FINAL ENVIRONMENTAL IMPACT STATEMENT
ST. LUCIE COUNTY SOUTH BEACH AND DUNE RESTORATION PROJECT
ST. LUCIE COUNTY, FLORIDA

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SUMMARY

FINAL ENVIRONMENTAL IMPACT STATEMENT ON ST. LUCIE COUNTY SOUTH BEACH AND DUNE RESTORATION PROJECT ST. LUCIE COUNTY, FLORIDA

Need or Opportunity. St. Lucie County is located on Florida's east coast about 100 miles north of Miami and due east of Lake Okeechobee. The county's coastline consists primarily of 21.5 miles of South Hutchinson and North Hutchinson Island, elongated barrier islands generally a mile or less wide separated by Ft. Pierce Inlet. The Indian River Lagoon, Ft. Pierce Inlet, and St. Lucie Inlet separate South Hutchinson Island from Florida's mainland. The project area lies within the southernmost 5.2 miles of the St. Lucie County shoreline.

The coastline and barrier islands of St. Lucie County are low-lying and vulnerable to storm surge and other storm event damages. Problems in the project area (from Florida Department of Protection (FDEP) monument R-87.7 to R-115 + 1,000 ft) include sand erosion and lowering of the beach profile with subsequent recession of the shoreline and dunes. The purpose of the proposed project is to stabilize the beach, which would also serve to restore the recreational area of the beach, restore beach and dune habitat for wildlife, and reduce potential storm damage by creating additional buffer between upland developments and the Atlantic Ocean. Hurricanes and severe "northeasters" have caused considerable erosion and damage to shoreline structures within the project area. Along parts of the shoreline, beach and dune erosion has made buildings and other structures vulnerable to severe storm damage.

The St. Lucie County Erosion District (the applicant) has proposed the St. Lucie County South Beach and Dune Restoration Project , a one time, single and complete project including beach and dune fill to provide storm damage protection to structures threatened by chronic shoreline retreat and storm-induced beach erosion. The project also maintains an area suitable for recreation and wildlife habitat.

The USACE determined that the scope of the proposed St. Lucie County South Beach and Dune Restoration Project and potential environmental effects of "new" beach nourishment could significantly affect the quality of the human environment, and authorization under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 (RHA) would constitute a major federal action. Based on these determinations, the USACE requires an environmental impact statement (EIS) as part of the permit application process.

The St Lucie County Florida Hurricane and Storm Damage Reduction Study Feasibility Report is an ongoing federal feasibility assessment study for this segment of the beach. The USACE Planning Division is performing the study that is concurrent to, but

independent of, the Regulatory Division's Environmental Impact Statement (EIS). The feasibility study is considering a federally funded project along the southern beach segment. This EIS may provide some or all of the National Environmental Policy Act (NEPA) documentation required for any federal beach stabilization project at this project site.

The applicant's objectives (benefits) include (1) re-establishing beaches as suitable recreational areas to maintain commerce associated with beach recreation in St. Lucie County; (2) maintaining suitable beach habitat for nesting sea turtles, invertebrate species, and shorebirds; and (3) reducing expected storm erosion damages to property and infrastructure

Major Findings and Conclusions. This EIS discloses the anticipated effects of the applicant's preferred alternative as well as other reasonable alternatives on the environment. The context of the evaluation is for the USACE to identify and quantify the resources and the reasonably anticipated beneficial, adverse, or other effects of the applicant's proposed project. The study includes a comparison of the applicant's proposal with other reasonable alternatives expected to achieve the project purpose. The comparison supports appropriate evaluations of relevant environmental factors, appropriate resource considerations, and a thorough understanding of the potential impacts and effects. Using this method the USACE can render an informed recommendation for approval, modification, or rejection of the applicant's proposal.

This EIS considers the environmental resources within the project area, the underlying natural processes normally occurring, and an evaluation and disclosure of the possible effects of the applicant's preferred project and alternatives on the human and natural environments is the intent of this EIS. Resource-related issues addressed include the quantity and duration of potential direct and temporary (construction related) impacts, cumulative effects on protected species, water quality, essential fish habitat (EFH), fish and wildlife resources, benthic communities, sediment transport, wave modification, cultural and socioeconomic resources, aesthetics and recreation.

The applicant's originally preferred alternative was identified in the Notice of Intent (NOI), during the scoping process, and as Alternative 4 in the DEIS. As presented in the original permit application, the applicant's preferred alternative consisted of beach fill and dune restoration in two segments within the project area. The north segment extended from FDEP monument R-87.7 to R-90.3. The southern segment extended from R-98 to the St. Lucie/Martin County line at R-115+1,000 ft. The project required approximately 610,000 cubic yards of beach quality sand which was to be dredged from an offshore shoal. However, on January 5, 2012, the applicant submitted a letter to the USACE deleting the north project segment (R-87.7 to R-90.3), in its entirety, from the preferred alternative **(See Appendix B**). The remaining project components (south segment) would remain as originally proposed; however, the quantity of beach fill required was reduced to approximately 458,900 cubic yards.

The applicant's preferred alternative as described in its January 5, 2012 letter became Alternative 6. With the change in the applicant's preferred alternative, the applicant is pursuing a less environmentally damaging alternative consistent with the USACE's requirements for measures to avoid and minimize impacts to the aquatic environment. The USACE continues to evaluate the full range (6) of alternatives that achieve the project purpose and the No Action alternative. The applicant's preferred alternative would directly impact about 0.57 acres of hardbottom habitat. It would also have a short-term impact to about one acre of hardbottom associated with construction related turbidity. Based on Uniform Mitigation Assessment Methodology (UMAM) assessments from the applicant and reviewed by USACE for this EIS, compensatory mitigation to offset the anticipated adverse effects on nearshore hardbottom associated with the applicant's preferred alternative would require construction of 0.78 acres of nearshore hardbottom reef. The mitigation site(s) would be located in the project area nearshore. Other alternatives considered in detail have a range of adverse effects, both greater and lesser, and mitigation commensurate with the adverse effect. The applicant identified likely locations for artificial reef placement in the general project area in approximately 15 feet (ft) of water and up to about 1,000 ft offshore. The applicant and FDEP are collaborating on resolution of the final amount of impact and the amount of mitigation required offsetting impacts in accordance with state requirements. The USACE will consider those findings when available.

The applicant submitted a turbidity monitoring plan to assess, avoid, and/or minimize impacts to reef communities adjacent to the proposed project beach during construction. A proposed biological monitoring plan would assess success of the mitigation reef(s) and direct, secondary, and long-term effects to nearshore hardbottom habitat associated with the proposed beach and dune restoration activities

The EIS considers and addresses all comments from the public and other state and federal stakeholders regarding the EIS. If recommended for approval, the DA authorization and the FDEP Joint Coastal Permit (both now under review by the federal and state agencies and their commenting agency partners) are expected to include measures for the applicant to follow for avoidance and minimization of adverse environmental effects.

Alternatives. This EIS included and evaluated a range of nonstructural and structural measures to stabilize the beach along southern Hutchinson Island. The USACE evaluated the range of reasonable alternatives included in this EIS since each was considered viable and capable of achieving the project purpose.

Both structural and nonstructural alternatives that did not meet the standards for detailed evaluation were eliminated due in part to a lack in the following: economic viability or effectiveness and/or political or social acceptance. In particular, many of the nonstructural alternatives would avoid adverse environmental effects and would help to alleviate economic impacts on project area property owners, but would not meet the project purpose or could result in unacceptable effects. For instance, the beaches in the project area would continue to erode and result in a loss of recreational benefits and/or

marine turtle nesting habitat. Other nonstructural alternatives such as changing the building code or beach construction setback may avoid future problems with beach erosion but would not address the current erosion issues related to existing upland development. Therefore, those alternatives would not be practicable. Various methods of hardened shore protection, such as revetments, did not warrant further consideration because such measures are known to function poorly in areas similar to the proposed project area. In addition, St. Lucie County Codes prohibit seawalls in this area.

This EIS considered the following alternatives in detail:

1. No Action Alternative (Status Quo)
2. Beach Fill with No Impact to Existing Hardbottom
3. Beach Fill to Restore the 1972 Beach and Dune
4. Beach Fill to Restore the 1972 Dune with a 35-ft Berm
5. Beach Fill to Restore the 1972 Dune with a 70-ft Berm
6. Beach Fill South Segment Only to Restore the 1972 Dune with a 35-ft Berm (Applicant's Preferred Alternative)
7. Beach and Dune Restoration with T-head Groins

The applicant described differences in design and resulting differences in levels of protection to development and in levels of erosion prevention. The alternatives considered in detail provided different recreational benefits and varying environmental impacts.

The range of alternatives includes the applicant's originally preferred alternative (Alternative 4) as presented in the DEIS and the applicant's currently preferred alternative (Alternative 6) as presented in this EIS and consistent with the applicant's January 5, 2012 letter to the USACE (see **Appendix F**: Pertinent Correspondence)[1].

The alternatives provided different recreational benefits and varying environmental impacts. Alternative 6 was shown to greatly decrease impacts to hardbottom habitat relative to the other alternatives, but also reduce storm protection in the proposed project north segment. However, modeling also showed that over time, dispersion of south segment beach fill increased the width of the north segment beach when the north beach had not received fill. Comparing performance of the applicant's originally proposed plan (Alternative 4) and applicant's preferred alternative (Alternative 6), after 10 years showed that Alternative 6 increases the north segment beach width to approximately ½ the width of the beach resulting from Alternative 4.

[1]In that letter, the applicant requested a preferred plan modification that deleted the project north segment. The USACE anticipates the northern segment could be deleted entirely as currently requested by the applicant, or constructed with dune only restoration above the mean high tide line and seasonal high water line using upland sourced sand. A dune-only restoration under those conditions would not require USACE authorization. The applicant intends, however, to avoid any project activity in the northern segment.

