatures reach 15 degrees Celsius, adults migrate back out to deeper offshore waters to spend summer months (Pereira et al., 1999). Migration of winter flounder may also be affected by food availability. Feeding migrations have been documented by several studies (Kennedy & Steele, 1971; Tyler, 1971b; Van Guelpen & Davis, 1979). Winter flounder are sight feeders. They position themselves on the bottom with eyes extended, then lunge at moving prey as it approaches (Olla et al., 1969). This feeding method has been shown to be disrupted by turbulence. Val Guelpen & Davis (1979) found that winter flounder moved out of shallow water during storm events to avoid turbulence.

There exists a very important commercial and recreational fishery for the winter flounder. The southern New England-Middle Atlantic stock is currently considered overexploited. This is a result of decreased landings since a peak of 39,000 mt in the 1980's. In 1996, winter flounder landings were 18,000 mt, an increase over the low of 8,500 mt in 1992. Although increasing, the stock remains below former levels, and is therefore overexploited (Brown & Gabriel, 1998).

This beach nourishment alternative may have minor, short-term adverse impacts on winter flounder juveniles and adults. Eggs and larvae are not found in the project area, but are concentrated within the protected estuarine system of Great South Bay. Juvenile and adult winter flounder would also likely be within the estuarine system during construction, as adults are spawning at this time. Surveys conducted in December 2001 and January 2002 found only 7 individuals within both borrow areas. It is likely that winter flounder inhabiting the borrow areas during fall/winter months will migrate out of the area when construction commences. As noted above, winter flounder have been shown to migrate from areas of high turbulence, as would be caused by dredging and construction activities. Accordingly, adverse impacts to winter flounder are not expected to be moderate or major due to the short-term nature of the disturbance and the motility of adult life stages which may be affected by the proposed project.

Yellowtail flounder (*Limanda ferruginea*)

Yellowtail flounder eggs and adults are listed in the EFH for the project area. Spawning for yellowtail flounder occurs from March through August at temperatures of 5-12 degrees Celsius (Fahay, 1983). Eggs are found in water with depths of 10-750 m, most frequently at depths of 30-90 m. In the Long Island and New Jersey region, eggs appear on the continental shelf in March and April.

Adults, as well as juveniles, tend to migrate away from coastal areas off southern New England in fall months. However, they are still found in the project vicinity in lower numbers. They prefer sand or sand-mud bottoms, were they will hunt for demersal prey including amphipods, polychaetes and sand dollars (Hahm & Langton, 1984; Collie, 1987a; Bowering & Brodie, 1991).

Yellowtail flounder became a commercially important species in the 1930's, when the winter flounder experienced a huge decline in stock (Royce et al., 1959). Abundance of the yellowtail has since fluctuated over time, reaching a record high in 1982 of 22,000 mt before falling to a record low in 1984 of 2,400 mt. The stock has appeared to rebound, however, with landings of 11,700 mt in 1996. Yellowtail flounder are not considered overfished in southern New England (Northeast Fisheries Science Center, 1997).

Dredging and construction during late fall/winter months would likely have only negligible adverse impacts on yellowtail flounder. Spawning in the area occurs in March and April, when construction activities will be complete. Adult yellowtail flounder are observed in the area in low numbers during fall/winter months; most migrate offshore in the fall. Surveys of the borrow areas conducted in December 2001 and January 2002 yielded no yellowtail flounder. Therefore, only short-term, negligible to minor impacts are expected to the few individuals that overwinter in the project area.

The following species have not been documented in the project area. Therefore, no adverse impacts from the proposed project are expected.

American plaice (*Hippoglossoides platessoides*)
Atlantic cod (*Gadus morhua*)
Atlantic sea scallop (*Placopecten magellanicus*)
Cobia (*Rachycentron canadum*)
Dusky shark (*Carcharhinus obscurus*)
Haddock (*Melanogrammus aeglefinus*)

Pollack (*Pollachius virens*)
Redfish (*Sebastes fasciatus*)
Sandbar shark (*Carcharhinus plumbeus*)
Shortfin mako shark (*Isurus oxyrinchus*)
Skipjack tuna (*Euthynnus pelamis*)
Spiny dogfish (*Squalus acanthias*)
Tiger shark (*Galeocerdo cuvieri*)
Tilefish (*Lopholatilus chamaeleonticeps*)
White hake (*Urophycis tenuis*)
White shark (*Charcharodon carcharias*)
Witch flounder (*Glyptocephalus cynoglossus*)

Conclusions:

Dredging and construction activities may have short-term, negligible to minor adverse impacts on some finfish species, such as Atlantic butterfish, summer flounder, whiting, windowpane flounder, and yellowtail flounder, if activities commence prior to fall offshore migrations of these species. There is also the slight potential for short-term, negligible to minor adverse impacts to small numbers of ocean pout, scup, Spanish mackerel, and winter flounder that may inhabit the project area during fall/winter construction. None of these potential impacts would affect species abundance or habitat nor are they expected to result in greater than negligible impacts to populations of these species.

Table 29. Summary of potential impacts of beach nourishment on EFH managed species.

Species	Potential Effects
American plaice (*Hippoglossoides platessoides*)	No effect. Species has not been documented in the project area.
Atlantic butterfish (*Peprilus triacanthus*)	Potential for negligible adverse impacts if dredging commences prior to winter offshore migration.
Atlantic cod (*Gadus morhua*)	No effect. Species has not been documented in the project area.
Atlantic mackerel (*Scomber scombrus*)	Potential for negligible adverse impacts to juveniles and adults found in the project area in small numbers during fall/winter. However, mobility of adults will enable them to avoid dredging area.
Atlantic salmon (*Salmo salar*)	No impacts expected. Species has not been observed in the project area.
Atlantic herring (*Clupea harengus*)	Potential for negligible adverse impacts to juveniles and adults found in the project area in small numbers during fall/winter. However, mobility of adults will enable them to avoid dredging area.
Atlantic sea scallop (*Placopecten magellanicus*)	No effect. Species has not been documented in the project area.
Black sea bass (*Centropristus striata*)	No effect. Species is not likely to inhabit the project area.
Bluefin tuna (*Thunnus thynnus*)	No effect. Species is not likely to inhabit the project area during fall/winter construction.
Bluefish (*Pomatomus saltatrix*)	Potential for negligible adverse impacts to juveniles and adults found in the project area in small numbers during fall/winter. However, mobility of adults will enable them to avoid dredging area.
Blue shark (*Prionace glauca*)	No effect. Species does not inhabit the project area and only migrates inshore following prey species, which will be displaced with construction acitivties.
Cobia (*Rachycentron canadum*)	No effect. This species has not been documented in the project area.

Species	Potential Effects
Common thresher shark (*Alopius vulpinus*)	No effect. Threshers are pelagic species that move to coastal waters to feed on schooling fish. Since all life stages are mobile and schooling fish will likely be displaced out of the project area, thresher sharks are not likely to be impacted.
Dusky shark (*Carcharhinus obscurus*)	No effect. Species has not been documented in the project area.
Haddock (*Melanogrammus aeglefinus*)	No effect. Species has not been documented in the project area.
King mackerel (*Scomberomorus cavalla*)	No effect expected. This species only rarely inhabits the project area.
Long-finned squid (*Loligo pealei*)	Potential for negligible adverse impacts if dredging commences prior to winter offshore migration.
Monkfish (*Lophius americanus*)	No effect. Species is only found in project area rarely during summer months.
Ocean pout (*Macrozoarces americanus*)	Potential for negligible adverse impacts to adults that may inhabit the project area during winter months.
Ocean quahog (*Arctica islandica*)	No effect. Species has not been documented in the project area.
Pollack (*Pollachius virens*)	No effect. Species has not been documented in the project area.
Red hake (*Urophycis chuss*)	Potential for negligible adverse impacts if dredging commences prior to winter offshore migration.
Sand tiger shark (*Odontaspis taurus*)	No effect expected. This species does not inhabit the project area during fall/winter months.
Sandbar shark (*Carcharhinus plumbeus*)	No effect. Species has not been documented in the project area.
Scup (*Stenotomus chrysops*)	Potential for negligible adverse impacts to adults that may inhabit the project area during winter months.
Shortfin mako shark (*Isurus oxyrinchus*)	No effect. No specimens have been documented in the project area.
Skipjack tuna (*Euthynnus pelamis*)	No effect. Species has not been documented in the project area.
Spanish mackerel (*Scomberomorus maculates*)	Slight potential for negligible adverse impacts to juveniles and adults found in the project area in small numbers during fall/winter. However, mobility of adults will enable them to avoid dredging area.
Spiny dogfish (*Squalus acanthis*)	No effect. Species has not been documented in the project area.
Surf clam (*Spisula solidissima*)	Short-term, negligible effects. Potential for mortality of surf clams found in low abundance in the borrow areas.
Summer flounder (*Paralicthys dentatus*)	Potential for negligible adverse impacts if dredging commences in the fall prior to winter offshore migration, or for the small numbers of juveniles and adults that overwinter in inshore waters.
Tiger shark (*Galeocerdo cuvieri*)	No effect. Species has not been documented in the project area.
Tilefish (*Lopholatilus chamaeleonticeps*)	No effect. Species has not been documented in the project area.
White hake (*Urophycis tenuis*)	No effect. Species has not been documented in the project area.
White shark (*Charcharodon carcharius*)	No effect. Species has not been documented in the project area.
Whiting (*Meriuccius bilinearis*)	Potential for negligible adverse impacts if dredging commences in the fall prior to winter offshore migration, or for the small numbers of juveniles and adults that overwinter in inshore waters.

Species	Potential Effects
Windowpane flounder (*Scopthalmus aquosus*)	Potential for negligible impacts to windowpane eggs with fall/winter construction. No effect expected to juveniles or adults, although there is potential for negligible impacts if dredging commences prior to fall offshore migration.
Winter flounder (*Pleuronectes americanus*)	Potential for negligible adverse impacts to the small number of winter flounder juveniles and adults that may inhabit the project area during fall/winter months.
Witch flounder (*Glyptocephalus cynoglossus*)	No effect. Species has not been documented in the project area.
Yellowtail flounder (*Limanda ferruginea*)	Potential for negligible adverse impacts if dredging commences in the fall prior to winter offshore migration, or for the small numbers of juveniles and adults that overwinter in inshore waters.

Benthic Macroinvertebrates

Dredging associated with beach nourishment would adversely impact benthic communities in the borrow area through increased turbidity and destruction of sessile and slow moving animals. This is impact is expected to be minor to moderate in intensity due to its temporary duration. Due to a high degree of dispersion among benthic larvae, re-colonization of the borrow areas is expected within 12-18 months (Naqvi & Pullen, 1982). As noted previously, sand is not likely to accrue in the borrow areas once dredging is complete; therefore, the substrate would be stable and capable of supporting benthic communities re-colonizing the borrow sites. The potential adverse impacts of dredging on EFH managed species, including longfin inshore squid (*Loligo pealeii*), ocean quahog (*Arctica islandica*), and surf clam (*Spisula solidissima*), have been examined in more detail as follows.

Longfin Inshore Squid (*Loligo pealeii*)

Little is known on the distribution of longfin squid eggs and larvae. However, it is known that eggs commonly attach to rocks or boulders on sandy bottoms, precluding the abundance of longfin squid eggs in the project areas. Larvae occur in pelagic waters near the surface, at temperatures of 10-26 degrees Celsius and salinities of 31.5-34.0 ppt (Cargnelli et al., 1999a).

Juvenile longfin squid inhabit the upper 10 m of the water column over water 50-150 m deep (Mercer, 1969; Vork & Khvichiya, 1980; Brodziak & Hendrickson, 1999). Pre-recruit depth varies seasonally and with inshore/offshore migrations. During summer months, pre-recruits were found in 10-40 m and 11-17 degrees Celsius, migrating offshore to overwinter in deeper waters over the continental shelf (Cargnelli et al., 1999a).

The stock of the longfin squid is considered almost fully exploited with a medium biomass (NE Fisheries Science Center, 1996). Dredging and construction in the fall/winter is not expected to impact longfin inshore squid, as this species migrates offshore in the fall. There exists a slight potential for negligible to minor impacts to individuals that have not made the offshore migration prior to commencement of construction. However, these impacts would not have greater than negligible impacts on longfin squid populations.

Ocean quahog (*Arctica islandica*)

Ocean quahogs are a suspension feeding bivalve. They are found on the continental shelf from Newfoundland to Cape Hatteras, with concentrations in offshore waters south of Nantucket to the Delmarva Penninsula (Serchuk et al., 1982). The inshore limit of their distribution is the 16 degree Celsius bottom isotherm occurring in summer months (Cargnelli et al., 1999b).

Eggs and larvae of ocean quahog occur at optimal temperatures of 13-15 degrees Celsius (Mann & Wolf, 1983). Spawning is protracted, occurring from September to November off New Jersey (Jones, 1981). This pattern should be similar for Long Island. Eggs and larvae are planktonic, drifting with currents until juvenile stage, when they settle to the bottom (MAFMC, 1997).

Juvenile quahog (pre-recruits) are found offshore at depths of 45-75 m and salinities of 32-34 ppt. They inhabit sandy substrates (Kraus et al., 1989, 1992). Adults (recruits) are found in dense beds over level bottoms. They are most abundant at depths of 25-61 m, but have been found in depths of 14-82 m (Merrill & Ropes, 1969; Serchuk et al., 1982). Ocean quahog are suspension feeders, filtering out phytoplankton with siphons raised above the sediment within which they inhabit.