The applicant's preferred alternative as presented in the permit application consisted of beach fill and dune restoration in two segments within the project area and was identified as Alternative 4 in the DEIS The north segment extended from Florida Department of Environmental Protection (FDEP) reference monument R-87.7 to R-90.3. The southern segment extended from R-98 to the St. Lucie/Martin County line at R-115+1,000 ft. However, on January 5, 2012, the applicant submitted a letter to the USACE requesting deletion of the north project segment (R-87.7 to R-90.3) from the proposal in its entirety.

Beach and dune fill with T-Head groins met applicant objectives but at a much greater cost with greater impacts.

Quality and quantity of sand used to nourish or replenish the eroding shoreline provide key components of beach nourishment project performance (NOAA 2008b). During project planning, the applicant considered locating an affordable and high quality sand source among the most critical plan aspects. Project alternatives considered three possible sand sources: offshore borrow areas located within the St. Lucie Shoal in state waters, offshore sand sources located in federal waters, and upland sand sources. Based on the availability of high quality sand within state waters and the extended level of effort necessary to obtain leases to dredge in federal waters, the applicant elected to propose the use of the borrow area in state waters. The applicant may propose over the 50-year project life span to use offshore borrow areas located in federal waters since the amount of sediments required are not available within the proposed dredge area located in state waters. The USACE typically uses a 50-year project horizon for planning purposes.

The upland sand source alternative for the 485,900 cy of sand required for the applicant's preferred alternative did not receive detailed evaluation for the proposed project. The alternative was not viable since the duration to construct the project required at least four months, and delivery of 485,900 cy of sand would likely exceed the construction window which typically coincides with the non-turtle nesting season (November 30 thru May 1). The upland sand source could potentially cost considerably more than offshore hopper dredging. The upland sand source alternative was eliminated from detailed evaluation since it was not feasible; however, the applicant may utilize upland sources of sand for some portions of the project or if project costs are acceptable.

Applicant's Preferred Alternative. Alternative 6, Beach Fill South Segment Only to Restore the 1972 Dune with a 35-ft is the applicant's preferred alternative. This alternative restores the south project segment to the 1972 dune and beach with a 35-ft berm from an offshore sand source, addresses the local planning objectives, anticipates beach erosion losses, minimizes environmental impact, and considers the needs of the study area.

Alternative 6 describes construction of a protective and recreational beach along about 18,000 ft (3.4 mi) of Hutchinson Island from FDEP monument R-98 to the St.

Lucie/Martin County line at R-115+1,000 ft. The project beach includes a section of Coastal Barrier Resource System (CBRS) Unit P-11 from R-101.1 to R-101.3. The applicant included this CBRS beach segment because the FDEP has defined it as critically eroded.

The applicant's preferred alternative design includes dune restoration and beach fill. The dune has an added crest width of between about 9 ft and 67 ft (average about 38 ft) at a crest elevation of 12.5 ft NAVD88. The landward slope on the restored dune face lies at 3H:1V (where applicable); the same slope on the seaward face of the restored dune face extends seaward to elevation 5.35 ft NAVD (the restored dune toe). From the toe of the restored dune, the beach berm extends seaward 35 ft at a 100H:1V top slope with a 10H:1V slope on the seaward face to the existing grade. A seaward extension of about 25 ft of the beach berm, at a 100H:1V top slope and 10H:1V seaward face slope, provides "advance" fill to offset expected future erosion. Planting of salt-tolerant native dune vegetation on the restored dune crest to help stabilize the dune completes the design. In addition, extension of existing public beach access dune walkovers provides access to the restored beach.

Approximately 485,900 cy of fill with an average fill density of 30.5 cy/ft would be necessary to complete the applicant's proposed plan revision. The applicant has identified an area at the southeast end of St. Lucie Shoal, approximately three miles offshore in state waters, as the proposed borrow area. Seismic and core boring investigations indicate that this area contains quantities (about 1.3 million cy) of beach quality material. Projected (future) renourishment events would require about 177,000 cy of fill at approximately 10-year intervals. The borrow area currently identified for project use and additional areas further along St. Lucie Shoal in federal waters could provide sufficient sand for a 50-year project life.

Construction would occur between November 1 and April 30 to avoid impacts to nesting of marine turtles. Direct impacts of Alternative 6 would include 0.57 acre of hardbottom habitat. Temporary indirect impacts related to turbidity would include 1.0 acre of hardbottom habitat. To mitigate for direct impacts, the applicant would create approximately 0.78 acre of artificial reef comprised of limestone boulders placed in areas of suitable, relatively shallow (12 – 15 ft deep) nearshore waters north of the beach fill area. Suitable mitigation sites include areas with sand about 1.0- to 4.0-ft deep overlying hard substrate in areas devoid of hardbottom or cultural resources.

The applicant's January 5, 2012 proposed plan revision minimizes environmental impacts and meets the applicant's objectives of restoring a beach for storm protection and for recreational and environmental needs of the project area.

Issues Raised by the Public and Agencies. As requested by the USACE on April 21, 2010, the Federal Register published a Notice of Intent (NOI) to prepare the Draft EIS for the St. Lucie County South Beach and Dune Restoration Project located in St. Lucie County, Florida. The scoping period commenced upon posting in the Federal Register (page 20826**,** Federal Register/Vol. 75, No. 76/ Wednesday, April 21, 2010) and mailing

by letter the NOI to state and federal stakeholders and interested and affected parties. Taylor Engineering, Inc., a contractor to the USACE for this EIS, coordinated with stakeholders, concerned citizens, and federal, state, and local agencies. Summaries of issues of concern raised by respondents to the NOI and EIS scoping meetings held in May and June 2010 begin below. The scoping period ended June 20, 2010.

Comments from the public included suggestions that the EIS consider using artificial reefs or other structural alternatives for shore protection, consider using upland sources for beach material, and consider using local labor for the construction. Others expressed concern about the use of St. Lucie Shoal as a borrow area given potential adverse effects on the shoreline and sand compatibility issues. Others who supported the proposed project were concerned that ignoring erosion could lead to county-wide impacts. Public participants expressed concern for marine life, including marine turtles, fish, and worm reef populations. Finally, some suggested that the EIS consider alternatives offered as more cost-effective and permanent solutions to beach erosion.

The NOAA National Marine Fisheries Service Habitat Conservation Service (NMFS-HCD) representatives indicated that their concerns for the proposed project were similar to those they had described to Martin County and others proposing similar beach fill projects using offshore sand sources. Those concerns included the potential significant adverse impacts of excavation of offshore shoals on the wave climate on the adjacent beaches. They indicated that shoal excavation had the potential to impact living marine resources, in particular the relatively poorly understood fish communities and the uses those species likely make of the shoals. They asked questions about dredging construction methods and the uses of the shoals by various groups of animals. They suggested potential approaches to evaluating the hardbottom and hardbottom impacts and expressed concern that offshore borrow area excavations and placement of fill below mean high water could adversely affect hardbottom habitat, including corals and worm reefs colonized by *Phragmatopoma lapidosa.* They requested that the USACE continue to coordinate closely with them. They suggested that the USACE also review NMFS-HCD letters evaluating other proposed projects.

Meetings with representatives from state agencies provided suggestions to consider carefully beach fill on the project northern segment, as some participants believed that sand placed in that location would erode very rapidly and provide little storm protection benefit. In that case, nourishment of the northern section might prove difficult to justify, as a significant fraction of the hardbottom impacts occur in that area. Other participants suggested that more hardbottom than the applicant mapped actually occurred in the project area and that the loss of nearshore hardbottom habitat would constitute a significant concern. Participants suggested that monitoring efforts include the mixing zones. Others suggested that the EIS consider impacts of adjacent projects on the proposed project area. FWC suggested that from a nesting sea turtle perspective, beach design should include a more gradual slope.

Areas of Controversy. Interested agencies and other parties raised controversial issues during review of the Draft EIS and the related public comment meeting.

Controversial issues included the following: dredging offshore shoals, deflating the offshore shoal and potentially increasing indirect adverse effects on the shoreline by changing the wave climate, local controversy related to county resident funding sources, fisheries impacts, and the adverse effects associated with loss of nearshore hardbottom. The Final EIS will fully consider and address all relevant issues.

Unresolved Issues. The proposed project includes new construction, both in borrow and fill areas. The project design, the level of hardbottom impact created by project construction, the level (but not kind) of mitigation, use of the proposed offshore borrow area, and the impacts that offshore shoal dredging would create constitute the main unresolved issues for the proposed St. Lucie County South Beach and Dune Restoration Project. The project proposes very similar impacts to the previously authorized impacts associated with the adjacent Martin County Shore Protection Project. The predicted level of impacts and mitigation opportunities are relatively well understood, except for the effects of shoal dredging on offshore fish communities. The applicant has committed to avoiding and minimizing impacts where possible, and mitigating for unavoidable adverse effects created by project construction. The permit application indicated that physical, biological, and turbidity monitoring during all phases of project construction would protect resources within and adjacent to the fill and borrow areas. All these issues and solutions offered in the permit application are under consideration as part of this EIS process

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LIST OF ABBREVIATIONS

ADA	American with Disabilities Act
BOEM	Bureau of Ocean Energy Management
CBRA	Coastal Barrier Resources Act of 1982
CBRS	Coastal Barrier Resources System
CCSP	U.S. Climate Change Science Program
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
Coastal Tech	Coastal Technology Corporation
CPE	Coastal Planning and Engineering, Inc.
CSA	CSA International, Inc.
CWA	Clean Water Act
cm	cubic meters
cy	cubic yards
DA	Department of the Army
DEIS	Draft Environmental Impact Statement
DNRBS	Department of Natural Resources Beaches and Shores
E.O.	Executive Order
EAI	Ecological Associates, Inc.
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act of 1973
ETOF	Equilibrium Toe of Fill
F.A.C.	Florida Administrative Code
F.S.	Florida Statutes
FCMP	Florida Coastal Management Program
FDEP	Florida Department of Environmental Protection
FEIS	Final Environmental Impact Statement
FL	Florida
FMC	Fisheries Management Council
FMP	Fisheries Management Plan
FNAI	Florida Natural Areas Inventory
FPL	Florida Power and Light, Inc.
ft	foot or feet

LIST OF ABBREVIATIONS

FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GPS	Global Positioning System
HAPC	Habitat Area of Particular Concern
hp	horsepower
hr	hour
ICW	Intracoastal Waterway
INBS	Index Nesting Beach Survey
IPCC	Intergovernmental Panel on Climate Change
IPF	Impact Producing Factor
JCP	Joint Coastal Permit
kg	kilogram
LEDPA	Least Environmentally Damaging Practicable Alternative
m	meter
MBTA	Migratory Bird Treaty Act of 1918
Mcy	Million Cubic Yards
MHW	Mean High Water
MHWL	Mean High Water Line
mm	millimeters
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MSL	Mean Sea Level
NAVD	North American Vertical Datum 1988
NEPA	National Environmental Policy Act of 1969
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NTU	Nephelometric Turbidity Units
OCS	Outer Continental Shelf
PEP	Prefabricated Erosion Prevention
RBA	Regional Biological Assessment
RHA	Rivers and Harbors Act of 1899
SADRBO	South Atlantic Division Regional Biological Opinion
SAFMC	South Atlantic Fisheries Management Council
SHPO	State Historic Preservation Office(r)
SNBS	Statewide Nesting Beach Survey
U.S.C	United States Code
UMAM	Uniform Mitigation Assessment Methodology
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile Organic Compounds
WIS	Wave Information Study

FINAL ENVIRONMENTAL IMPACT STATEMENT
ON
ST. LUCIE COUNTY SOUTH BEACH AND
DUNE RESTORATION PROJECT
ST. LUCIE COUNTY, FLORIDA

1. PROJECT PURPOSE AND NEED

1.1. PROJECT PURPOSE

The U.S. Army Corps of Engineers (USACE) has prepared this Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, to evaluate environmental effects associated with a proposed beach nourishment project in St. Lucie County, Florida. The St. Lucie County Erosion District (the applicant), the local sponsor for the proposed project, is seeking federal authorization to construct the project. The project purpose is to stabilize and widen a segment of beach along South Hutchinson Island to provide additional storm protection for the adjacent upland developments. Meeting that purpose by offsetting the current sediment deficit would also increase wildlife habitat and recreational opportunities.

This local project involves federal action because the dredging and filling activities associated with beach nourishment require authorization through a U.S. Department of the Army (DA) permit under Section 404 of the Clean Water Act (CWA) (33 U.S.C. 1251 et seq.) and Section 10 of the Rivers and Harbors Act (RHA). The USACE determined that the scope of the St. Lucie County South Beach and Dune Restoration project and cumulative impacts of beach nourishment could significantly affect the quality of the human environment, and that the CWA Section 404 and RHA Section 10 authorizations constitute a major federal action. Based on these determinations, an environmental impact statement is required pursuant to (1) Section 102(2)(c) of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), (2) the Council on Environmental Quality guidelines on preparing environmental impact statements (EISs) (40 CFR 1502.4 et seq.), (3) USACE Engineering Regulation 200-2-2, “Environmental Quality: Policy and Procedures for Implementing NEPA,” and (4) Section 404 of the CWA of 1972 on permitting disposal sites for dredged or fill material (33 U.S.C. 1344), as amended.

The USACE is currently developing a Feasibility Study for a federal project overlapping part or all of the proposed project area. While the currently proposed project considers activity only in state waters, the permit application also indicates that in future projects, the applicant may mine beach quality sand from the Outer Continental Shelf (OCS), which comprises federal waters under Bureau of Ocean Energy Management (BOEM) jurisdiction. Under the Outer Continental Shelf (OCS) Lands Act, the BOEM has jurisdiction over mineral resources in the OCS. As a Federal agency, BOEM also is required to evaluate the environmental effects of the Federal actions in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended; to evaluate the effects of the proposed action on any federally listed threatened or endangered species

or its designated critical habitat under the Endangered Species Act (ESA); and to consult with the NMFS on all actions that may have a substantial effect on Essential Fish Habitat (EFH) or species managed under the Magnuson-Stevens Fishery and Conservation Management Act (MSFCMA). To minimize duplication of efforts, BOEM has agreed to be a cooperating agency for this EIS. BOEM may incorporate the EIS information in whole or in part to satisfy its obligations under NEPA for OCS activities under its jurisdiction. Additionally, this FEIS may be incorporated in whole or in part into the Feasibility Study for the federal project. For this EIS and the associated DA permit reviews, the USACE serves as the lead federal agency.

1.2. PROJECT NEED

The proposed beach nourishment project would restore a protective beach lost to historical and ongoing erosion. St. Lucie County beaches south of Fort Pierce Inlet have sustained long-term erosion due to the downdrift effects of the inlet, which has intercepted sand and deprived sand from the beaches south of the inlet. In addition, damaging storms have exacerbated the inlet's effects and caused significant sand losses along county beaches since at least 1972. Net erosion rates of 13.1 feet per year (ft/yr) (Coastal Tech 2009: Attachment P Conditions Assessment Report), long-term erosion, hurricanes, and emergency fill efforts have left numerous buildings with minimal dune protection (**Figure 1.2-1**).

The Florida Department of Environmental Protection (FDEP) has classified much of the south St. Lucie County Atlantic shoreline as “critically eroded areas” where erosion threatens development interests (FDEP 2010). The proposed project includes only areas so identified by FDEP and avoids those areas not so identified. The federal government has also recognized portions of St. Lucie County as severely eroded. Congressional Resolution Dockets 2757 (July 23, 1998) and 2634 (April 11, 2000) authorized the USACE to study St. Lucie County beaches. The USACE completed the authorized reconnaissance level (Section 905(b)) report for the St. Lucie County beaches from FDEP reference monument R-77 to the St. Lucie/Martin County line in November 2002.

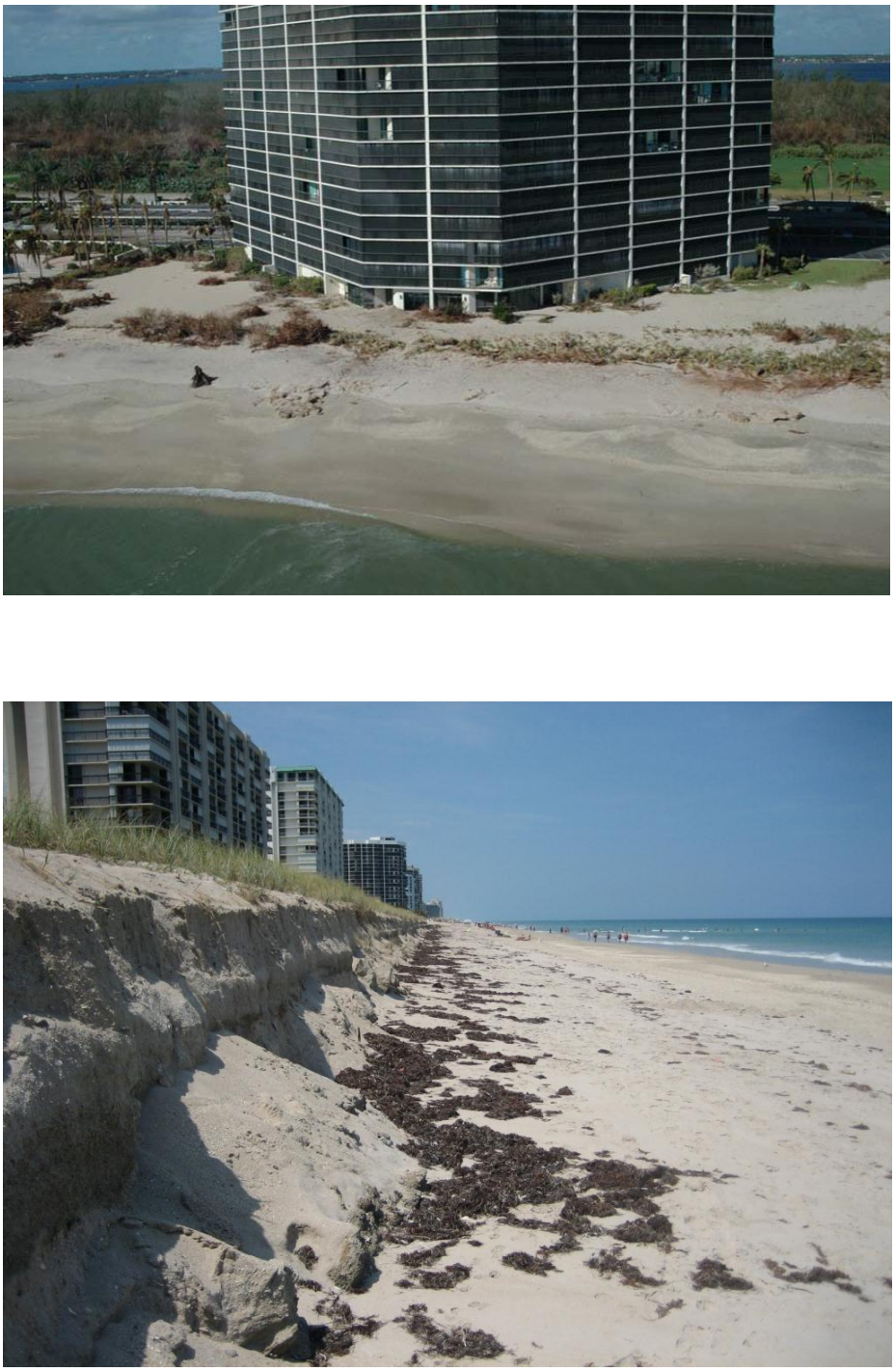

Figure 1.2-1. Post-hurricane storm damage and escarpments, south Hutchinson Island, St. Lucie County, Florida.
Top: from FDEP (2004). Bottom: (personal communication, Applicant's consultant,; March 2011)

The USACE is currently developing a Feasibility Study for a federal project overlapping part or all of the proposed project area. Construction of a federal project would occur only after completion of a Feasibility Study, congressional authorization with approval of the study, and federal appropriations. Given the eroded condition of St. Lucie County beaches, the value of properties at risk, the decline of recreation values, and the uncertainty of securing federal appropriations, the applicant decided to pursue a locally sponsored beach nourishment project. Goals of the proposed project include shoreline restoration and storm protection and restoration of the recreational beach and its associated natural habitats.