Beach nourishment activities would not adversely affect ocean quahog species abundance. They do not occur within the project area, but are found in dense beds offshore of the borrow sites. Surveys of the borrow areas found no individuals inhabiting the area in December 2001, January 2002, September 2002, or May 2008.

Atlantic surf clam (*Spisula solidissima*)

Atlantic surf clams are planktivorous siphon feeders occurring on sandy continental shelf habitats from the southern Gulf of St. Lawrence to Cape Hatteras. Spawning occurs from June through August in New Jersey; this would be similar timing for Long Island waters. Distribution of eggs is not clear, but Tarnowski (1982) reported high larval concentrations in spring and fall in New Jersey. Surveys indicate that Atlantic surf clams are abundant in the southern Middle Atlantic Bight (Cargnelli *et al*., 1999c), although not in the borrow areas or immediate vicinity.

Project sponsors conducted surf clam surveys in the borrow areas during spring of 2008 and fall of 2002. On May 19, 2008 and September 20, 2002, the clam fishing vessel *Ocean Girl* was utilized to perform ten (10) random sample tows within the borrow areas, for a total of twenty sample tows over the two dates. Ten survey tows were conducted within Borrow Area 2-West and ten tows were conducted within Borrow Area 2-East (Figures 27, 28). The vessel used for the surf clam surveys, F/V *Ocean Girl*, is an eighty-foot stern rigged commercial surf clam and ocean quahog fishing vessel. This is the same vessel utilized by NYSDEC staff conducting surf clam assessments along Long Island's south shore. The vessel's 90-inch dredge was utilized as formatted for NYSDEC sampling protocol, lined with 1" x 3" wire mesh. The blade depth was set at 4.5" with a hose length of 140' and tow warp of 130'. Water pressure was 80psi. The fishing vessel used an onboard "chart plotter" interphased with GPS to locate and enter the corner coordinates of the borrow sites sampled. Once the boundaries of the borrow sites were established, five random points within each site were selected (Figures 27, 28). The vessel located each site and while on station, the dredge was dropped, set and towed for three (3) minutes at an average speed of 1.5 knots. At the end of each tow, the contents of the dredge were emptied into the hopper and analyzed.

Results are shown in Table 30. In 2008, Borrow Area 2-West had surf clam densities ranging from 0.49 to 0.06 clams/m^2 and Borrow Area 2-East had surf clam densities ranging from 0.54 to 0 clams/m^2. This is slightly higher than 2002 surveys, in which Borrow Area 2-West contained a surf clam density ranging from 0.15 to 0.03 clams/m^2 and Borrow Area 2-East contained a surf clam density from 0.16 to 0 clams/m^2. Size classes were similar for both borrow sites, with a range in 2008 of 100-160 mm, compared to 80-150 mm in 2002. The majority of clams fell in the 150-160 mm size class in 2008, compared to 100-120 mm size class in 2002.

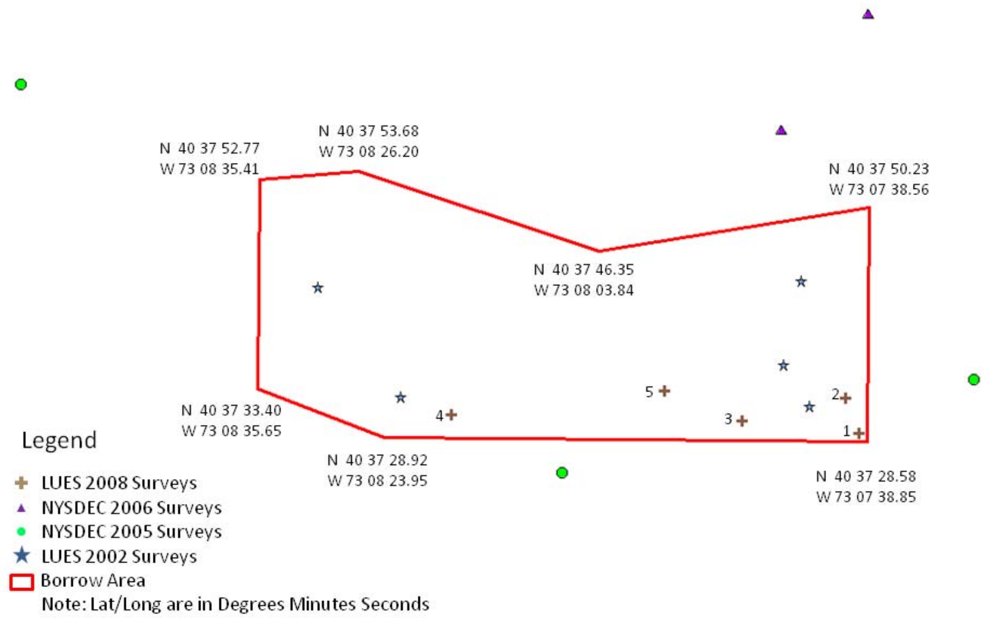


Figure 27. Surf Clam Sample Sites Within and Near to Borrow Area 2-E

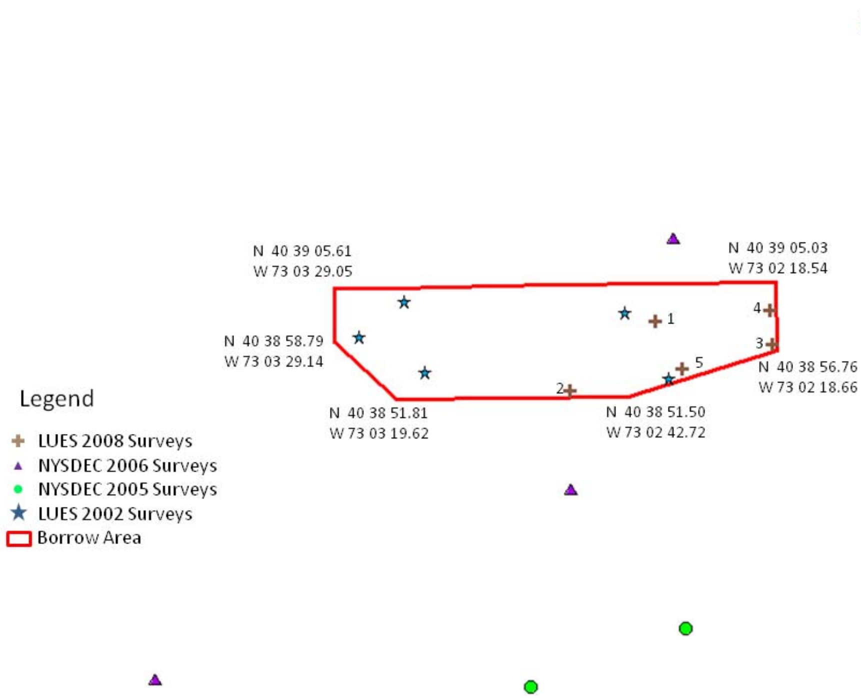


Figure 28. Surf Clam Sample Sites Within and Near to Borrow Area 2-W

Table 30. Surf clam survey results for Borrow Areas 2-West and 2-East.

Survey Date	Borrow Area	Station	SOG (knots)	Depth (feet)	Catch (# of clams)
5/19/2008	2-West	1	1.4		104
		2	1.5		37
		3	1.6		20
		4	1.7		155
		5	1.7		37
	2-East	1	1.3		7
		2	1.5		43
		3	1.6		172
		4	1.7		0
		5	1.4		24
9/20/2002	2-West	1	1.5	51	42
		2	1.5	50	49
		3	1.5	51	31
		4	1.5	47	13
		5	1.5	51	11
	2-East	1	1.5	37	0
		2	1.5	45	5
		3	1.5	43	50
		4	1.5	43	30
		5	1.5	40	6

NYSDEC conducts regular surf clam surveys along the entire south shore of Long Island. Surveys are conducted in three zones: 0-1 mile offshore, 1-2 miles offshore, and 2-3 miles offshore. Borrow Areas 2-West and 2-East are approximately 0.9-1.1 miles offshore. The most recent survey data, from 2005 and 2006, indicates that surf clams are most abundant within the 0-1 mile zone; however, they are not found in the borrow areas in significant numbers (NYSDEC 2006, 2007). Although there were no sample sites within the borrow areas (Figures 27, 28), those in the vicinity of the borrow sites had few, if any, surf clams, with 2006 densities of 0.0-1.4 clams/m^2.

The USACOE also conducted a stock assessment of the Atlantic surf clam during the period of August 18-September 27, 2001 (USACOE, 2002). They surveyed borrow areas in locations similar to those proposed for use in this project. Data suggests the borrow areas delineated by the USACOE (NY District) have very small to no localized surf clam populations, with the exception of the borrow areas off Fire Island Pines and Shinnecock Inlet. Borrow Area 2-East lies partially in the densely populated Fire Island Pines borrow area of the USACOE survey. Surveys indicate that this borrow area is the most heavily populated of all those sampled. However, the dense concentrations of surf clams (up to 67 bushels) occurred on the nearshore (north) side of the borrow area; the area of Borrow Area 2-East lies along the southwest boundary of the borrow area surveyed, which was found to have 0-1.5 bushels of clams. In general, the USACOE found that fewer clams were observed as depth and distance from shore increased. Therefore, although the whole of Borrow Area 2-East was not sampled by the USACOE, it is inferred from their results that surf clam density would be low to nonexistent in the remainder of the borrow area. The USACOE borrow areas surveyed did not fall within any portion of Borrow Area 2-West. However, Borrow Area 2-West would have surf clam densities similar to those found in borrow areas 2B and 2C of the USACOE survey, due to similar depth and distance from shore. Surf clam densities in those borrow areas was very low, at 0-2.0 bushels per station.

The minimum length requirement for surf clams taken for commercial sale is 4.0 in (10.2 cm). Surveys of Borrow Areas 2-West and 2-East, conducted by the project sponsor in May 2008, indicate that the mean length of clams found in these areas is 5.4 inches (2-East) to 5.8 inches (2-West). NYSDEC surf clam surveys indicate that the average size of surf clams in the vicinity of the borrow sites was 5.4 inches (13.7 cm) in 2005 and 4.9 inches (12.4 cm) in 2006 (NYSDEC 2006, 2007). These sizes are above the minimum length requirement for commercial sale. However, loss of low numbers of commercially legal clams is insignificant, and would not affect the commercial industry.

The USACOE stock assessment of surf clams during the period of August 18-September 27, 2001 also looked at size distribution. For the purposes of this report, we will concentrate on data from USACOE Borrow Areas 2B, 2C, and 2AD, which lie within or near the proposed borrow areas for this project. Borrow Areas 2B and 2AD contained both sub-legal and legal sized clams; Borrow Area 2C contained only legal sized clams. The USACOE suggests that the surf clam population in Borrow Area 2AD, which overlaps project Borrow Area 2-East, will increase in the future. Data also suggests that the recruitment of younger clams into this area is high. Proportionally, the surf clam populations in each of the borrow areas contained few sub-legal clams when compared with legal clams.

According to NMFS, the commercial status of the Atlantic surf clam is that it is not overfished, nor is it approaching an overfished condition. Landings in 1996 were 28,800 mt; they have been stable near this level since 1984. The species is at a medium biomass level, and is considered underexploited by the Northeast Fisheries Science Center (1998). NYSDEC 2006 data, however, indicates that surf clam abundance from Rockaway to Montauk Point is decreasing, from a high of 18.6 million clams in 2002 to 9.5 million clams in 2006.

Surf clams are a state managed fishery in New York, with annual and weekly limits. In 2006, there was a limit of 500,000 industry bushels in New York State, with 407,254 industry bushels landed. The only potential harvest site within the project area is USACOE Borrow Area 2AD, in the area close to shore with the highest legal size clam densities. As stated previously, Borrow Area 2-East overlaps the offshore (south) side of Borrow Area 2AD, in a low-density area. In conclusion, the number of legal sized clams would not be able to sustain a commercial fishery within any of the delineated borrow areas.

Dredging and construction associated with this beach nourishment alternative are expected to have a short-term minor impact on the Atlantic surf clam. It is expected that few surf clams will be destroyed during dredging operations. The effect of the project would be felt the following summer, when surf clam densities will be low to nonexistent in the borrow areas as recolonization occurs. However, data confirms that concentrations are already low in these borrow areas, and they would not support a commercial or recreational clamming area even without dredging. Beach nourishment would therefore have no impact on species abundance or the commercial industry.

Organisms in the Water Column (Planktonic Forms)

Turbidity associated with dredging may have moderate adverse impacts on the photosynthetic activity in phytoplankton due to reduced light penetration. However, thorough mixing and the large volume of ocean waters would result in turbidity and associated water quality parameters at the borrow areas rapidly returning to pre-construction levels with no long-term or major adverse impacts expected to phytoplankton.

Marine Mammals and Sea Turtles

Beach nourishment activities are not expected to adversely impact marine mammals, due to the transient nature of occurrence in the project area. Adverse impacts to sea turtles may potentially occur if hopper dredge equipment is used prior to November 15th. A discussion of the impacts to marine mammals and sea turtles is provided in the following paragraphs and in Table 31.