1.3. PROJECT LOCATION

St. Lucie County is located on Florida's east coast about 100 miles north of Miami and 25 miles east of Lake Okeechobee. The project area extends along 3.8 miles of barrier island shoreline on South Hutchinson Island in southern St. Lucie County. A network of FDEP survey monuments (R-monuments) identifies coastal locations, including the project area shoreline, along St. Lucie County beaches. The beach project construction area recognized in this EIS as the applicant's preferred alternative extends from R-98 south to R-115+1,000 ft (St. Lucie/Martin County line). The proposed project does not include the beach between R-90.3 and R-98, part of the Coastal Barrier Resources System (CBRS Unit P-11) and not defined by FDEP as critically eroded. **Figure 1.3-1** depicts the project evaluation areas. The applicant's preferred alternative as expressed in the initial permit application package submitted to the USACE also included a north segment extending between R-87.7 and R-90.3. In a January 5, 2012 letter to the USACE the applicant revised its preferred alternative to eliminate that segment. Other alternatives considered in detail still include this northern segment.

The applicant's preferred offshore borrow area (**Figures 1.3-1** and **2.1-1**) lies in approximately 40 ft of water on the southern portion of St. Lucie Shoal in state waters less than three nautical miles offshore. The borrow site comprises the landward terminus of the St. Lucie Shoal, which extends north-northeast from that location. The borrow area contains approximately 1.3 million cubic yards (Mcy) of beach compatible material, assuming a maximum depth of cut no deeper than -49 ft NAVD and no dredging within a proposed "refuge patch", the highest elevation of the shoal in the general borrow area.

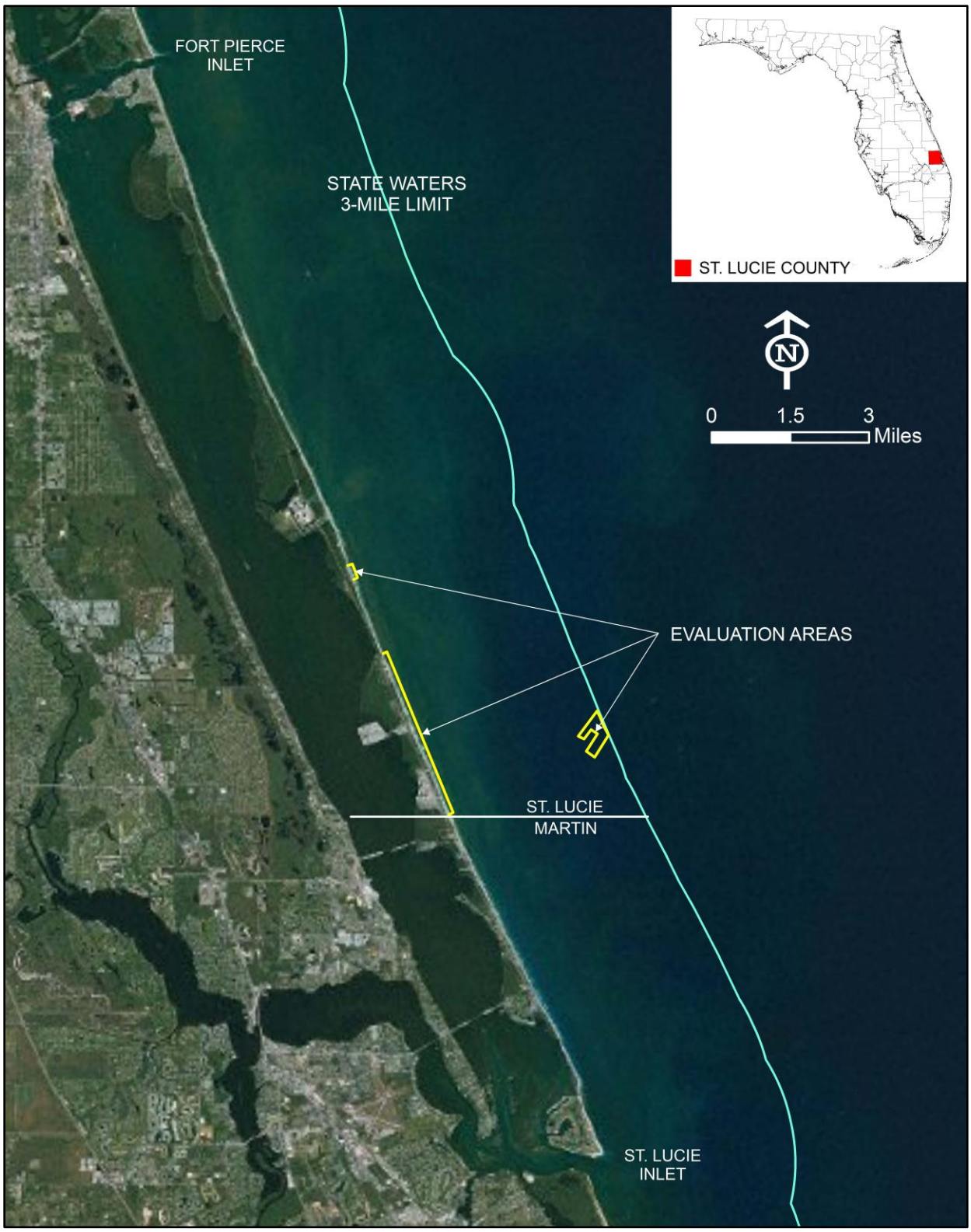

Figure 1.3-1. Project Location, St. Lucie County South Beach and Dune Restoration Project, St. Lucie County, Florida

1.4. ORGANIZATION OF THE DOCUMENT

The content and organization of this EIS for the St. Lucie County South Beach and Dune Restoration Project follows NEPA requirements. The document includes the following sections:

Summary
1.0 Project Purpose and Need
2.0 Alternatives
3.0 Affected Environment
4.0 Environmental Effects
5.0 List of Preparers and Reviewers
References
Appendices

Various appendices (see enclosed CD) supplement the main text. Appendices include:

APPENDIX A STAKEHOLDER LIST, PUBLIC INPUT SUMMARIES AND PUBLIC SCOPING MEETING REPORT

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APPENDIX T COASTAL ZONE MANAGEMENT CONSISTENCY DETERMINATION

1.5. AGENCY GOAL OR OBJECTIVE FOR THIS EIS

The objectives of this EIS are to

- Evaluate the existing environmental and socioeconomic conditions and potential future impacts associated with shoreline restoration in south St. Lucie County. The applicant's proposal is being evaluated for DA authorization under Section 404 and Section 10 of the Rivers and Harbors Act of 1899.
- Describe and assess alternatives to the proposed beach nourishment project in the project area

1.6. DECISIONS TO BE MADE

The USACE will use the information compiled in this EIS to determine whether it should authorize CWA permits for the purpose of a single shoreline stabilization project in south St. Lucie County. Chapter 2 presents the alternatives under consideration. These alternatives include the No Action Alternative (i.e., no federal permits issued and no changes to the shoreline's current condition) and six shoreline restoration alternatives.

1.7. APPLICANT GOAL OR OBJECTIVE

The permit application for the proposed project identifies the following goals and objectives for the South St. Lucie County Beach and Dune Restoration Project:

- Offset historical erosion through beach and dune restoration
- Increase the storm protection function of the beach to protect upland property and infrastructure
- Restore important coastal habitat for wildlife such as sea turtles and shorebirds
- Maintain the recreational capacity of the beach for the public and for commerce

1.8. RELATED ENVIRONMENTAL DOCUMENTS

The EIS reviews and considers numerous reports, technical documents, and studies about the project and project area. The following documents, not cited elsewhere, provided important information related to this EIS.

Gilmore, R.G., Jr. 2008. *Regional Fishery Resource Survey and Synthesis in Support of Martin County's Comprehensive Beach and Offshore Monitoring Program.* Final Report Prepared for Martin County Engineering Department Coastal Engineering Division, Stuart, Florida 34996. Prepared by R.G. Gilmore, Jr., Ph.D., Senior Scientist, Estuarine, Coastal and Ocean Sciences, Vero Beach, Florida 32968. December 2008.

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U.S. Fish and Wildlife Service (USFWS). 2005. *Biological Opinion: Martin County Shore Protection Project*. South Florida Ecological Services Office, Vero Beach, Florida. January 5, 2005. Service Log No: 4-1-05-F-10476.

URS. 2007. *Florida Central Atlantic Coast Reconnaissance Offshore Sand Search (Ross).* Prepared for Florida Department of Environmental Protection Bureau of Beaches and Coastal Systems. 3900 Commonwealth Boulevard, Tallahassee, Florida 32399. October 29, 2007. URS Project Number 12804709.00000.

1.9. SCOPING AND ISSUES

1.9.1. INTRODUCTION

The applicant has developed a long record of public involvement concerning proposed beach nourishment activities in south St. Lucie County. The local public has some familiarity with such involvement, and the applicant has used that knowledge in developing public understanding and interest in the proposed project. The applicant has other ongoing beach nourishment projects north of the proposed project area, and adjacent counties have a relatively long history of beach nourishment projects over a large portion of the last decade. The applicant has provided significant public access for comment and conceptual input to the south county beach nourishment project. Earlier activities included presentations at regular public meetings and special charettes held by the applicant. The applicant and its consultants developed pre-application meetings with state and federal regulatory agencies. Most recently, the applicant hosted the USACE scoping meetings for this EIS.

1.9.2. COORDINATION PRIOR TO PUBLICATION OF A NOTICE OF INTENT (NOI) FOR THIS EIS

Since 2006, the applicant has held a series of public information meetings and presentations at regularly scheduled board meetings regarding the proposed project. The county has provided presentations and encouraged discussions at those meetings, to develop public understanding of the scope and status of the proposed project. The applicant advertises that all board meetings that are open to the public.

The applicant held two planning charettes that provided for public input on the conceptual plan. Those meetings and two pre-application meetings comprised major activities of the public input process. **Appendix A** includes summary documentation from the public charettes conducted by the applicant in 2007 and 2009.

An NOI (Notice of Intent) to prepare the EIS appeared in the Federal Register on April 21, 2010. In addition, the NOI was mailed to interested and affected parties by letter dated April 27, 2010. **Appendix A** provides a copy of the scoping letter, NOI, and comments received as part of the scoping process.

Prior to submitting permit applications, the applicant solicited public input to help develop the preferred alternative. The applicant conducted two public meetings and met with representatives of state and federal agencies (**Table 1.9-1**). Certain elements of the applicant's preferred alternative incorporate recommendations from those agencies to facilitate review and approval.

Table 1.9-1. Coordination Meetings Held with Federal and State Regulatory Agencies and with the Public

Date/Location	Agency/Entity and Name(s)	
April 30, 2007 St. Lucie County Planning Charette	Private Citizens: St. Lucie County: Coastal Tech:	150 – 200 (approximate attendance count) Richard Bouchard Michael Walther Walker Dawson
Regulatory Preapplication Meeting May 29, 2007 USACE Palm Beach Gardens Regulatory Office	USACE: NMFS: EPA: St. Lucie County: Coastal Tech:	Penny Cutt Jocelyn Karazsia Audra Livergood (by phone) Tori Foster Richard Bouchard Walker Dawson, Kim Colstad Michael Walthers, Lois Edwards (by phone), and Peter Ravella (by phone)
Regulatory Preapplication Meeting February 7, 2008 Teleconference	FDEP: St. Lucie County: Presidents' Council S. Hutchinson Island: Coastal Tech:	Mike Barnett, Marty Seeling, Ralph Clark, Jennifer Koch, Caitlin Lustic, Becky Prado, and Brian Taylor Richard Bouchard Pat Pacitti Michael Walther, Dilip Barua, Leighann Leanne Budde, Kim Colstad, Walker Dawson, and Lois Edwards
April 29, 2009 St. Lucie County Planning Charette	Private Citizens: St. Lucie County: Coastal Tech:	50 – 150 (approximate attendance count) Richard Bouchard Don West Michael Walthers Walker Dawson

1.9.3. EIS PUBLIC INVOLVEMENT

One of the basic tenets of NEPA is that the public and agency officials should receive and comment on comprehensive project information packages before federal agencies make decisions and take actions. In addition, NEPA gives all persons, organizations, and government agencies the right to comment on proposed federal actions that an EIS

evaluates. Early identification of issues and potential impacts is critical in order to provide the public with the comprehensive information it needs to comment effectively.

Two information dissemination processes are essential to ensure the public has sufficient access and input to project information: Publication of a NOI and a scoping process. In accordance with federal regulations, the federal agency that makes the decision to prepare an EIS must, in a timely manner, initiate a scoping process for the EIS and publish a NOI in the federal register. A NOI to prepare an EIS on the St. Lucie County South Beach and Dune Restoration Project appeared in the Federal Register on April 21, 2010. The NOI was widely distributed. The NOI advised the public of the project background, the project purpose, the alternatives that were under consideration, and major issues associated with the project. The NOI also advised the public of the scoping process and invited all parties to participate in the process by identifying any additional concerns, studies needed, alternatives, procedures, and other matters related to the scope of the EIS.

NEPA requires in 40 Code of Federal Regulations (CFR) 1501.7 "… an early and open process for determining the scope of issues to be addressed and for identifying significant issues related to the proposed action." This process, known as the scoping process, must occur before an EIS is prepared. In order to ensure that everyone is heard and that open communication occurs, the USACE holds a *"Public Scoping Meeting*". The USACE uses scoping to ensure that the EIS addresses the concerns of both the public and other governmental agencies. **Appendix A** of this EIS provides the summary report for the EIS scoping process.

As indicated above, the public has provided numerous comments concerning the project at various opportunities provided by the applicant and USACE between 2007 and 2009. The USACE conducted a public scoping meeting on May 19, 2010. Comments consistently ranged from unqualified support for the project to expressed concerns over any beach nourishment activity. The applicant and USACE have received a variety of comments with a wide range of specific concerns including the following:

- Protection of the CBRS units in the general project area by omitting so-designated areas from the project
- Repair and replacement of dunes and dune vegetation damaged by erosion
- Impacts to nesting turtles and shorebirds that use the beach
- Concerns with burial of benthic invertebrates on the beach during the nourishment and impacts to benthic invertebrates living in the offshore shoal areas used as a sand source for the nourishment
- Disturbance to fishes living in the nearshore environments (and those that recreational fishermen try to catch) and fishes using the offshore shoals
- Impacts to benthic, hardbottom, and water column habitats in both the nearshore and offshore project areas. These issues included concerns related to effects of physical alterations of offshore shoals recommended by the applicant as a sand source.
- Long-term implications of repeated nourishments

- Impacts to fishing, diving, surfing, and general water recreation from the placement of sand on the beach
- Desire for additional hard structure to protect the beach (e.g., pep reefs, groins, etc.)
- Sand quality of the sand sources
- The use of local labor and local upland sand to support the county economy rather than the use of imported labor and materials
- The cost to be charged by the applicant to individual property owners to fund the nourishment project.

The applicant developed the permit application in consideration of the input provided between 2007 and 2009 (personal communication, applicant, St. Lucie County coastal engineer; May 2010). Changes made by the USACE in response to comments received during the scoping process included:

- Added analysis of upland sand sources and sand sources in federal waters
- Added project design alternatives associated with the northern project segment (FDEP monument R-87.7 to R-90.3), the use of structures (breakwaters and T-head groins) with and without sand fill. Two of the additional alternatives merited detailed evaluation.

1.9.4. STAKEHOLDER / EIS RECIPIENT LIST

Appendix A provides the list of those people and organizations identified by the USACE as stakeholders or potential stakeholders and those individuals or organizations requesting involvement in the EIS process through submittal of comments or requests for EIS documents. The USACE will continue to add new names to the list as necessary or requested until completion of the Record of Decision.

1.9.5. COMMENTS RECEIVED AND RESPONSES

The USACE mailed copies of the DEIS with a public meeting announcement and published the Notice of Availability (NOA) on June 3, 2011, to start a 45-day comment period on the DEIS. In addition to the NOA and mailings, the USACE provided copies of the DEIS to three St. Lucie County libraries for public viewing.

- Ft. Pierce Branch Library 101 Melody Lane, Fort Pierce
- Lakewood Park Branch Library 7605 Santa Barbara Drive, Fort Pierce
- St. Lucie West Library J Building, 500 N.W. California Blvd., Port St. Lucie

A copy was also available at the USACE Palm Beach Gardens Regulatory Office, 4400 PGA Boulevard, Suite 500 Palm Beach Gardens. The applicant provided a copy for viewing at its government offices, St. Lucie County Administration Building, 2300 Virginia Ave., Fort Pierce, FL 34982.

Public comment meeting advertisements were placed in the St. Lucie News Tribune, a local St. Lucie County newspaper, two weeks and one week prior to the meeting. The public meeting was held on the evening of Wednesday, June 29 2011 at the St. Lucie

County Commission chambers. **Appendix B** provides a report documenting the public comment period process and a summary of the public comment meeting. The public comment period ended July 18, 2011.

During the public comment period, the USACE received numerous written comments concerning the information in the DEIS. **Appendix C** provides the comments and USACE responses to those comments. Where appropriate, the comment responses are incorporated into the EIS.

1.9.6. ISSUES EVALUATED IN DETAIL

The following issues identified during the EIS scoping period and by the preparers of this Environmental Impact Statement received evaluation:

- Vegetation
- Threatened and Endangered Species
- Hardbottom
- Fish and Wildlife Resources
- Essential Fish Habitat
- Offshore Borrow Area Resources
- Coastal Barrier Resources
- Water Quality
- Hazardous, Toxic, and Radioactive Waste
- Air Quality
- Noise
- Aesthetic Resources
- Recreation Resources
- Navigation
- Historic Properties
- Socioeconomics
- Native Americans
- Drinking Water
- Scientific Resources

1.9.7. IMPACT MEASUREMENT

The following provides the means and rationale for measurement and comparison of impacts of the proposed action and alternatives. Section 4.0 Environmental Effects specifically investigates impact measurement and comparison.