Marine mammals and sea turtles have been observed offshore of Fire Island, although rarely. Cetaceans (whales, dolphins, and porpoises) migrate through the project area; observations of these species are typically farther offshore than the borrow areas proposed for dredging. Previous studies and NMFS Biological Opinions indicate that nourishment projects off the south shore of Long Island and Northern New Jersey are not likely to adversely affect listed whales (NMFS, 1995). Seals typically inhabit shallow embayments and rock outcroppings found along the north shore of Long Island from November to May. Seals are not typically observed in the project area, except when resting or loafing for short periods on the beach.

Sea turtles are found more typically in Long Island Sound and shallow embayments, where they feed on vegetation and invertebrates (Morreale & Standora, 1994). Studies show that sea turtles utilize Long Island waters in the warm seasons from June through October, leave the area with falling water temperatures in September, and are gone by early November (NMFS, 1995). Loggerhead, Kemp's ridley, and green sea turtles are mostly subsurface and are observed most frequently in depths less than 15 m; leatherback sea turtles are pelagic in nature. All sea turtle species are thought to be using New York waters as important feeding habitat for growth and development. However, both borrow areas lie offshore in the Atlantic Ocean, where there is typically not an abundance of food such as spider crabs or rock crabs for loggerheads and Kemp's ridleys, or eelgrass and other algae for green sea turtles. It is therefore highly unlikely that any sea turtles would remain in the borrow area(s) longer than the time it takes to traverse them (USACOE, Biological Assessment: Sea Turtles in the New York District).

Direct impacts to sea turtles are unlikely, but could occur if hopper dredging is permitted prior to November 15th. Although dredging has not been implicated as a major cause of death or injury to sea turtles in the northeast, the potential exists for impacts from the use of hopper dredge equipment. Hopper dredges are known to entrain sea turtles, while cutterhead, clamshell and other similar dredges do not typically impact sea turtles (NMFS 1995). Few turtle interactions have been observed in monitored nourishment projects off NY throughout 1995 (NMFS 1995).

Table 31. The effects of alternative 2.3 on marine mammal and sea turtle species of special status.
FE=Federally endangered; FT=Federally threatened; SE=state endangered; ST=state threatened.

Common Name (Scientific Name)	Status	Potential Effect
Kemp's ridley sea turtle (*Lepidochelys kempii*)	FE, SE	Potential to affect sea turtles if hopper dredge equipment is used prior to November 15th. Impacts may be minimized if USACOE protocol for use of hopper dredges in sea turtle habitat is followed. NMFS conservation measures will be followed to avoid and minimize impacts. Safety windows and equipment selection will
Leatherback sea turtle (*Dermochelys coriacea*)	FE, SE	
Atlantic green sea turtle (*Chelonia mydas*)	FT, ST	

Common Name (Scientific Name)	Status	Potential Effect
Loggerhead sea turtle (*Caretta caretta*)	FT, ST	avoid and minimize impacts.
Sei whale (*Balaenoptera borealis*)	FE, SE	Potential to but not likely to adversely effect. Species has not been documented in action area during proposed project activity period. NMFS conservation measures will be followed to avoid and minimize impacts. Safety windows and equipment selection will avoid and minimize impacts.
Finback whale (*Balaenoptera physalus*)	FE, SE	
Humpback whale (*Megaptera novaeangliae*)	FE, SE	
Northern right whale (*Eubalaena glacialis*)	FE, SE	

In conclusion, impacts to marine mammals are not anticipated from this beach nourishment alternative. However, conservation measures to avoid, minimize, and mitigate for any possible impacts would still be followed per NMFS guidelines.

Summary of Potential Adverse Direct and Indirect Impacts

The potential direct and indirect impacts of this beach nourishment alternative on aquatic ecology include the adverse and impacts listed below. The realization of these impacts will depend on the timing and extent of the projects and the severity of storm and weather conditions.

Direct Impacts

- Very high mortality of invertebrates in the intertidal zone. Recolonization is expected within 2 to 7 months of beach nourishment.
- Complete mortality of benthic invertebrates in the borrow areas. Re-colonization is expected within 12-18 months.
- Complete mortality of the small, non-commercial densities of surf clams present in the borrow areas.
- Burial and destruction of demersal finfish eggs by settling sediments.
- Clogging of gills and filter-feeding structures by suspended sediments which result in increased mortality and decreased ability to avoid predators.
- Displacement of motile fish species from borrow areas and nearshore sand placement sites to adjacent unaffected waters during construction.
- Disturbance to migrations of finfish species including butterfish, bluefish, scup, and summer flounder
- Temporary reductions in photosynthetic production of phytoplankton in nearshore areas and borrow site due to increased turbidity and decreased light penetration.

Indirect Impacts

- Clogging of gills and filter-feeding structures by suspended sediments which result in reduced reproduction.

<u>Cumulative Impacts</u>

Suffolk County Department of Parks may also be undertaking a beach nourishment of the middle portion of Smith Point Park and western portion of Cupsogue Park using Moriches Inlet dredging as a sand source. Therefore, the adverse direct and indirect effects on finfish, benthic invertebrates of the borrow area and nearshore sand placement sites, and marine mammals/sea turtles described above would apply to the Suffolk County borrow site (Moriches Inlet) and sand placement sites.

FIIS would continue to operate under its Endangered Species Management Plan to avoid adverse impacts to any protected species and would continue to report the results of inventory and monitoring programs established for beach nourishment projects to the USFWS, NYSDEC, and NMFS. In addition, planning for the USACOE FIMP project and its associated reach project are on-going as are additional projects encompassing Shinnecock and Westhampton Dunes. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area or surrounding areas, but cannot be predicted at this time.

The aquatic ecology of the nearshore areas of Fire Island and the offshore borrow sites would continue to be affected by variation in water quality resulting from residential and commercial development in watersheds; contributions of non-point source pollution including excess nutrients, sediments, chemicals, and pathogens; contributions of wet- and dry-atmospheric deposition of pollutants; recreational and commercial boat traffic; and discharge of stormwater runoff. In addition, aquatic ecological resources would be impacted by commercial and recreational fisheries and regulations/quotas aimed at managing these resources. Considering the wide range of factors influencing the aquatic ecological resources of Fire Island, unrelated to this alternative or other beach management, alternative 2.3 would likely have a negligible contribution to the cumulative impacts on these resources.

4.4.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

The potential direct and indirect impacts, both beneficial and adverse, to aquatic ecological resources under alternative 2.4 are largely identical to those described in the preceding section and, accordingly, these identical impacts will not be reiterated. The following section will describe the potential for the nourishment design modifications included in this alternative to result in increased impacts relative to alternative 2.3.

The proposed variation in the cross-section of project design would not result in any additional adverse impacts to aquatic ecological resources as the total volume of placed sand in intertidal and nearshore habitats would not be altered.

The proposed placement of 400-500’ taper sections on Federal property would result in a slight increase in the size of the project area and, consequently, the areas of intertidal and nearshore habitats impacted by the project. Accordingly, due to the inclusion of tapers on Federal property, the potential adverse and beneficial impacts of this alternative to aquatic ecological resources are likely to show a negligible increase in intensity relative to the impacts expected from alternative 2.3.

The proposed modification to the borrow area cut depth would result an increase in the cut depth by approximately 1-3’ below existing grade of the ocean floor in Borrow Area 2-East. Due to lack of an increase in the areal extent of the borrow site, this proposed modification is not expected to result in any increase in the intensity of impacts to benthic organisms of the borrow site, which are to be destroyed completely under both nourishment alternatives, or the finfish which utilize the borrow site as habitat. Potential adverse impacts to aquatic ecological resources could result if the increased cut depth results in less recruitment of benthic macroinvertebrates to the borrow area after dredging or decreased habitat quality in the borrow area for finfish. Due to the small size of the proposed modification of cut depth (1-3') relative to the variation in water depth in the borrow area (43-48'), it is unlikely that the increased water depth would adversely impact invertebrate recruitment or finfish use of the borrow site after completion of the dredging. Similarly, the proposed modification to cut depth is not likely to adversely impact the water quality in the borrow area, through decreased water circulation and a decrease in dissolved oxygen concentration, in the borrow area. This is because the modest change in depth is not likely to be large enough, relative to the existing bathymetry and size of the borrow area, to impede mixing of waters within the borrow area.

The proposed modification of the construction timeline has the potential to result in a negligible increase in the magnitude of the potential adverse impact to finfish. Earlier commencement of the proposed project has the potential to coincide with fall migrations of several finfish including butterfish, bluefish, sand tiger shark, scup, summer flounder, whiting, yellowtail flounder, and winter flounder. The earlier commencement date of September 15th proposed in alternative 2.4 is not expected to result in greater adverse impacts relative to alternative 2.3, as these migrating fish are expected to avoid offshore and nearshore areas being disturbed.

There is a potential for direct impacts to sea turtles if hopper dredging is permitted prior to November 15th. Sea turtles utilize Long Island waters in the warm seasons from June through October, leave the area with falling water temperatures in September, and are gone by early November (NMFS, 1995). Although dredging has not been implicated as a major cause of death or injury to sea turtles in the northeast, the potential exists for impacts from the use of hopper dredge equipment from September 15th to November 15th. Hopper dredges are known to entrain sea turtles, while cutterhead, clamshell and other similar dredges do not typically impact sea turtles (NMFS 1995). Even so, the USACOE has developed protocols to minimize direct impacts to turtles from hopper dredging in Florida; these protocols could be incorporated into NY dredging to allow use of a hopper dredge prior to November 15th. USACOE protocols are described below (taken from Standard Hopper Dredge Conditions, Jacksonville District, Regulatory Division, 11/21/2003):

- An NMFS approved sea turtle monitor must be on board the vessel at all times to monitor for presence of sea turtles. An observation sheet must be completed for each dredging cycle, whether or not sea turtles or parts are present.
- Use of an approved turtle deflector device (refer to design specifications at http://www.saj.usace.army.mil/pd/turtle/htm). Turtle deflector device shall remain in place and functional for the duration of dredging activities.
- Installation of baskets or screening over hopper inflow(s) with no greater than 4" x 4" openings. Screening shall provide 100% screening of the hopper inflow. Baskets/screening shall remain in place and functional for the duration of dredging activities.
- A NMFS permit for sea turtle trawling must be obtained. If one green, one Kemp's ridley, or three loggerheads are taken, dredging operations will cease and a sea turtle mortality report will be completed and sent immediately to the USACOE Chief, Enforcement Section. Dredging activities recommence only upon notification from the USACOE Chief, Enforcement Section.

- If one green, one Kemp's ridley, or three loggerheads are taken, trawling activities will cease within eight hours of the occurrence. A sea turtle risk assessment will be prepared as a summary of all Sea Turtle Trawling Reports, and will include total trawling times, number of trawls, and number of captures. The sea turtle risk assessment shall be submitted to the USACOE Chief, Enforcement Section prior to recommencement of dredging.
- An approved sea turtle trawling and relocation supervisor shall provide researchers and trawl nets to capture and relocate sea turtles, shall conduct sea turtle trawling, and shall complete the sea turtle risk assessment. Any turtles taken during trawling will be measured, tagged, and relocated at least three miles from the recorded location.
- Any uninjured sea turtles incidentally taken by the dredge shall be measured, weighed, tagged, and released. Injured sea turtles shall be transported to a rehabilitation facility such as the Riverhead Foundation for Marine Research and Preservation in Riverhead, NY.
- When initiating dredging, suction through the drag heads shall be allowed just long enough to prime the pumps and then the drag heads must be placed firmly on the bottom. When lifting drag heads from the bottom, suction through drag heads shall be allowed just long enough to clear the lines, and then must cease. Pumping water through drag heads while maneuvering or during travel to/from disposal area must cease.
- Raising drag heads off the bottom to increase suction velocities is prohibited.
- Drag head shall be buried a minimum of six inches (6") in the sediment at all times.
- During turning activities, pumps must either be shut off or reduced in speed to the point where no suction velocity or vacuum exists.
- All hopper dredge(s) shall be equipped with recording devices for each drag head that capture real time, drag head elevation, slurry density, and at least two of the following: pump(s) slurry velocity measured at the output side, pump(s) vacuum, and/or pump(s) rpm. Continuous real time shall be recorded during the entire dredging cycle, including dredging area and disposal area.

Similarly, USACE sea turtle protocols, particularly the use of turtle monitors, will serve to prevent interactions between dredging equipment and marine mammals, such as sei whale (*Balaenoptera borealis*), northern right whale (*Eubalaena glacialis*), finback whale (*Balaenoptera physalus*), and humpback whale (*Megaptera novaeangliae*), which may migrate through New York waters during the summer months.

<u>Cumulative Impacts</u>

Cumulative impacts associated with this alternative are the same as those described for alternative 2.3 above.

4.4.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

<u>Direct and Indirect Impacts</u>

This alternative is similar to alternative 2.4 above, except that there are no tapers proposed on Federal property with this alternative. Tapers on Town of Islip and Town of Brookhaven (Point O' Woods) lands are still proposed. Accordingly, the expected direct and indirect impacts to aquatic ecological resources in this alternative are identical to those described in the previous discussion for alternative 2.4, with the exception that the small decrease in the project area resulting from the elimination of taper sections on Federal property would result in a negligible decrease in the intensity of impacts to nearshore species relative to the impacts expected from alternative 2.4.

Cumulative Impacts

The cumulative impacts impacts to aquatic ecological resources under this alternative are identical to those described for alternative 2.3 and, accordingly, are not reiterated.