1.9.7.1. Hardbottom Impacts

Impacts to hardbottom and reef habitat can be predicted based upon proximity, currents, nature of borrow material, buffer zones and other factors. Alternatives will be reviewed based on their quantitative impacts to hardbottom habitats.

1.9.7.2. Sea Turtles.

Continued beach erosion would reduce available nesting habitat. Impacts to nearshore hardbottom would reduce available foraging habitat. Offshore dredging activities could entrain and kill swimming sea turtles, and vessels involved in the project may collide with turtles, injuring or killing them. The project alternatives have been reviewed to evaluate the potential effects on endangered and threatened sea turtles. Protective and mitigative protocols have been established with the goal of minimization of impacts to sea turtles and compliance with the requirements of the Endangered Species Act.

1.10. PERMITS, LICENSES, AND ENTITLEMENTS

From the State of Florida, any selected build alternative would require a joint coastal permit (JCP) and authorization to use sovereign submerged lands as well as a DA authorization for the proposed dredging and filling. The BOEM may require a lease if dredging occurs on the OCS, which begins three nautical miles from shore.

A JCP application was prepared and submitted to the FDEP and USACE in September 2009. A complete copy of the permit application file is available for download at the following website: http://bcs.dep.state.fl.us/env-prmt/st_lucie/pending/.

1.11. MAJOR DIFFERENCES BETWEEN THE DEIS AND FEIS

The FEIS differs from the DEIS in several important ways. The DEIS disclosed the project purpose and need, a range of reasonable alternatives, and identified and evaluated the anticipated effects of each alternative. The DEIS was based on project design and environmental information provided by the applicant and information obtained during the scoping process and feedback from stakeholders. The FEIS provides additional requested information, project designs modifications, additional relevant data, and further refinement and discussion of environmental effects recently identified or not considered at the time of the DEIS. Revisions to the text included the following:

- Revision of the applicant's preferred alternative
- Additional detail on construction methods (Section 2.1.1.1)
- Addition of best management practices discussion (Section 2.1.1.1)
- Addition of discussion of the endangered beach jacquemontia (*Jacquemontia reclinata*) in Sections 3 and 4
- Use of the most recent (October 2010) aerial photography to map nearshore hardbottom habitat. The more recent data changed the amount of hardbottom habitat and the amount of hardbottom habitat impacted by the various alternatives. The changes occur in appropriate sections of the text as well as in **Appendix M**, where DEIS 2008 hardbottom maps and FEIS 2010 hardbottom maps may be viewed.
- Changes to impact and mitigation calculations due to the change in hardbottom map information. Those changed values are provided in Table 2.6-2, Estimated Impact and Mitigation Acres for Each Alternative Evaluated in Detail.

- Evaluation of wave climate modeling provided by the applicant to assess the potential effects of offshore shoal dredging on the wave climate in the nearshore area. The analysis (with supporting documents provided in **Appendix Q**) found that the offshore dredging would not significantly impact the nearshore wave climate.
- Inclusion of additional appendices to provide readily available information pertinent to the EIS analyses.

In a letter dated January 5, 2012 (see **Appendix F**), the applicant reduced the scope of its preferred alternative in response to comments received during this evaluation. The applicant modified its preferred alternative to delete the northern segment FDEP (from FDEP Monument R-87 to R-90.3). The applicant retained the southern segment, R-98 to R-1115+1,000 ft and the project cross section design. The removal of the northern project segment resulted in a substantial reduction in the amount of hardbottom habitat impacted by the project and the corresponding amount of compensatory mitigation. The applicant's alteration of its proposed project resulted in a project plan equivalent in hardbottom impact and compensatory mitigation to Alternative 6 "South Segment Beach and Dune Restoration; North Segment Dune Restoration Only" discussed in the DEIS.

2. ALTERNATIVES

The Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA), Title 40 of the *Code of Federal Regulations,* Parts 1500–1508, state that alternatives are the heart of the environmental impact statement (EIS). Title 33 of the *Code of Federal Regulations,* Part 325, Appendix B, sets forth the NEPA implementing procedures for the USACE regulatory program. CEQ and USACE regulations require that the Federal decision maker perform the following tasks:

- Assess and objectively evaluate all reasonable alternatives. For alternatives that were eliminated from the detailed study, briefly discuss the reasons for their elimination.

- Disclose the potential environmental consequences of each alternative, including the No Action Alternative and the applicants' preferred alternative so that reviewers may evaluate their comparative merits.

These regulations require that all reasonable, feasible, prudent, and practicable alternatives that might accomplish the objectives of a proposed project be identified and evaluated. Therefore, in compliance with NEPA, the USACE independently identifies, reviews, and analyzes those alternatives that could achieve the purpose and need for the project. An EIS is not a USACE regulatory decision document. It is used by agency officials, in conjunction with other relevant information in a permit application file, including public and agency comments on the final EIS, to inform the final decision on a permit application.

Only reasonable alternatives need be considered in detail, as specified in Title 40 of the *Code of Federal Regulations,* Section 1502.14(a). Reasonable alternatives are those that are feasible; such feasibility must focus on the accomplishment of the purpose and need that would be satisfied by the proposed Federal action (permit issuance). Those alternatives that are unavailable to the applicants (such as mining outside the State of Florida), whether or not they require Federal action (permits), should normally be included in the analysis of the No Action (permit denial) Alternative. Such alternatives should be evaluated only to the extent necessary to allow a complete and objective evaluation of the public interest and a fully informed decision regarding the permit application.

This chapter describes the USACE's process of identifying and evaluating alternatives for meeting the established purpose and need for the proposed project, which, as discussed in Chapter 1, is to stabilize and widen a segment of beach along South Hutchinson Island to provide additional storm protection for the adjacent upland developments.

2.1. DESCRIPTION OF ALTERNATIVES EVALUATED IN DETAIL

This EIS considers seven one time, single and complete project alternatives in detail:

1. No Action Alternative (Status Quo)
2. Beach Fill with No Impact to Existing Hardbottom
3. Beach Fill to Restore the 1972 Beach and Dune
4. Beach Fill to Restore the 1972 Dune with a 35-ft Berm
5. Beach Fill to Restore the 1972 Dune with a 70-ft Berm
6. Beach Fill South Segment Only to Restore the 1972 Dune with a 35-ft Berm (Applicant's Preferred alternative)
7. Beach and Dune Restoration with T-head Groins

For the purposes of this EIS, a 50-year project horizon provides the basis for consideration of cumulative effects. However, any future projects proposed for this site would require new permit applications.

Appendices D and **E** provide plan and cross section views of each alternative considered in this EIS. The following subsections describe the general construction process and each of the alternatives.

2.1.1. GENERAL DESCRIPTION OF PROJECT CONSTRUCTION

For any alternative including beach fill, potential sand sources include offshore dredging and upland mines. If an offshore sand source provides the fill, project construction includes three activity phases: dredging, conveyance and pumping of dredged material from the hopper dredge to the beach, and fill grading on the beach. If upland mines provide the fill, truck transport of sand to the beach fill site replaces the dredging and conveyance phase of the offshore sand source alternative. All alternatives considered that include beach and dune construction would use the same construction methods. Sand Source Alternatives (**Section 2.1.9.**) provides detailed descriptions of proposed offshore sand source and upland sand source alternatives. The construction description below focuses on the use of an offshore sand source and the construction activities associated with the dredging and handling of dredged sand.

2.1.1.1 Construction Using Offshore Sand Source

<u>Dredging</u>

A hopper dredge comprises a self-propelled floating plant capable of dredging material from the ocean bottom, storing it on board, transporting it to a disposal point, and dumping or pumping it to the disposal site. Ocean-going hopper dredges are typically large vessels (>200 ft in length) capable of storing 2,000 cy or more of sediment in their holds. These vessels typically operate on a 24-hours/day, 7-days/week schedule with a crew of several dozen. Workboats transport workers, required materials, and supplies to and from the hopper dredge.

During dredging operations, hopper dredges travel at a ground speed of 2 to 3 mph. They can dredge in depths up to about 80 ft and come equipped with twin propellers and twin rudders as well as bow and stern thrusters to provide the required maneuverability. Precise vessel location and elevation are provided by a Real-time Kinematic (RTK) Global Positioning System (GPS) hardware/software system that ensures proper elevation and location control of the dredging activity.

Hopper dredges in operation drag one or more suction heads along the bottom within the dredging template. As the material discharges into the ship hold (hopper), sand material falls out of suspension and the excess water flows overboard by gravity or is discharged overboard using a pump. When full, the hopper dredge moves to a location offshore of the beach disposal area and pump the stored sand onto the beach through a submerged pipeline (subline) lying on the nearshore ocean bottom and emerging on the beach. Hopper dredges always locate outside hardbottom areas to avoid any impacts to that habitat.

A 2,000 cy capacity dredge would require 243 loads to complete the applicant's preferred alternative. An approximate five-hour round trip cycle time from borrow area to discharge point and back allows dredging, transit, dredged material offload, and return to the dredging location. This schedule would allow approximately four trips per day. Note that actual construction values may vary from these estimates.

Conveyance and Pumping

Transfer of the dredged sand to the beach occurs through a subline located along each of five pipeline corridor locations noted below by the FDEP R-Monument. For a project as long as this (up to 3.4 mi) with several "no-impact" access points through the nearshore hardbottom zone, the subline location may likely move several times as the work progresses along the beach. This method reduces the required total length of shore-parallel discharge pipeline, lowers equipment costs, and makes pumping the sediment easier because the pipelines along the beach are shorter. The number of workdays associated with each subline location represents a likely distribution of effort along the project beach for the applicant's preferred alternative.