4.4.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

Impacts to aquatic ecology from this alternative are similar to alternative 2.3 above. Accordingly, the expected direct and indirect impacts to aquatic ecological resources in this alternative are identical to those described in the previous discussion for alternative 2.3.

Cumulative Impacts

The cumulative impacts impacts to aquatic ecological resources under this alternative are identical to those described for alternative 2.3 and, accordingly, are not reiterated.

4.4.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

There is the realistic potential for several beach nourishment and beach scraping projects during the project timeframe. This could result in nearly 6 miles of beach manipulation with a combination of the direct and indirect impacts to aquatic ecology described in Sections 4.4.3 and 4.4.4. As discussed, the effects of these impacts may be beneficial or adverse. In addition, beneficial and adverse indirect impacts resulting from littoral drift and sand movement of nourished sand may occur one-mile to the west and 1000’ ft to the east of the project site. This could result in direct and indirect impacts from Alternative 2.7 that may potentially occur from the Fire Island Lighthouse Visitor Center in the west to the Watch Hill Visitor Center in the East.

Cumulative Impacts on Aquatic Ecology

The cumulative impacts impacts to aquatic ecological resources under this alternative are identical to those described for alternative 2.3 and, accordingly, are not reiterated.

4.5 Impacts on Transportation

4.5.1 Impacts of Alternative 2.2, No Action Alternative

Direct and Indirect Impacts

In the short term, no action would not adversely impact the typical Fire Island visitor that utilizes ferry and or boat service to get to Fire Island, and walks or bicycles around once on Fire Island. However, a no-action alternative would result in long-term adverse impacts to transportation year-round. During early spring, fall and winter months, when beach driving is permitted, narrow beach areas would result in minor to major adverse impacts, as vehicles would need to traverse interior routes for access to communities and recreation areas. This slows travel time and may cause potential safety hazards for pedestrians or bicyclists if interior roadways are crowded with vehicles that would normally utilize the beach, resulting in minor to moderate impacts. However, if a longer response time results in inability of personnel to respond to an emergency in a timely manner, the impact on transportation could become major.

During late spring and summer, beach driving is restricted to park personnel, essential services, and emergency response vehicles needing access to community and recreation areas. No action would have a minor to major adverse impact on transportation, similar to impacts described in the paragraph above. However, due to the significant increase in population during late spring and summer months, the potential for safety and emergency impacts is increased.

Cumulative Impacts

Under a no action alternative, erosion would continue, likely resulting in greater lengths of beach that would become impassable for vehicles. This would exacerbate the adverse impacts on transportation discussed above.

In addition, even beaches that may be passable during all tidal cycles may be adversely impacted with implementation of other beach projects such as re-piling of dwellings or reconstruction of walkways. Although most of this work takes place landward of vehicle routes, a beach just wide enough to allow passage of vehicles may be impacted if even five feet is utilized with equipment during a project such as re-piling of dwellings or reconstruction of walks.

Cumulative impacts to transportation may result from the potential impacts of other projects, including potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.5.2 Impacts of Alternative 2.3, Beach Scraping

Direct and Indirect Impacts

Beach scraping has no affect on transportation. Communities that qualify for scraping have beaches wide enough for vehicles to traverse the area during all tidal cycles. During scraping activities, contractors and monitors ensure that a vehicle path exists for park personnel, utilities, and emergency response vehicles to safely traverse the beach.

Cumulative Impacts

Beach scraping is not expect to contribute to cumulative impacts on transportation. Cumulative impacts to transportation may result from the potential impacts of other projects, including potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.5.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

This beach nourishment alternative would result in construction of a beach wide enough to accommodate vehicles during all tidal cycles for the 5-6 year duration of the project. The project would provide vehicle access to areas that are currently impassable at high tide, such as Davis Park, Ocean Beach, and Saltaire (Appendix A). This would result a moderate beneficial impact on transportation, and, with the ability to respond to emergencies in the fastest manner, will also lead to a benefit to public safety.

Construction of this beach nourishment alternative would result in short-term minor to moderate adverse impacts to transportation during sand placement and manipulation activities. Beaches would be closed to driving during construction activities, forcing contractors, residents, essential services, and emergency personnel to utilize interior routes to traverse the island. This would result in impacts similar to those described for the no action alternative above; however, these impacts would only be short-term, during construction activities, under this alternative. Once construction is complete, the beneficial impacts discussed in the paragraph above will be realized.

Cumulative Impacts

Cumulative impacts from this beach nourishment alternative would be beneficial when combined with impacts to transportation that may result from the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.5.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

Direct and indirect impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.5.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

Direct and indirect impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.5.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

Direct and indirect impacts to transportation are similar to those discussed for alternative 2.3 above. The only difference is the duration of beneficial impacts, which would be reduced to 3-4 years for this alternative.

Cumulative Impacts

Cumulative impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.5.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

Direct and Indirect Impacts

Direct and indirect impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to transportation are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.6 Impacts on Community Services

4.6.1 Impacts of Alternative 2.2, No Action Alternative

Direct and Indirect Impacts

No action would have long-term, negligible to moderate adverse impacts on community services. As stated previously, no action would allow the continued erosion of the beach and dune systems. A USACOE (1997) study determined that beach use in the study area declined due to beach shoreline change. Erosion would impact the ability of the beaches in the community areas to provide adequate area for recreational activities such as sunbathing, beach-combing, nature viewing, and hiking. In addition, lack of beaches would adversely impact the communities that utilize lifeguards; if the beach is not wide enough for lifeguard stands and areas, it will lead to adverse impact on swimming and surfing. This impact is expected to be negligible to minor in the short term, as beachgoers could traverse a few hundred feet to find adequate beach width for recreational activities in most areas. However, in the long-term, as erosion continues and fewer and fewer beaches are of adequate width for recreation activities, the impact becomes minor to moderate, and it may begin to impact socioeconomics of the communities (Section 4.7.1).

No action would also have minor to moderate adverse impacts on public access to the beaches. Beach access stairs may be damaged or destroyed, resulting in a lack of public access to the beach for recreational activities. This has already occurred in Davis Park and Fire Island Pines (Appendix A).

No action would not directly or indirectly impact marinas, restaurants, snack bars, public restrooms, or other structures that provide community services. However, no action would impact socioeconomics associated with these structures (see Section 4.7.1).

Cumulative Impacts

No action would result in adverse cumulative impacts to community services. Continued erosion of the beaches, while a natural process, would further decrease the areas available for recreational activities and would increase the risk to public access structures such as stairs. As beach width decreases along greater lengths of the communities, the likelihood of other projects (such as re-piling of dwellings) impacting community services increases.

Potential beneficial impacts of FIMP may mitigate for adverse impacts of no action on community services. However, implementation of FIMP for Fire Island is still several years away.

4.6.2 Impacts of Alternative 2.3, Beach Scraping

Direct and Indirect Impacts

Beach scraping would have short-term, negligible impact on community services during construction activities. Communities that qualify to scrape have beaches of sufficient width for recreation activities such as sunbathing, beach combing, swimming, and nature viewing. Although use of the beach for recreational activities is prohibited in active scraping areas, visitors are able to travel only a few hundred feet down the beach to enjoy its benefits. Once scraping activities are completed in a given area, the beach is once again open for recreational use.

Cumulative Impacts

Beach scraping is not expect to contribute to cumulative impacts on community services. Cumulative impacts may result from the potential impacts of other projects, including potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.6.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

This beach nourishment alternative would have long-term moderate to major beneficial impacts on community services for the 5-6 year duration of the project. Beach nourishment would result in greater beach areas, enabling more visitors the pleasure of swimming, sunbathing and other recreation activities. In addition, this beach nourishment alternative would provide adequate beach width for lifeguard stations in areas that may be too narrow currently, such as Ocean Beach and Saltaire, which could result in increased visitorship to the beaches.

This beach nourishment alternative will also provide increased storm damage protection for the 5-6 year duration of the project, thereby decreasing the risk of potential storm and wave damage to public facilities and businesses. This is especially true for stairs that provide public access to the beach, some of which have been damaged by storms in 2007 and 2008 (Appendix A).

This beach nourishment alternative would have short-term negligible to minor adverse impacts on community services during construction. Beaches are closed in active construction areas, decreasing the area available for recreation activities. In addition, noise from construction equipment would adversely impact community services. However, construction during the fall and winter months will mitigate for this impact, as the beaches are sparsely used during this time. Those visitors wishing to use the beach during construction may travel to adjacent beaches to partake in recreational activities.

Cumulative Impacts

Cumulative impacts from this beach nourishment alternative would be beneficial when combined with impacts to transportation that may result from the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.6.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

Direct and indirect impacts to community services are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to community services are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.6.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

Direct and indirect impacts to community services are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to community services are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.6.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

Direct and indirect impacts to community services are similar to those discussed for alternative 2.3 above. The difference will be that with this alternative dune crest line, beneficial impacts on community services are expected for only 3-4 year duration of the project.

Cumulative Impacts

Cumulative impacts to community services are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.6.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

Impacts for this alternative are a combination of impacts for alternative 2.3 (beach scraping) and 2.4, 2.5, and 2.6 (beach nourishment).

4.7 Impacts on Socioeconomic Environment

4.7.1 Impacts of Alternative 2.2, No Action Alternative

Direct and Indirect Impacts

A no action alternative is expected to have long-term, moderate to major negative impacts on the socioeconomic environment of Fire Island. Fire Island communities are completely reliant on tourism and its boost to commercial businesses during the summer months. A no action alternative would not provide protection to community structures and infrastructure, which would potentially lead to damage of structures and infrastructure due to natural beach dynamics. Damage to structures and infrastructure would disrupt economic activity, including tourism and commercial businesses, as well as utility services.

Cumulative Impacts

Cumulative impacts due to a no action alternative would be similar to those described in the above paragraph, but continued no action would exacerbate these problems and could lead to severe socioeconomic impacts for Fire Island communities. Continued loss of tourism could have major impacts to the tourism-based economies of Fire Island communities. Impacts to socioeconomic environment due to a breach or catastrophic storm, such as a hurricane, are beyond the scope of this EA.

4.7.2 Impacts of Alternative 2.3, Beach Scraping

Direct and Indirect Impacts

A beach scraping alternative may have negligible positive impacts on socioeconomics of Fire Island. Beach scraping redistributes sand to augment the dunes, thereby providing additional protection to structures and infrastructure. However, beach scraping is designed to last only a single season, so benefits of a single scraping project are short-term.

Cumulative Impacts

Annual beach scraping could have positive cumulative impacts on the socioeconomic environment. Dunes would continue to build year after year, providing more and more protection for structures and infrastructure. Socioeconomic benefits to real estate and business markets could be expected due to increased height and width of dunes with repeated scraping events.

4.7.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

Beach nourishment will have long-term moderate positive impacts to socioeconomics of Fire Island. Nourishment of the community beaches would provide protection for structures and infrastructure, including utilities and commercial businesses, in addition to residences. This protection is expected to last for the 5-6 year duration of the project.

Cumulative Impacts

Cumulative impacts of beach nourishment are similar to those described in the above paragraph. Impacts to the tourism based economy will last several years, although the beach is expected to erode to pre-nourishment conditions within 5-6 years. Cumulative impacts from this beach nourishment alternative would also be beneficial when combined with impacts to socioeconomics that may result from the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.7.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

Direct and indirect impacts to socioecnomics are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to socioeconomics are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.7.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

Direct and indirect impacts to socioecnomics are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Cumulative impacts to socioeconomics are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.7.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line

Direct and Indirect Impacts

Direct and indirect impacts to community services are similar to those discussed for alternative 2.3 above. The difference will be that with this alternative dune crest line, beneficial impacts on socioeconomics are expected for only 3-4 year duration of the project.

Cumulative Impacts

Cumulative impacts to socioeconomics are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.7.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

Impacts of this alternative are similar to those described for the beach nourishment alternatives (2.4, 2.5, and 2.6) above.

4.8 Impacts on Cultural Resources

4.8.1 Impacts of Alternative 2.2, No Action Alternative

Ethnographic Resources

There are no known ethnographic resources within the project areas. Therefore, no impacts to ethnographic resources are expected from a no action alternative. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Archeological Resources

There are no known archeological resources within the project areas. Therefore, no impacts are expected to cultural resources from a no action alternative. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Terrestrial Sites

Although no listed cultural resources are found in the project area, negative impacts to structures, some of which are greater than 50 years old, can be expected with this alternative, as discussed in section 4.7.1 above. Structures could be threatened with damage or loss due to natural beach dynamics.

Drowned Terrestrial Sites

The USACOE remote sensing survey of the project area revealed 26 anomalies that may be drowned terrestrial sites. However, a no action alternative will not have any impacts on these possible resources.

Maritime Resources

No impact to maritime resources is expected with a no action alternative.

4.8.2 Impacts of Alternative 2.3, Beach Scraping

Ethnographic Resources

There are no known ethnographic resources within the project areas. Therefore, no impacts to ethnographic resources are expected from a beach scraping alternative. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Archeological Resources

No impacts to cultural resources are anticipated with this alternative, as surveys indicated that there are no cultural resources listed in the project area. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Terrestrial Sites

No impacts to cultural resources are anticipated with this alternative, as surveys indicated that there are no cultural resources listed in the project area. However, short-term, positive impacts to structures, including those that are greater than 50 years old, would result from beach scraping, as these structures would be afforded additional protection from an augmented dune.

In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Drowned Terrestrial Sites

The USACOE remote sensing survey of the project area revealed 26 anomalies that may be drowned terrestrial sites. However, the shallow cut depth of beach scraping and resulting placement of fill on the dune would not impact any of the anomalies, and as such, beach scraping will not have any impacts on these possible resources.

Maritime Resources

Beach scraping occurs landward of apparent high water, and will therefore have no impact on maritime resources in the project areas.

4.8.3 Impacts of Alternative 2.3, Beach Nourishment: 2003 Permitted Conditions

Direct and Indirect Impacts

Ethnographic Resources

There are no known ethnographic resources within the project areas. Therefore, no impacts to ethnographic resources are expected from beach nourishment. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Archeological Resources

No impacts to archeological resources are anticipated with this alternative, as surveys indicated that there are no resources listed in the project area. The proposed area to be affected by the preferred alternative is located between the existing dunes and nearshore zone. This area is highly dynamic and the sands are continually deposited, disturbed, and displaced. The minimal ground disturbing activities as a result of the project will not likely disturb any intact archeological remains. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Terrestrial Sites

No impacts to cultural resources are anticipated with this alternative, as surveys indicated that there are no cultural resources listed in the project area. The proposed area to be affected by the preferred alternative is located between the existing dunes and nearshore zone. This area is highly dynamic and the sands are continually deposited, disturbed, and displaced. The minimal ground disturbing activities as a result of the project will not likely disturb any intact archeological remains.

However, short-term, positive impacts to structures, including those that are greater than 50 years old, would result from beach nourishment, as these structures would be afforded additional protection from a nourished beach and dune system. This protection is expected to last for the 5-6 year duration of the projet.

Drowned Terrestrial Sites

The placement of sand in the vicinity of potentially eligible sites is not expected to adversely impact on them. Sand placement would not disturb the sites buried under the barrier island or in the nearshore zone. The use of sand fill may help to protect these sites from being exposed and destroyed (JMA, 1998). In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Maritime Resources

Magnetometer and side scan sonar surveys of the borrow areas showed no anomalies in either borrow area. Therefore, direct or indirect impacts to maritime resources are not expected. In the unexpected event that resource(s) are found, Federal and state cultural and historic preservation laws would ensure their protection.

<u>Cumulative Impacts</u>

Ethnographic Resources

Cumulative impacts of beach nourishment are similar to those described in the above paragraphs, which would apply to additional projects such as the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

Archeological Resources

Cumulative impacts of beach nourishment are similar to those described in the above paragraphs, which would apply to additional projects such as the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

Terrestrial Sites

Cumulative impacts of beach nourishment are similar to those described in the above paragraphs, which would apply to additional projects such as the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

Drowned Terrestrial Sites

Cumulative impacts of beach nourishment are similar to those described in the above paragraphs, which would apply to additional projects such as the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

Maritime Resources

Cumulative impacts of beach nourishment are similar to those described in the above paragraphs, which would apply to additional projects such as the potential reach projects associated with USACOE FIMP project. Additional FIIS and community projects may also be proposed within the project life that may or may not have additional effects to this project area of or surrounding areas, but cannot be predicted at this time.

4.8.4 Impacts of Alternative 2.4, Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property

Direct and Indirect Impacts

Ethnographic Resources

Direct and indirect impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Direct and indirect impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Direct and indirect impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Direct and indirect impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Direct and indirect impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Ethnographic Resources

Cumulative impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Cumulative impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Cumulative impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Cumulative impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Cumulative impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.8.5 Impacts of Alternative 2.5, Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property

Direct and Indirect Impacts

Ethnographic Resources

Direct and indirect impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Direct and indirect impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Direct and indirect impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Direct and indirect impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Direct and indirect impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Ethnographic Resources

Cumulative impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Cumulative impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Cumulative impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Cumulative impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Cumulative impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.8.6 Impacts of Alternative 2.6, Beach Nourishment: 2008 Dune Crest Line, FIMP Template

Direct and Indirect Impacts

Ethnographic Resources

Direct and indirect impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Direct and indirect impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Direct and indirect impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Direct and indirect impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Direct and indirect impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Cumulative Impacts

Ethnographic Resources

Cumulative impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Cumulative impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Cumulative impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Cumulative impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Cumulative impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

4.8.7 Impacts of Preferred Alternative (2.7), Combination of Beach Scraping and Nourishment

Direct and Indirect Impacts

Ethnographic Resources

Direct and indirect impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

No impacts to archeological resources are anticipated with this alternative, as surveys indicated that there are no resources listed in the project area. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Terrestrial Sites

No impacts to cultural resources are anticipated with this alternative, as surveys indicated that there are no cultural resources listed in the project area. Impacts to older structures (50+ years old), which may be eligeable for listing as cultrutal resources, are expected to be similar to those described for the beach nourishment alternatives above. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Drowned Terrestrial Sites

The placement of sand in the vicinity of potentially eligible sites is not expected to adversely impact them. Sand placement would not disturb potential sites buried under the barrier island or in the nearshore zone. The use of sand fill may help to protect these sites from being exposed and destroyed (JMA, 1998). In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Maritime Resources

No impacts to maritime resources are anticipated with this alternative, as surveys indicated that there are no resources within the nearshore or borrow areas. In the unexpected event that cultural resource(s) are found, NPS would protect them as mandated by Federal and state cultural and historic preservation laws.

Cumulative Impacts

Ethnographic Resources

Cumulative impacts to ethnographic resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Archeological Resources

Cumulative impacts to archeological resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Terrestrial Sites

Cumulative impacts to terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Drowned Terrestrial Sites

Cumulative impacts to drowned terrestrial sites are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Maritime Resources

Cumulative impacts to maritime resources are the same as those discussed for alternative 2.3 above, and as such, will not be reiterated here.

Table 32. Summary of potential impacts of each alternative.

Alt.	Description	Geology	Water Quality
2.1	No Action	•No short-term impacts to geological characteristics of project or borrow area •Increased likelihood of overwash or breach in the long-term.	•No short-term impacts to water quality of Atlantic Ocean or Great South Bay •Increased likelihood of breach in the long-term, potentially resulting in changes to water quality parameters of Great South Bay.
2.2	Beach Scraping	•Short-term, negligible impacts to geological characteristics of supratidal beach and dune	•No impacts expected
2.3	Beach Nourishment: 2003 Permitted Conditions	•No anticipated impacts to coastal geological processes •Negligible impacts to beach and dune sediments due to similarity of fill sand and beach sand •No impacts to wave height, direction, or velocity	•Short-term, moderately negative impacts to water quality during construction resulting from increased turbidity.
2.4	Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property	•No anticipated impacts to coastal geological processes •Negligible impacts to beach and dune sediments due to similarity of fill sand and beach sand •No impacts to wave height, direction, or velocity	•Short-term, moderately negative impacts to water quality during construction resulting from increased turbidity
2.5	Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property	•No anticipated impacts to coastal geological processes •Negligible impacts to beach and dune sediments due to similarity of fill sand and beach sand •No impacts to wave height, direction, or velocity	•Short-term, moderately negative impacts to water quality during construction resulting from increased turbidity
2.6	Beach Nourishment: 2008 Dune Crest Line	•No anticipated impacts to coastal geological processes •Negligible impacts to beach and dune sediments due to similarity of fill sand and beach sand •No impacts to wave height, direction, or velocity	•Short-term, moderately negative impacts to water quality during construction resulting from increased turbidity
2.7	Preferred Alt.: Combination of Beach Scraping (2.2) and Beach Nourishment (2.5)	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3

Alt.	Description	Terrestrial Ecology	Aquatic Ecology	Transportation
2.1	No Action	•Negligible impacts to maritime/dune/beach plant communities, wildlife, invertebrates, or nearshore/offshore finfish and invertebrate communities •Only in the event of an overwash or breach would these assemblages be impacted •Increased likelihood of overwash or breach under this alternative results in potential minor to moderate beneficial and adverse impacts to Federally- or state-protected species	•Negligible impacts to intertidal invertebrates, nearshore and offshore finfish and benthic invertebrates, marine mammals, or sea turtles are expected. •Only in the event of an overwash or breach would these assemblages be impacted •The short- and long-term impacts of a breach to these biological assemblages are unpredictable due to the potential implementation of the FIIS Breach Contingency Plan and/or emergency actions	•No adverse impact to visitors utilizing ferries, boats, and bicycles for transportation •Long-term adverse impacts to year-round transportation due to narrow beach areas •Increased congestion on interior roadways •Potential for adverse impacts resulting from longer response time for emergency personnel.

2.2	Beach Scraping	•Direct mortality to slow-moving or burrowing small mammals, terrestrial herpetiles, and invertebrates •Temporary loss of foraging and resting habitat for various avian and wildlife species •No anticipated impact to piping plover and least tern due to project timing and protection measures •Burial/disturbance of seabeach amaranth seed bank	•No impacts to aquatic ecology as all construction activities will occur landward of mean high water mark	•No potential impacts as beach scraping does not restrict park personnel, contractors, utilities, or emergency response vehicles.
Alt.	**Description**	**Terrestrial Ecology**	**Aquatic Ecology**	**Transportation**
2.3	Beach Nourishment: 2003 Permitted Conditions	•Burial/destruction of existing beach and dune vegetation communities •Direct mortality to slow-moving or burrowing small mammals, terrestrial herpetiles, and beach/intertidal/nearshore invertebrates •Temporary loss of foraging and resting habitat for various avian and wildlife species, including migratory shorebirds •Temporarily reduced prey availability for plovers due to burial of prey base •Creation of sub-optimal habitat due to high-levels of human activity and predator abundance in nourished area leading to a population sink. •Changes to existing plover and amaranth habitat on FIIS due to sediment transport (could be a positive or negative impact) •Reduction of potential formation and maintenance of optimal overwash piping plover breeding and foraging habitat •Potential significant increase in beach profile height and width and creation of increased nesting, colonization, germination, and foraging habitat •Potential for ephemeral pool creation and less scarping •Decreased likelihood of mortality and loss of productivity due to flooding	•Temporary adverse impact resulting from high mortality of invertebrates in the intertidal zone •Temporary adverse impact resulting from complete mortality of benthic invertebrates in the borrow areas •Complete mortality of the small, non-commercial densities of surf clams present in the borrow areas. •Burial and destruction of demersal finfish eggs by settling sediments. •Clogging of gills and filter-feeding structures by suspended sediments which result in increased mortality, decreased ability to avoid predators, and decreased reproduction •Displacement of motile fish species from borrow areas and nearshore sand placement sites to adjacent unaffected waters during construction •Disturbance to migrations of finfish species including butterfish, bluefish, scup, and summer flounder •Temporary reductions in photosynthetic production of phytoplankton	•Moderate beneficial impact on transportation due to the increased beach width that would provide vehicle access to areas that are currently impassable at high tide •Moderate beneficial impact resulting from ability of emergency response vehicles to travel beaches at all tides •Short-term minor to moderate adverse impacts to transportation during sand placement as beaches would be closed to driving during construction activities

2.4	Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property	•Potential impacts are largely identical to those described for Alternative 2.3. •The proposed 400-500' taper sections would result in a negligible increase in intensity relative to the impacts expected from alternative 2.3 above. •The proposed modification of the construction timeline has the potential to result in a negligible increase in the magnitude of the potential adverse impact to migratory shorebirds relative to Alternative 2.3	•Potential impacts, both beneficial and adverse, are largely identical to those described in Alternative 2.3 •The proposed placement of 400-500' taper sections on Federal property would result in a negligible increase in intensity of impacts relative to those expected from Alternative 2.3 •Earlier commencement has the potential to result in a negligible increase in the magnitude of the potential adverse impact to finfish, as it has the potential to coincide with fall migrations of several finfish species •There is a potential for direct impacts to sea turtles if hopper dredging is permitted prior to November 15th. USACOE protocols will be employed to minimize direct impacts to sea turtles.	•Potential impacts are identical to those described for Alternative 2.4
Alt.	**Description**	**Terrestrial Ecology**	**Aquatic Ecology**	**Transportation**
2.5	Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property	•Potential impacts are identical to those described for Alternative 2.4, except that there are no taper sections proposed on Federal property with this alternative.	•Potential impacts are identical to those described for Alternative 2.4, except that there are no taper sections proposed on Federal property with this alternative.	•Potential impacts are identical to those described for Alternative 2.4
2.6	Beach Nourishment: 2008 Dune Crest Line	•Potential beneficial and adverse impacts are identical to those described in Alternative 2.3	•Potential beneficial and adverse impacts are identical to those described in Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.4
2.7	Preferred Alternative: Combination of Beach Scraping (2.2) and Beach Nourishment (2.5)	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3
Alt.	**Description**	**Community Services**	**Socioeconomics**	**Cultural Resources**
2.1	No Action	•No action would have long-term, negligible to moderate adverse impacts on community services including decreased areas available for recreational activities and decreased beach access	•Long-term, moderate to major negative impacts due to damage of structures and infrastructure resulting from natural beach dynamics. Damage to structures and infrastructure would disrupt economic activity, including tourism and commercial businesses, as well as utility services.	•No impacts on cultural resources
2.2	Beach Scraping	•No impacts expected	•No impacts expected	•No impacts expected
2.3	Beach Nourishment: 2003 Permitted Conditions	•Long-term moderate to major beneficial impacts on community services resulting from increased beach areas for recreation and increased storm damage protection to public facilities and businesses	•Long-term moderate positive impacts resulting from increased protection for structures and infrastructure, including utilities, commercial businesses, and residences.	•No impacts expected
2.4	Beach Nourishment: Modified Conditions, Combination Template, Tapers on Federal Property	•Potential impacts are identical to those described for Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.3
2.5	Beach Nourishment: Modified Conditions, Combination Template, No Tapers on Federal Property	•Potential impacts are identical to those described for Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.3

Alt.	Description	Community Services	Socioeconomics	Cultural Resources
2.6	Beach Nourishment: 2008 Dune Crest Line	•Potential impacts are identical to those described for Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.3	•Potential impacts are identical to those described for Alternative 2.3
2.7	Preferred Alternative: Combination of Beach Scraping (2.2) and Beach Nourishment (2.5)	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3	•Potential impacts to include a combination of impacts resulting from Alternatives 2.2 and 2.3

CHAPTER 5—Consultation and Coordination

Coordination with the following agencies and organizations was conducted throughout this project:

- U.S. Army Corps of Engineers, New York District: Planning, Engineering and Regulatory Divisions
- U.S. Fish and Wildlife Service
  - Long Island Field Office
  - New York Field Office, Region 5
- National Marine Fisheries Service
- Department of the Interior, Office of the Regional Soliciter
- Federal Emergency Management Agency/State Emergency Mangement Office
- New York State (NYS) Department of Environmental Conservation
- NYS Department of State
- Town of Brookhaven
- Town of Islip
- Coastal Planning & Engineering, Inc.
- Land Use Ecological Services, Inc.
- Rutgers University Institute of Marine & Coastal Studies

A series of meetings and correspondences with regulatory agencies and community stakeholders were held to collect information and input as well as to provide progress updates. In addition, two Public Scoping meetings were held to present the project and contents of this EA to the general public, for solicitation of comments and input.