- R-100 – Approximately 14 work days
- R-104 – Approximately 11 work days
- R-108 – Approximately 15 work days
- R-114 – Approximately 16 work days

Subline construction occurs by connecting multiple sections of pipe with bolt-on, watertight collars. When the sub-line reaches the desired length, the pipe ends are sealed and the pipe is pressurized to test for leaks. If no leaks are detected, the pipe is floated into place and sunk by allowing water into the pipe.

Prior to placement of a sub-line, a survey of the 50-ft wide pipeline corridor would locate any natural resources. Avoidance and minimization measures, such as relocating the

pipeline to an area devoid of hardbottom would be required. If impacts are unavoidable, compensatory mitigation may be required. When hardbottom is present within the pipeline corridor, several actions can avoid and minimize impacts from the pipeline and develop an accurate record of any unavoidable impacts. These actions include:

- Video survey of bottom conditions within the authorized pipeline corridor before pipeline placement.
- Alignment of the pipeline on the surface followed by pipe flooding allows visual verification of the general orientation of the pipeline. The pipe sinks to the bottom in the desired location. Floating the pipe into place avoids impacts associated with dragging the pipeline over hardbottom.
- In areas of hardbottom, the pipeline can be equipped with collars or other similar types of "stand-off" devices to minimize impacts to hardbottom.
- Daily monitoring to record and verify pipeline location in corridors containing hardbottom

Pipeline anchoring is not anticipated since the pipeline mass should be sufficiently negatively buoyant to keep it in place on the ocean bottom.

A buoy attached to the seaward end of the pipeline allows the hopper dredge to easily locate and connect to the pipeline. Once the pipeline is connected to the hopper dredge, the hopper contents would be pumped through the subline to the beach placement area.

Beach Construction

Mechanized equipment grades the discharged sand to the permitted cross section templates. Multiple pieces of heavy equipment are required to perform the necessary grading. When necessary, use of a front-end loader with a rake bucket or similar attachment could be used to help connect additional sections of beach pipeline to allow construction to progress down the beach. In addition to this equipment, a few all-terrain vehicles and one or two pickup trucks provide the typical equipment set associated with a beach construction crew. Typically, beach nourishment activities require a construction shed on a skid, a temporary restroom facility, and double-walled fuel tanks. Operation and construction may include two crews with multiple staging areas, which may be used simultaneously as a cost-savings measure.

Dredge pipeline placed shore parallel along the beach normally extends about half of the way between pipeline corridors to the north and south, a maximum of about 3,000 ft, based on proposed and biologically surveyed corridors. As the sand pile grows around the pipe end, earthmoving equipment continually grade the sand into the desired template. When the area around the pipe end has received enough sand, the pipe is shortened or lengthened to nourish additional beach areas. Typically, booster pumps are not employed to extend the beach pipeline beyond the capacity of the hopper dredge to pump the sand. When the extended (or shortened) pipeline can no longer reach additional areas effectively, the dredger would cease the pumping operation by pumping water through the pipeline until no sand remains in the pipeline. At that time,

the dredger would force air through the pipeline to float it and move the floating pipe to the new location. After completing any necessary lengthening or shortening, pipeline placement as described above would occur at the new location. After satisfactory placement, dredging would commence.

On the beach, construction of shore-parallel dikes several hundred feet long provide a settling basin for the sand to fall out of the sand slurry. This technique reduces turbidity of the discharge water to acceptable levels and minimizes water quality impacts. Earthmoving equipment continually maintains these dikes and moves sand from the settling area into the beach template, maintaining the settling basin while shaping the beach template Maintaining the settling area helps maintain water quality (i.e., turbidity) within permitted limits by providing an area of attenuation of the pumped sand/water slurry and subsequent fill accumulation through sedimentation.

Nighttime work would require the use of lights both on the mechanized machinery, and on the beach work areas. Lighting plans would include consideration of adjacent properties. Lighting plans would include limitations on wattage, orientation, and extent of lighting appurtenances. Plans for beach lighting would be required to meet the terms and conditions of the USFWS Statewide Programmatic Biological Opinion on nesting sea turtles dated August 2011, or other guidance from USFWS, whichever is more restrictive.

If sand from upland mines provides the beach nourishment material for any build alternative, in-water activity related to dredge pipelines and pipelines along the beach would not occur. Trucks filled at the sand mine would traverse the beach and deposit sand at the necessary location where bulldozers would shape the sand to fill the permitted template. The fill template may include filling below the mean high water line depending upon the selected alternative.

Planting of salt tolerant native dune vegetation on the restored dune crest to help stabilize the dune completes the design. Extension of existing public beach access dune walkovers will provide access to the restored beach.

2.1.1.2. Construction Best Management Practices

Best management practices (BMPs) include methods designed to avoid and minimize environmental impacts before, during, and after construction. Not all BMPs apply to every project, but the project designers and contractors should consider applying all reasonable BMPs. Typically, beach nourishment projects in Florida using sand dredged from offshore include water quality monitoring plans, biological monitoring plans, and a construction window to minimize seasonal impacts to sea turtle nesting.

Some aspects of hopper dredge operation, such as the use of wildlife observers and turtle deflectors are generally included in environmental permit conditions. Potential hopper dredge operation BMPs are very dependent on the available equipment, weather conditions, and dredge site characteristics (depth, wave energy, etc.).

Design BMPs for Offshore Shoal Dredging

- Configure the shoal's dredge design template to limit radical changes in bottom topography. Allow dredging a larger area of the shoals downdrift/landward slope to maximize the distribution of sediment removal from a larger area. The borrow area long axis would be parallel to the length of the shoal. Dredging should not occur across the entire width of the shoal.
- Maintain a refuge patch at the highest shoal elevations to help minimize the impacts to the shoal habitat.
- Dredge on the downdrift/landward side of the shoal.
- Excavate only to the elevation of the surrounding ocean floor elevations.

Operational BMPs for Hopper Dredges

Nearshore

- Locate pipeline corridors to avoid and minimize impacts to hardbottom
    - The applicant has selected pipeline corridors that avoid and minimize impacts to hardbottom habitat. The applicant has also recognized a 50 ft pipeline corridor width that the applicant conservatively assumes would sustain impacts from pipeline placement, 2-3 week residence, and removal. Where hardbottom exists within 100 ft of the pipeline, daily monitoring of the pipeline using DGPS to track pipeline movements would allow relatively complete characterization of pipeline impacts. Detection of a leak would require
        - Immediate cessation of pumping
        - Notification of the project owner, the USACE, and FDEP
        - Assessment and reporting of any impacts to hardbottom, consultation with requlatory agencies concerning impacts and necessary mitigation
        - Repair of the leak prior to resuming pumping activity
- Use pipeline collars in corridors including hardbottom habitat
    - The construction plan provided by the applicant includes the use of pipeline collars to minimize contact between the pipeline and hardbottom habitat.
- Locate the sub-line to avoid hardbottom impacts from the hopper dredge.
    - The sub-line end should lie at least 500 ft seaward of the nearest hardbottom habitat.
- Establish vessel ingress and egress corridors
    - For this project, the hopper dredge should approach the sub-line location on a shore-perpendicular path for at least the last 1,000 ft of the travel path. This would minimize the likelihood of vessel impact to hardbottom due to movement of vessels to and from a site during coastal construction, and while pumping out the sand. The hopper dredge should not travel landward of the sub-line end when approaching or leaving the sub-line connection location.
- Use of manatee signage/observer

Offshore

- Use of marine turtle deflectors/marine turtle trawling (required during all hopper dredge activities). The hopper dredge for this project will use a turtle deflector to deflect sea turtles in or near the path of the draghead during dredging activities and prevent sea turtle mortality.
- Use of manatee signage/observer

The hopper dredge operator has some options to minimize impacts during dredging operations.

- Eliminate or reduce hopper overflow. Eliminating or reducing hopper overflow reduces the volume of fine material that flows from the hopper in the overflow. Note that this control may significantly reduce hopper dredge production and greatly increase project costs. Unless the fine material in the overflow exceeds permitted water quality standards, the hopper dredge operator would probably not consider the use of this method.
- Lower hopper fill level. Lowering the hopper fill level in rough sea conditions can prevent material loss during transport. Implementation of this BMP is an option that the hopper dredge operator should use as necessary to operate safely and economically in rough seas.
- Implement a recirculation system. Re-circulating water from the hopper overflow to the draghead can reduce water discharged from the hopper. However, this idea requires additional research before wide-scale implementation is likely http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/MICCI_6_BMP_Manual.pdf).
- Use an integrated GPS system
    - Use of integrated GPS systems to monitor dredge position and cutterhead location allows more accurate dredge operations, and allows calculation of dredge production status. The specifications for the construction should include this BMP, as the dredger is typically required to maintain dredging within the specified borrow area boundaries and report the record of his dredge head to verify that the dredging occurred only within the specified borrow area.
- Use floating towlines. Floating towlines avoid impacts from lines dragging along the bottom and intersecting benthic resources. Lines primarily for attaching the sub-line buoy and may be used and would locate at least 500 ft from the nearest hardbottom.

2.1.2. NO ACTION ALTERNATIVE (STATUS QUO)

The No Action alternative would not require DA authorization, but potentially could include construction activities that may protect the dune and upland development. USACE would not regulate construction occurring in areas landward of mean high water and the seasonal high tide line. However, the activities would be limited to dune restoration or other construction activities located wholly in uplands. The construction activities related to this alternative could include upland retaining walls, shoreline armoring, or other structures or work in uplands. Upland sand mines would likely

generate sand for dune restoration and no hopper dredging would occur. The No Action alternative would not include any work, fill, structures, or dredging in any Waters of the United States. The alternative would stabilize the dune area and provide limited storm protection to upland development. Upland development would likely remain vulnerable to storm damage, the recreational capacity of the beach would remain in its natural state, and nesting sea turtle habitat would be subject to the natural waxing and waning fluctuations in the volumetric quantity of sand within the existing beach profile.