Section 7 consultation was inititiated with USFWS and NMFS. A Biological Assessment was submitted to USFWS and NMFS and is currently under review. A Biological Opinion is expected from USFWS by Septebmer 15, 2008 (Appendix C). NMFS has not provided written correspondence on their timeline for review.

An Essential Fish Habitat Assessment was submitted to NMFS and is also under review. No correspondence has been received from from NMFS regarding their timeline.

In addition to the meetings and correspondences listed above, applications for beach nourishment as described in Alternative 2.4 (Beach Nourishment from Offshore Borrow Source: Modified Conditions, Combination Template, Tapers on Federal Property) have been submitted to permitting agencies (Table 33). NYSDEC has issued SEQRA Negative Declarations and Notices of Complete Application for all four reaches; permits are expected soon. NYSDOS has issued a Status of Consistency Review that states the consistency review is in a Public Notice period and cannot be completed until that notice period expires. USACOE issued request(s) for additional information on April 15, 2008; revised plans were resubmitted May 27, 2008 and are currently under review. USACOE has not issued a Public Notice to date. Appendix C provides copies of pertinent documents outlined above.

Table 33. List of permit applications submitted to date for the 2008 community beach nourishment project.

Agency/Contact	Application Number	Submitted	Status
USACOE Naomi Handell 917-790-8523	NAN-2008-511-EHA (WFI)	3/24/2008	Application under review
	NAN-2008-809 (CFI)	3/24/2008	Application under review
	NAN-2008-510-EHA (FIP)	4/10/2008	Application under review
	NAN-2008-505-EHA (DP)	3/24/2008	Application under review
NYSDEC Mark Carrara 631-444-0374	1-4722-03299/00005 (WFI)	2/26/2008	• SEQR Negative Declaration issued • Public comment period over 5/30/2008 • Application under review
	1-4722-00080/00001 (CFI)	4/10/2008	Letter of Coordination sent 5/2/2008 for SEQR Lead Agency
	1-4722-01483/00005 (FIP)	2/26/2008	• SEQR Negative Declaration issued • Public comment period over 5/30/2008 • Application under review
	1-4722-01129/00005 (DP)	2/26/2008	• SEQR Negative Declaration issued • Public comment period over 5/30/2008 • Application under review
NYSDOS Rebecca Madlin 518-486-7669	F2008-0271 (WFI)	3/24/2008	• Application under review; DOS is awaiting public release of EA to review for consistency determination
	F2008-0325 (CFI)	4/10/2008	• Application under review; DOS is awaiting public release of EA to review for consistency determination
	F2008-0270 (FIP)	3/24/2008	• Application under review; DOS is awaiting public release of EA to review for consistency determination
	F2008-0266 (DP)	3/24/2008	• Application under review; DOS is awaiting public release of EA to review for consistency determination
Town of Brookhaven Tom Carrano 631-451-6455	(CFI)	4/10/2008	• Permit to be issued upon receipt of NYSDEC permit
	PP-3420-08 (FIP)	2/26/2008	• Permit to be issued upon receipt of NYSDEC permit
	PP-3417-08 (DP)	2/26/2008	• Permit to be issued upon receipt of NYSDEC permit
Town of Islip	(WFI)	2/26/2008	Application under review
	(CFI)	4/10/2008	Application under review

CHAPTER 6—References

Allen, J.R. and Psuty, N.P., 1987. Morphodynamics of a single-barred beach with a rip channel, Fire Island, New York. *Proceedings of Coastal Sediments '87* (American Society of Civil Engineers Press), pp. 1964-1975.

Allen, James R. Charles L LaBash, and Petrer V. August. Bathymetric Change Analysis, Moriches Inlet, Fire Island National Seashore, NY (Abstract from URI Web Site)

Allen, Thomas B. 1999. The Shark Almanac. The Lyons Press. New York, NY. 274p.

Alpine Ocean Seismic Survey, Inc. November 1998. Final Report Delineation of Sand Borrow Areas, Atlantic Coast of Fire Island, Fire Island to Montauk Point, NewYork, Norwood.NJ.

Barber, R. J., "A Survey of Archaeological and Historical Resources, Fire Island Beach Erosion and Hurricane Protection Project," Institute for Conservation Archaeology, Peabody Museum, Harvard University, Cambridge, 1980.

Batten, Brian Keith, A dissertation presented by, Marine Sciences Research Center, Stony Brook University, Morphologic typologies and sediment budget for the ocean shoreline of Long Island, New York. August 2003

Benedet, L.; Andrews, J.; Finkl, C.W.; Kaub, F., and Andrews, M., 2004. Prospecting sand offshore Collier County: Lessons Learned from the analysis of historical datasets in a geospatial framework and application of geological models. *Proceedings of the 18th Annual National Conference on Beach Preservation Technology* (11-13 February 2004, Lake Buena Vista, Florida), CD-ROM. 16p.

Bodge, K. R., 1994. The Extent of Inlet Impacts Upon Adjacent Shoreline. *Coastal Engineering*, Vol. 3.

Bruun, P., 1994. The Development of Downdrift Erosion. Proceedings of the International Coastal Symposium (Iceland, June 1994).

Bumpus, D. F., 1965. Residual drift along the bottom on the continental shell in the Middle Atlantic Bight area. *Limnology and Oceanography*, Supplement, 10, R50-R53.

Cargnelli, L.M. S.J. Griesbach, D.B. Packer, E. Weissberger. 1999. Essential fish habitat source Document: Ocean quahog, Arctica islandica, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-148.

Cargnelli, L.M. et al. 1999. Essential fish habitat source document: Pollack, Pollachius virens, Life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-131.

Cargnelli, L.M. et al. 1999. Essential fish habitat source document: Longfin inshore squid, Loligo pealeii, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-146.

Cargnelli, L.M., S.J. Griesbach, D.B. Packer, E. Weissberger. 1999. Essential fish habitat source Document: Atlantic surfclam, Spisula solidissima, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-142.

Chang, S., P.L. Berrien, D.L. Johnson, W.W. Morse. 1999. Essential fish habitat source Document: Windowpane, Scophthalmus aquosus, life history and habitat characteristics. NOAA Technical Memorandum NMFS-N-137.

Coastal Planning & Engineering, Inc 2004 Hurricane Impacts on Captiva and Sanibel Islands, Florida. Post-Storm Survey and Report. November 2004.

Coastal Planning & Engineering, Inc Lovers Key Beach Restoration Project, Post-Construction Report, April 2005.

Coastal Planning & Engineering, Inc., "2003-04 Western Fire Island and Fire Island Pines Beach Renourishment Projects 3-Year Monitoring Report", February 2007.

Coastal Planning & Engineering, Inc., "Fire Island Beach Renourishment Projects Post Construction Report", May 2004.

Coastal Planning & Engineering, Inc., "Saltaire, Fair Harbor and Dunewood Beach Restoration Project 78-Month Monitoring Report", February 2001.

Coastal Planning & Engineering, Inc., "Saltaire, Fair Harbor and Dunewood Beach Restoration Project 90-Month Monitoring Summary", November 2001.

Coastal Planning & Engineering, Inc., "Fire Island Pines Beach Renourishment Project 4-Year Monitoring Summary", December 2001.

Coastal Planning & Engineering, Inc., 2002a. Preliminary Engineering Report, Western Fire Island Beach Renourishment Project, August 2002.

Coastal Planning & Engineering, Inc., 2002b. Preliminary Engineering Report, Fire Island Pines Beach Renourishment Project, August 2002.Coastal Planning & Engineering, Inc., Moffat Nichol and URS, Fire Island to Montauk Point Reformulation Study; Fill Alternative Development; Work Order No. 1 – Interim Submission 8A-Draft. February 2002.

Coastal Planning & Engineering, Inc., Draft Engineering Design Report, Plans and associated supporting documents for the 2008 Fire Island Renourishment Project. May 2008.

Conley DC. 2000. Numerical modeling of Fire Island storm breach impacts upon circulation and water quality of Great South Bay, NY. 124, Marine Sciences Research Center, State University of New York, Stony Brook.

Couch, Stephen. Personal communication by E-Mail. February 15, 2008.

Croker, R.A. 1977. Intertidal sand macrofauna from Long Island, NY. Chesapeake Science. 11: 134-137.

Cross, J.N. et al. 1999. Essential fish habitat source document: Butterfish, Peprilus triacanthus, Life history and habitat characteristics. NOAA Technical Memorandum NMFSj-NE-145.

Dean, Robert G. Richard A. Davis and Karyn M. Erickson Beach Nourishment: A Guide for Local Government Officials, Beach Nourishment with Emphasis on Geological Characteristics Affecting Project Performance. http://www.csc.noaa.gov/beachnourishment/html/geo/scitech.htm

Duane, D.B.; Field, M.E. ; Meisburger, E.P.; Swift, D.J.P., and Williams, S.J., 1972. Linear shoals on the Atlantic Inner continental shelf, Florida to Long Island. *In*: Swift, D.J.P.; Duane, D.B., and Pilkey, O.H. (eds.), *Shelf Sediment Transport: Process and Pattern*. Stroudsburg, PA: Dowden, Hutchinson, and Ross, pp. 447-498.

Dyer, K. R., and Huntley, D.A., 1999. The origin, classification and modeling of sand banks and ridges. *Continental Shelf Research*, 1999, 1285-1330.

Emery, K.O. and Uchupi, E., 1965. Structure of Georges Bank. *Marine Geology*, 3, 349-358.

Emery, K.O. and Uchupi, E., 1984. *The Geology of the Atlantic Ocean*. New York: Springer, Chapter 5: Drift Supersequence, pp. 369-671.

Fahay, M.P., P.L. Berrien, D.L. Johnson, W.W. Morse. 1999. Essential fish habitat source Document: Bluefish, Pomatomus saltatrix, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-144.

Fairbridge, R.W., 1992. Holocene marine coastal evolution of the United States. *In*: Fletcher, C.H., III, and Wehmiller, J.F. (eds.), *Quaternary Coasts of the United States: Marine and Lacustrine Systems*. Tulsa, Oklahoma: SEPM Special Publication No. 48, pp. 9-20.

Fenneman, N.M., 1938. *Physiography of the Eastern United States*. New York: McGraw-Hill, 714p.

Filin, S., 2003. Recovery of systematic biases in laser altimetry data using natural surfaces. *Photogrammetric Engineering and Remote Sensing*, 69(11): 1235-1242.

Finkl, C.W., 2005. Nearshore geomorphological mapping. *In*: Schwartz, M.L., (ed.), *The Encyclopedia of Coastal Science*. Dordrecht, The Netherlands: Kluwer Academic (now Springer), pp. 849-865.

Finkl, C.W. and Walker, H.J., 2005. Beach nourishment. *In*: Schwartz, M. (ed.), *The Encyclopedia of Coastal Science*. Dordrecht, The Netherlands: Kluwer Academic (now Springer), pp. 37-54.

Finkl, C.W. and Warner, M.T., 2004. Morphologic features and morphodynamic zones along the inner continental shelf of southeastern Florida: An example of form and process controlled by lithology. *Journal of Coastal Research*, SI 42, 79-96.

Fire Island National Seashore. June 12, 2008. Overall comments on the draft environmental assessment Fire Island community short-term storm protection project, Patchogue, New York. 33 pp.

Fire Island National Seashore. 1999. Checklist of the Birds of Fire Island National Seashore. Compiled by S. Mitra and J. Putnam. 2 pp.

Fire Island National Seashore. 2003. Fire Island National Seashore. Short-term Community Storm Surge Protection Plan. Environmental Assessment. Patchogue, NY. 146 pp.

Fisher, J.J., 1985. Atlantic USA – North. *In*: Schwartz, K.L. and Bird, E.C.F. (eds.), *The World's Coastline*. New York: Van Nostrand Reinhold, pp. 223-234.

Foley, M., 2008. Telephone conference with community representatives on 06/20/2008 (9AM).

Foster, D.S.; Swift, B.A., and Schwab, W.C., 1999. Stratigraphic Framework Maps of the Nearshore Area of Southern Long Island from Fire Island to Montauk Point, New York. U.S. *Geological Survey Open-File Report 99-559*.

Franz, D.R. 1975. Distribution and abundance of inshore populations of the surf clam, Spisula solidissima. Proceedings of the Symposium of the American Museum of Natural History. NYC. November, 1975.

Galgano, F. A. and S. P. Leatherman, "Beach Erosion, Tidal Inlets and Politics: The Fire Island Story," *Shore & Beach*, Vol. 67, No. 2&3, April & July 1999.

Gayes, P.T. and Bokuniewicz, H.J., 1991. Estuarine paleoshorelines in Long Island Sound, New York. *In*: Gayes, P.T.; Lewis, R.S., and Bokuniewicz, H.J. (eds.), *Quaternary Geology of Long Island Sound and Adjacent Coastal Areas*. Journal of Coastal Research, Special Issue No. 11 (Walter S. Newman Memorial Volume), pp. 39-54.

Gosner, K.L. 1978. A field guide to the Atlantic Seashore. Houghton Mifflin Co. Boston, USA.

Gravens, M.B., 1999. Periodic shoreline morphology, Fire Island, NY. *Proceedings of Coastal Sediments '99*, Happague, NY, 1613-1626.

Gravens, Mark B, Julie D. Rosati and Randall A Wise, Fire Island to Montaulk Point Reformulation Study (FIMP): Historic and Exixting Condition Coastal Process Assessment Coastal & Hydraulics Laboratory U.S. Army Corps of Engineers. Sept. 1999 (Draft Report).

Hackney, C.T., M.H. Posey, S.W. Ross, A.R. Norris. 1996. A review and synthesis of data on surf zone fishes and invertebrates in the South Altantic Bight and the potential impacts from beach nourishment. Prepared by the University of North Carolina at Wilmington and the North Carolina National Estuarine Research Reserve for the USACOE. Wilmington, NC.

Hall, C. and Staimer, M. 1995. Concerns about the coast. USA Today. Augsut 9, 1995. p1A.

Hayes, M.O. and Nairn, R.B., 2003. Natural maintenance of sand ridges and linear shoals on the U.S. Gulf and Atlantic continental shelves and the potential impacts of dredging. *Journal of Coastal Research*, 20(1), 138-148.

Hinga KR. 2005. Water quality and ecology of Great South Bay (Fire Island National Seashore Science Synthesis Paper). Technical Report NPS/NEP/NRTR- 2005/019. 54 pgs.

Holthuijsen, L.H., N. Booij and R.C. Ris, 1993: A spectral wave model for the coastal zone, *Proc. of 2nd Int. Symposium on Ocean Wave Measurement and Analysis*, New Orleans, USA, 630-641.

Houston, James R. 2002. The economic value of beaches. Shore & Beach, January 2002.

Houston, James R. 1996. Simplified Dean's Method for Beach Fill Design. Journal of Waterway, Port, Coastal and Ocean Engineering. May/June 1997.

Howe, M.A. et al. 1978. MESA New York Bight Program. Marine and Coastal Birds. NY Sea Grant Institute. Albany, NY.

Hutchinson, D.R.; Klitgord, K.D., and Detrick, R.S., 1986. Rift basins of the Long Island Platform. *GSA Bulletin*, 97(6), 688-702.

JMA (John Milner Associates), "Cultural Resources Study, Fire Island Inlet to Montauk Point, Suffolk County, New York, Reformulation Study: Phase I Archaeological Survey Volumes I and II," 1998.

JMA (John Milner Associates), "Cultural Resources Baseline Study, Fire Island Inlet to Montauk Point, Suffolk County, New York, Reformulation Study," 2000.

Johnson, D.L., W.W. Morse, P.L. Berrien, J.J. Vitaliano. 1999. Essential fish habitat source Document: Yellowtail flounder, Limanda ferruginea, life history and habitat Characteristics. NOAA Technical Memorandum NMFS-NE-140.

Kana, T.W., 1995. A mesoscale sediment budget for Long Island, New York. Marine Geology, 126(1-4): 87-110.

Kana, T. W., and R. Krishnamohan, "Assessment of the Vulnerability of the Great South Bay Shoreline to Tidal Flooding," Coastal Science & Engineering, Inc., April 1994.

Kana, T. W American Shore and Beach Preservation Assiation Presentation, Galveston Tx, October 2007.

Katona, S.K., V. Rough, and D.T. Richardson. A Field Guide to Whales, Porpoises, and Seals from Cape Cod to Newfoundland. 4th ed. Smithsonian Press. Washington DC. 316 pp.

Keehn, Stephen and Tom Pierro. Temporal variations of offshore sand bars in response to extreme storms. Proceedings of Coastal Sediments 03. Clearwater Beach, Fl. May 2003

Lavelle, J.W.; Swift, D.J.P.; Gadd, P.E.; Stubblefield, F.N.; Case, F.N.; Brashear, H.R., and Haff, K.W., 1978. Fair weather and storm sand transport on the Long Island inner shelf. *Sedimentology*, 25(6), 823-842.

Lavelle, J.W. and Swift, D.J.P., 1982. Nearshore currents measured in ridge-and-swale topography off Long Island, New York. *Journal of Geophysical Research*, 87(C6), 4190-4194.

Leatherman, S.P. and Allen, J.R., 1985. *Geomorphic Analysis, Fire Island to Montauk Point, Long Island, New York: Reformulation Study and Final Report.* Boston, Massachusetts: National Park Service, Technical Report, 350p.

Leatherman, S.P., 1985. Geomporphic and stratigraphic analysis of Fire Island, New York. *Marine Geology*, 63(1-4), 173-195.

Lentz, E.E., C.J. Hapke and W.C. Schwab. A review of sediment budget estimations at Fire Island Baech National Seashore. New York. Technical report NPS/NER/NRTR-2008-114. National Park Service, Boston, MA. 2008.

McCormick, C.L. and Toscano, M.A., 1981. Origin of the barrier system of Long Island, New York. *Northeastern Geology*, 3, 230-234.

McDermott, J.J. 1983. Food web in the surf zone of an exposed sandy beach along the mid-Atlantic coast of the United States. Pp. 529-538 in A. McLachian and T. Erasmus (Eds.). Sandy Beaches as Ecosystems. Dr. W. Junk Publishers. Boston, MA.

McMillan, D.G. and W.W. Morse. 1999. Essential fish habitat source document: Spiny dogfish, Squalus acanthias, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-150.

Moore, L.J., P. Ruggiero and J.H. List, 2006. Comparing mean high water and high, water line shorelines: Should proxy-datum offsets be incorporated into shoreline change analysis. *Journal of Coastal Research*, 22(4): 894-905.

Morse, W.W., D.L. Johnson, P.L. Berrien, S.J. Wilk. 1999. Essential fish habitat source Document: Silver hake, Merluccius bilinearis, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-135.

National Audobon Society Field Guide to North American Fishes, Whales, and Dolphins. 1998. Alfred A. Knopf, Inc. New York.

Naqvi, S.M. and E.J. Pullen. 1982. Effects of beach nourishment and borrowning on marine Organisms. Miscellaneous Report No. 82-14. USACOE, Coastal Engineering Research Center. Fort Belvoir, VA.

Nelson, W.G. 1985. Guidelines for beach restoration projects. Part I: Biological guidelines. Report No. 76. Florida Sea Grant College. Florida Institute of Technology. Melbourne, FL.

Niedoroda, A.W. and Swift, D.J.P., 1981. Maintenance of the shoreface by wave orbital currents and mean flow: Observations from the Long Island coast. *Geophysical Research Letters*, 8, 340-377.

Niedoroda, A.W.; Swift, D.J.P.; Hopkins, T.S., and Chen-Mean, M., 1984. Shoreface morphodynamics on wave dominated coasts. *Marine Geology*, 60, 331-354.

Niedoroda, A.W.; Swift, D.J.P.; Figueiredo, A.G., and Freeland, G.L., 1985. Barrier island evolution, middle Atlantic shelf, U.S.A. *Marine Geology*, 63, 363-396.

Northeast Fisheries Science Center. 1998. Report of the 26th Northeast Regional Stock Assessment Review Workshop (26th SAW): Stock Assessment Review Committee (SARC) concensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 98-03. 283p.

NYSDEC. 1994. 1992-1993 Long Island colonial waterbird and piping plover survey. NSYDEC Division of Fish, Wildlife and Marine Resources (Stony Brook, NY) and Nongame and Habitat Unit (Delmar, NY). Document prepared by K. Meskill, M. Alferi, L. Sommers, and R. Miller.

NYSDEC. 1995. 1994 Long Island colonial waterbird and piping plover survey. NSYDEC Division of Fish, Wildlife and Marine Resources (Stony Brook, NY) and Nongame and Habitat Unit (Delmar, NY). Document prepared by K. Meskill, M. Alferi, L. Sommers, and R. Miller.

NYSDEC. 1998. NY Natural Heritage Program, Natural Heritage Database Report on Rare Species and Ecological Communities. Site Specific Report: Fire Island Inlet to Moriches Inlet.

NYSDEC. 1998a. Roseate Tern Fact Sheet. Endangered Species Unit. Delmar, NY.

NYSDEC. 1998b. 1997 Long Island Colonial Waterbird and Piping Plover Survey. Non-game and Habitat Unit. Delmar, NY.

NYSDEC. 1998c. Least Tern Fact Sheet. Endangered Species Unit. Delmar, NY.

NYSDEC. 1998d. Common Tern Fact Sheet. Endangered Species Unit. Delmar, NY.

NYSDEC. 2000. Piping Plover Fact Sheet. Endangered Species Unit. Delmar, NY.

NYSDEC 2005. 2005 Atlantic Ocean Surfclam Population Assessment. Division of Fish, Wildlife, and Marine Resources. Document prepared by M. Davidson, M.C. Cammarota, P. Monsen, and G. Varas. 48 pages.

NYSDEC 2007. 2006 Atlantic Ocean Surfclam Population Assessment. Division of Fish, Wildlife, and Marine Resources. Document prepared by M. Davidson, E. P. Espinosa, P. Monsen, C. Perretti, and J. Hornstein. 75 pages.

Oldale, R.N. and Coleman, S.M., 1992. On the age of the penultimate full glaciation of New England. *Geological Society of America, Special Paper No. 270*, pp. 163-170.

Parker, D. et al. 1999. Essential fish habitat source document: Summer flounder, Paralichthys Dentatus, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-151.

Pearce, J.B., D.J. Radoshi, J.V. Caracciolo, and F.W. Steimle, Jr. 1981. Benthic Fauna. MESA Monograph 14. NY Sea Grant Institute. Albany, NY.

Pereira, J. et al. 1999. Essential fish habitat source document: Winter flounder, Pseudopleuronectes americanus, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-138.

Poag, C.W., 1978. Stratigraphy of the Atlantic continental shelf and slope of the United States. *Annual Review of Earth and Planetary Sciences*, 270, 163-170.

Psuty, Norbert P., Tanya Mendes Silveira. Foredune Crestline Procedures, Fire Island, 2005 Foredune Creastline with annotated aerial photographs. Institute of Marine and Coastal Science, Sandy Hook, NJ. April 2008.

Psuty, N.P.; Grace, M., and Pace, J.P., 2005. *The Coastal Geomorphology of Fire Island: A Portrait of Continuity and Change (Fire Island National Seashore Science Synthesis Paper)*. Boston, Massachusetts: USDI, NPS, Northeast Region, Technical Report NPS/NER/NRTR-2005/021.

Rakocinski, C.F., R.W. Heard, S.E. LeCroy, J.A. McLelland and T. Simmons. 1996. Responses By macrobenthic assemblages to extensive beach restoration at Peridido Key, Florida, USA. Journal of Coastal Research. 12: 326-353.

Reid, R.N. et al. 1999 Essential fish habitat source document: Atlantic herring, Clupea harengus, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-126.

Reilly, F.J. and V.J. Bellis. 1983. The ecological impact of beach nourishment with dredged materials on the intertidal zone at Bogue Banks, North Carolina. Miscellaneous Report No. 83-3. USACOE, Coastal Engineering Research Center. Fort Belvior, VA.

Ris, R.C., 1997: Spectral modelling of wind waves in coastal areas, (Ph.D. Dissertation Delft University of Technology, Department of Civil Engineering), Communications on Hydraulic and Geotechnical Engineering, Report No. 97-4, Delft, The Netherlands.

Riverhead Foundation for Marine Research and Preservation. 2002. Species composition and distribution of marine mammals and sea turtles on Long Island. Riverhead, NY.

RMC Environmental Services. 1996. Fire Island Inlet to Montauk Point Reformulation. Borrow Sites Macroinvertebrate Community Characterization. Prepared for the USACOE Contract No. DACW51-94-D-0035.

Robertson, W.; Whitman, D.; Zhang, K.Q., and Leatherman, S.P., 2004. Mapping shoreline position using airborne laser altimetry. *Journal of Coastal Research*, 20, 884-892.

Robertson, W., K. Zhang and D. Whitman, 2007. Hurricane-induced beach change derived from airborne laser measurements near Panama City, Florida. *Marine Geology*, 237(3-4): 191-205.

Robertson, W., K. Zhang, D. Whitman and S.P. Leatherman, 2005. Shoreline and beach volume change before and after the 2004 hurricane season, Palm Beach County, Florida. *Shore & Beach*, 73(2-3): 79-84.

Robertson, W, Unpublished study analyzing beach scraping impact using lidar data. 2008.

Rosati, J.D.; Gravens, M.B., and Smith, W.G., 1999. Regional sediment budget for Fire Island to Montauk Point, New York, USA. *In*: Kraus, N.C. and McDougal, W.G. (eds.). *Coastal Sediments '99*, pp. 802-817.

RPI (Research Planning Institute, Inc.), 1985. *Sediment Budget Analysis: Summary Report to Final Report of Fire Island Inlet to Montauk Point, Long Island, New York*. Columbia, South Carolina: Research Planning Institute, Inc., v.p. (Prepared for the U.S. Army Corps of Engineers, New York District, Contract No. DACW 51-81-C-0030).

Sallenger, A.H., W.B. Krabill, R.N. Swift, J. Brock, J. List, M. Hansen, R.A. Holman, S. Manizade, J. Sontag, A. Meredith, K. Morgan, J.K. Yunkel, E.B. Frederick and H. Stockdon, 2003. Evaluation of airborne topographic lidar for quantifying beach changes. *Journal of Coastal Research*, 19(1): 125-133.

Sanders, J.E. and Kumar, N., 1975. Evidence of shoreface retreat and in place 'drowning' during Holocene submergence of barriers. *Geological Society of America Bulletin*, 86, 65-76.

Santomauro, Frank, USACE New York District Planning Division Chief. Personal Communication. 2007.

Schwab, W.C.; Thieler, E.R.; Allen, J.R.; Foster, D.S.; Swift, B.A.; Denny, J.F., and Danforth, W.W., 1999. Geologic Mapping of the nearshore area offshore Fire Island, New York. *In*: Kraus, N.C. and McDougal, W.G. (eds.). *Coastal Sediments '99*, Vol. 2, pp. 1552-1567.

Schwab, W.C.; Thieler, E.R.; Denny, J.F., and Danforth, W.W., 2000. Seafloor Sediment Distribution off Southern Long Island, New York. *U.S. Geological Survey Open-File Report 00-243*.

Sherk, J.A., Jr. 1971. The Effects of Suspended and Deposited Sediments on Estuarine Organisms: Literature summary and research needs. Chesapeake Biol. Lab. Contrib. No. 443. Solomons, MD. 73 pp.

Steimle, F.W. et al. 1999. Essential fish habitat source document: Scup, Stenotomus chrysops, Life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-149.

Steimle, F.W. et al. 1999. Essential fish habitat source document: Ocean pout, Macrozoarces Americanus, life history and habitat characteristics. NOAA Technical Memorandum

NMFS-NE-129.

Steimle. F.W. W.W. Morse, D.L. Johnson. 1999. Essential fish habitat source document: Goosefish, Lophius americanus, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-127.

Steimle, F.W., C.A. Zetlin, P.L. Berrien, S. Chang. 1999. Essential fish habitat source document: Black sea bass, Centropristis striata, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-143.

Steimle, F.W., W.W. Morse, P.L. Berrien, D.L. Johnson. 1999. Essential fish habitat source Document: Red hake, Urophycis chuss, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-133.

Stockdon, H.F.; Sallenger, A.H.; List, J.H., and Holman, R.A., 2002. Estimation of shoreline position and change using airborne topographic lidar data. *Journal of Coastal Research*, 18, 502-513.

Studholme, A.L. et al. 1999. Essential fish habitat source document: Atlantic mackerel, Scomber Scombrus, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-141.

Suter, R.; de Laguna, W.; and Perlmutter, N.M., 1949. Mapping of geologic formations and aquifers of Long Island, New York. *State of New York Department of Conservation Water Power and Control Commission, Bulletin GW-18*, 212p.

Swift, D.J.P., Field, M.E., 1981. Evolution of a classic sand ridge field: Maryland sector North American inner shelf. *Sedimentology*, 28, 461– 482.

Swift, D.J.P.; McKinney, T.F., and Stahl, L., 1984. Recognition of transgressive and post-transgressive sand ridges on the New Jersey continental shelf: Discussion. *In*: Tillman, R.W., and Siemers, C.T. (eds.), Siliclastic shelf sediments. *Society of Economic Paleontologists and Mineralogists Special Publication No. 34*, pp. 25-36.

Taney, N.E., 1961a. Geomorphology of the south shore of Long Island, New York, Coastal Engineering Research Center, Vicksburg.

Taney, N.E., 1961b. Littoral materials of the south shore of Long Island, New York, U.S. Army Corps of Engineers, Vicksburg.

Tanski, J. 2007. Long Island's Dynamic South Shore — A Primer on the Forces and Trends Shaping Our Coast. New York Sea Grant. 27 pages.

Thornbury, W.D., 1965. *Regional Geomorphology of the United States*. New York: Wiley, 609p.

Trowbridge, J.H., 1995. A mechanism for the formation and maintenance of shore-oblique sand ridges on storm-dominated shelves. *Journal of Geophysical Research*, 100(C8), 16071-16086.

Tuttle, M. C., "Remote Sensing Survey, Tidal Zone and Nearshore Project Area, Atlantic Coast of Long Island, Fire Island Inlet to Moriches Inlet," Panamerican Consultants, Inc., Memphis, 1999.

Uchupi, E.; Driscoll, N.; Ballard, R.D., and Bolmer, S.T., 2001. Drainage of late Wisconsin glacial lakes and the morphology and late Quaternary stratigraphy of the New Jersey - southern New England continental shelf and slope. *Marine Geology*, 172, 117-145.

USACOE. 1996. Fire Island to Montauk Point, Long Island, New York Breach Contingency Plan. Executive Summary and Environmental Assessment. USACOE, New York District.

USACOE, Waterways Experiment Station. Progress Report, "Coastal Studies for the South Shore of Long Island, Fire Island to Montauk Point reformulation Study." Vicksburg, MS, Dec 9, 1997.

USACOE. 1998. Draft Pre-Construction Baseline Studies Report: The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury to Manasquan Section, Beach Erosion Control Project, Phase I. USACOE, New York District.

USACOE. 1999. Draft Environmental Impact Statement. Atlantic Coast of Long Island, Fire Island to Montauk Point. Reach I-Evalutaion of Interim Plan for Storm Damage Reduction. USACOE. New York District. 151 pages.

USACOE. 1999b. Fire Island to Montauk Point, Long Island, New York Project. Storm Damage Reduction Reformualtion Study, Interim Submission 6, Screening of Protection Alterntives. USACOE, New York District.

USACOE. 2000. Benthic invertebrate survey: Napeague to east of Fire Island Inlet. USACOE, New York District.

USACOE. 2001. Final Report. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury to Manasquan Section, Beach Erosion Control Project. USACOE. New York District.

USACOE. 2001b. Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York: Reformulation Study (West of Shinnecock Inlet and Cherry Grove Multispecies Sampling). USACOE, New York District.

USACOE. 2001c. *Coastal Engineering Manual*. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes) *Revised 2006*.

USACOE. 2002. Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York. Storm damage reduction reformulation study: surf clam stock assessment. USACOE, New York District.

USACOE. 2002. Fire Island Inlet to Montauk Point Reformulation Study, Fill Alternative Development, Work order Number 1 – Interim Submission 8A. Prepared by CPE, Moffat-Nichol and URS. February February 2002.

USACOE. 2003. Final Avian Survey Summary Report May 2002-May 2003. New York District. New York, New York. 71 pp.

USACOE. 2004. Final Small Mammal and Herpetile Survey Summary Report, May-August 2002. USACOE. New York District. 63 pp.

U.S. Army Engineering Research and Development Center. Coastal and Hydraulics Laboratory. Review of National Parks Service draft report. A review of sediment budget estimations at Fire Island National Seashore, NY January 26, 2008USACE. Appendix B, Borrow site investigations, FIMP Reformulation study, Fire Island Inlet to Montaulk Point, New York, U.S. Army Corps of Engineers, New York District, New York, NY.1996.

U.S. Fish & Wildlife Service. 1988. Atlantic Coast Piping Plover Recovery Plan. Region 5. Newton Corner, MA.

Vincent, C.W.; Swift, D.J.P., and Hillard, B., 1981. Sediment transport in the New York Bight, North American Atlantic shelf. *Marine Geology*, 42, 369-398.

Vincent, C.W.; Young, R.A. and Swift, D.J.P., 1983. Sediment transport on the Long Island shoreface, North American Atlantic shelf: Role of waves and currents in shoreface maintenance. *Continental Shelf Research*, 2, 163-181.

Walker, H.J. and Coleman, J.M., 1987. Atlantic and Gulf coastal province. *In*: Graf, W.L. (ed.), *Geomorphic Systems of North America*. Boulder, Colorado: Geological Society of America, Centennial Special Volume 2, pp. 51-110.

Watts Jr., Gordon. 2001. Remote sensing archaeological survey of borrow areas 2A, 2B, 2C, 3A, 4A, 4B, 5A, 5B, 6A, 7A, 8A, Atlantic coast of Long Island, Fire Island Inlet to Moriches Inlet, Suffolk County, New York, Reformulation Study. Tidewater Atlantic Research, Inc.

Williams, A.T. and Morgan, P., 1993. Scanning electron microscope evidence for offshore-onshore sand transport at Fire Island, New York, USA. *Sedimentology*, 40(1), 63-77.

Williams, S.J., 1976. Geomorphology, shallow subbottom structure and sediments of the Atlantic inner continental shelf off Long Island, New York. U.S. Army Corps of Engineers Coastal Engineering Research Center, *Technical Paper No. 76-2*, 123p.

Williams, S.J. and Duane, D.B., 1974. *Geomorphology and Sediments of the Inner New York Bight Continental Shelf*. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Technical Memorandum No. 45, 75p.

Williams, S.J. and Meisburger, E.P., 1987. Sand sources for the transgressive barrier coast of Long Island, New York: Evidence for landward transport of shelf sediments. *Coastal Sediments '87*, pp. 1517-1532.

Zhang, K. and D. Whitman, 2005. Comparison of three algorithms for filtering airborne lidar data. *Photogrammetric Engineering and Remote Sensing*, 71(3): 313-324.

Zhang, K.Q., S.C. Chen, D. Whitman, M.L. Shyu, J.H. Yan and C.C. Zhang, 2003. A progressive morphological filter for removing nonground measurements from airborne LIDAR data. *IEEE Transactions on Geoscience and Remote Sensing*, 41(4): 872-882.

Zhang, K.; Whitman, D.; Leatherman, S., and Robertson, W., 2005. Quantification of beach changes caused by Hurricane Floyd along Florida's Atlantic coast using airborne laser surveys. *Journal of Coastal Research*, 21, 123-134.

Zimmerman, M., 1983. *Coastal Facets as Indicators of Shoreline Response to Rising Sea Level*. Stony Brook: State University of New York, Marine Sciences Research Center, unpublished Master's thesis, 91p.

CHAPTER 7—List of Preparers

The 2008 EA was prepared using information and formatting from the 2003 EA, with revisions and updates for additional studies and monitoring, as well as new project parameters.

The 2008 EA preparers are as follows:

Charles Bowman
President
Land Use Ecological Services, Inc.

William Bowman, PhD.
Senior Scientist
Land Use Ecological Services, Inc.

Thomas J. Campbell, P.E.
President
Coastal Planning & Engineering

Charles Finkl, Ph.D.
Principal Geologist
Coastal Planning & Engineering

Stephen Keehn, P.E.
Senior Coastal Engineer
Coastal Planning & Engineering

Kelly Risotto, M.A.
Senior Ecologist
Land Use Ecological Services, Inc.

William (Quinn) Robertson, Ph.D.
Geologist
Coastal Planning & Engineering

The 2003 EA was prepared by:

Michael Bilecki,
Chief of Resources Management
Fire Island National Seashore

Steve Finn
Park Ranger
Fire Island National Seashore

Richard Ramsdell
Environmental Protection Specialist
Fire Island National Seashore

Kathy Schwager
Biological Technician
Fire Island National Seashore

---

[i] *Glauconite* is a phyllosilicate (mica group) mineral of formula: $(K,Na)(Fe^{3+},Al,Mg)_2(Si,Al)_4O_{10}(OH)_2$. It can also be referred to as an iron silicate. It crystallizes with monoclinic geometry. The name is derived from the Greek *glaucos* (*γλαυκος*) meaning 'gleaming' or 'silvery', to describe the appearance of the blue-green color, presumably relating to the sheen and blue-green color of the sea's surface.

[ii] *Cuesta* is a geological term, used to describe the ridges formed by gently tilted hard rock layers. Every cuesta has a steep slope, where the rock layers are exposed on their edges, called an escarpment or, if more severe, a cliff. Usually an erosion-resistant rock layer also has a gentler slope on the other side of the ridge called a 'dip slope'. The term derives from the Spanish word for 'slope'.

[iii] A *ravinement* is a time-transgressive or diachronous subaqueous erosional surface resulting from nearshore marine and shoreline erosion associated with a sea-level rise. This erosional surface parallels the migration of the shoreface "razor" across previously deposited coastal deposits. Burrows in this surface are often filled by sediments deposited during a sea-level rise.