2.1.3. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

The construction profile for this alternative comprises a dune restoration with an additional average crest width of about 23 ft (width range 0 to 52 ft, location dependent) at an elevation of +12.5 ft NAVD, a landward slope on the restored dune face of 3H:1V (where applicable), and a seaward dune face slope of 3H:1V to approximately +7.5 ft NAVD. From the toe of the restored dune, the fill would slope seaward to the existing grade at 10H:1V. Based on an August 2008 survey, the intersection of the constructed dune and surveyed surface ranges from +8 to +14 ft NAVD. The design also includes a 1,000-ft template tapered back to the R-monument line at the beginning and end of the north and south project sections. Planting of salt-tolerant native dune vegetation on the restored dune crest would support long-term maintenance of the dune. This alternative would not affect hardbottom within the equilibrium toe of fill (ETOF). However, using an offshore sand source may result in 0.1 acre of hardbottom impact within the pipeline corridor. **Appendix D** provides plan and cross section views of this design alternative.

The Beach Fill with No Impact to Existing Hardbottom yields only a minimal fill project with a very low fill density (8.1 cy/ft) and a total volume of 162,174 cy. The relatively low density and total volume of this alternative would likely allow trucking the sand (a “truck haul” project) as an alternative to the use of the St. Lucie Shoal offshore borrow area. Using an upland sand source would avoid all pipeline corridor impacts to hardbottom.

Based on the best professional judgment provided by the applicant, the life expectancy of this alternative should fall within the range of two to four years.

2.1.4. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

The construction template for this alternative comprises a dune restoration with an added average crest width of about 30 ft (range 9 to 52 ft, location dependent) at an elevation of +12.5 ft NAVD, a landward slope on the restored dune face of 3H:1V (where appropriate), and a seaward restored dune face slope of 3H:1V to approximately +7.5 ft NAVD. From that point seaward, the fill slopes at 10H:1V to the sediment interface. The design also includes a 1,000-ft template tapered back to the R-monument line at the beginning and end of the north and south project sections. Planting of salt-tolerant native dune vegetation on the restored dune crest would support long-term maintenance of the dune. Direct nearshore hardbottom impacts associated with this alternative would total 0.77 acre (0.67 acre within the ETOF and 0.10 acre within the pipeline corridor). In addition, elevated turbidity during construction may temporarily impact up to 9.83 acres of nearshore hardbottom within the beach

placement mixing zone. **Appendix D** provides plan and cross section views of the design alternative.

The Beach Fill to Restore the 1972 Beach and Dune alternative yields a project with a very low fill density (10.5 cy/ft) and a total fill volume of 209,249 cy. This alternative might allow construction using an upland sand source and truck haul to supply the sand as an alternative to the St. Lucie Shoal offshore borrow area. Using and upland sand source would avoid hardbottom impacts within the pipeline corridor, but create the same impacts by burial of hardbottom as when using an offshore sand source.

Based on the best professional judgment provided by the applicant, the life expectancy of this alternative should fall within the range of two to four years.

2.1.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM

This beach and dune restoration project alternative consists of a dune restoration with an added average crest width of about 38 ft (range 59-67 ft) at an elevation of +12.5 ft NAVD. The landward slope on the restored dune face lies at 3H:1V (where applicable); the same slope on the seaward face of the restored dune face extends seaward to elevation +5.35 ft NAVD (the restored dune toe). The beach berm extends 35 ft seaward from the toe of the restored dune at a 100H:1V top slope and ties to the existing grade with a 10H:1V seaward face slope. A seaward extension of about 25 ft of the beach berm at the same 100H:1V top slope and 10H:1V seaward face slope provides “advance” fill to offset expected future erosion.

This alternative would require approximate 610,000 cy of fill with an average fill density of 30.5 cy/ft. An offshore sand source would provide the most likely means of sand supply for this alternative.

Direct nearshore hardbottom impacts associated with this alternative would total 2.73 acres (2.63 acres within the ETOF and 0.10 acre within the pipeline corridor). Direct hardbottom impacts within the ETOF would occur primarily in the northern segment of the project area (R-87.7 to R-90.3). In addition, elevated turbidity during construction may temporarily impact up to 10.85 acres of nearshore hardbottom within the beach placement mixing zone. **Appendix D** provides plan and cross section views of the design alternative.

Life expectancy calculations provided by the applicant suggest that the initial advanced nourishment fill should last approximately 10 years. Renourishment should occur every 10 years to maintain the project throughout the 50-year project life. The USACE typically uses a 50-year project horizon for planning purposes.

2.1.6. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

This beach and dune restoration project alternative consists of a dune restoration with an added average crest width of about 33 ft (range 59-67 ft) at an elevation of +12.5 ft NAVD. The landward slope on the restored dune face lies at 3H:1V (where applicable); the same slope on the seaward face of the restored dune face extends seaward to

elevation +5.35 ft NAVD (the restored dune toe). The beach berm extends 70 ft seaward from the toe of the restored dune at a 100H:1V top slope and ties in to the existing grade with a 10H:1V seaward face slope. A seaward extension of about 25 ft of the beach berm at the same 100H:1V top slope and 10H:1V seaward face slope provides "advance" fill to offset expected future erosion. Planting of salt-tolerant native dune vegetation on the restored dune crest to help stabilize the dune completes the design. In addition, extension of existing public beach access dune cross-overs would provide access to the restored beach. Direct nearshore hardbottom impacts associated with this alternative would total 3.48 acres (3.38 acres within the ETOF and 0.10 acre within the pipeline corridor). Direct hardbottom impacts within the ETOF would occur primarily in the northern segment of the project area (R-87.7 to R-90.3). In addition, elevated turbidity during construction may temporarily impact up to 11.03 acres of nearshore hardbottom within the beach placement mixing zone. **Appendix D** provides plan and cross section views of this design alternative.

The Beach Fill to Restore the 1972 Dune with a 70-ft Berm alternative would require approximately 899,600 cy and entail an average fill density of approximately 44.9 cy/ft.

Life expectancy calculations provided by the applicant suggest that the initial advanced nourishment fill should last approximately 10 years. Renourishment should occur every 10 years to maintain the project throughout the 50-year project life.

2.1.7. BEACH FILL SOUTH SEGMENT ONLY TO RESTORE THE 1972 DUNE WITH A 35-FT BERM (APPLICANT'S PREFERRED ALTERNATIVE)

This alternative excludes beach fill from the north segment and conforms to the applicant's January 5, 2012 plan revision (that eliminates the project north segment in terms of expected impacts and federal authority). While this EIS includes dune restoration in the south segment as part of Alternative 6, dune restoration above the mean high water line would not be subject to federal regulatory authority under the Clean Water Act and Rivers and Harbors Act.

The north segment of the project beach area, that this alternative eliminates, consists of a relatively short beach length (R-87.7 to R-90.3; ~2,600 ft) separated from the larger south segment by approximately 7,700 ft. The south segment extends from R-98 to R115+1,000 (about 18,000 ft). The short north segment is anticipated to erode at a higher rate than the south segment. Accordingly, a thorough evaluation of project performance must compare alternatives with beach fill and without beach fill in the north segment. **Appendix E** provides a detailed comparison of changes in project beach widths over time with and without beach fill in the north segment.

The applicant used the "Department of Natural Resources Beaches and Shores Model" (DNRBS Model) to assess erosion behavior of the north and the south project segments. This allowed analysis of the short and long-term effect of filling or not filling the north segment beach. If filled, the short length of the north segment and large adjacent gap without beach fill would cause the north segment beach fill to experience much more rapid erosion following project construction than the south segment (between R-98 and R-115+1,000) with the same fill design. Results for modeling

erosion of the "Beach Fill with 35' Berm" alternative (**Appendix E: Figure 2.1**) demonstrate the more rapid erosion of the 1-year shoreline in the north segment as compared to the south segment. The 10-year shoreline position in the north segment extends seaward about one half as far (10 ft less) of the shoreline width of the north segment constructed with a 35 ft berm.

By comparison, DNRBS modeling of the "Beach Fill South Segment Only to Restore the 1972 Dune with a 35-ft Berm" alternative shows that the northern segment features minimal additional berm width for the 1-yr shoreline and approximately 10 ft of additional berm width for the 10-yr shoreline (**Appendix E: Figure 2.4**). This results from dispersion of material from the south segment to the north (as well as south) following project construction. Over time, the north segment shoreline width slowly increases as the south shoreline width decreases. Ten years post-construction, the north segment beach has about half the beach width it would have had if construct same construction cross section as Alternative 4 (compare **Appendix E: Figures 2.1** and **2.4**).

The Beach Fill South Segment Only to Restore the 1972 Dune with a 35-ft Berm alternative eliminates hardbottom impacts from the north segment template. Direct nearshore hardbottom impacts within the south segment would total 0.57 acre (0.55 acre with the ETOF and 0.02 acre within the pipeline corridor). In addition, elevated turbidity during construction may temporarily impact up to 1.00 acre of nearshore hardbottom within the beach placement mixing zone.

The Beach Fill South Segment Only to Restore the 1972 Dune with a 35-ft Berm alternative provides a reduced level of protection on the north segment beach compared to the alternatives that include beach fill within the north segment. However, DNRBS modeling results predict that over time, the north segment beach width increases due to dispersion of sand from the south segment of the project. The gradual increase in beach width over time provides an increasing level of protection along the north segment. However, by the tenth year, the north segment beach width extends only about ½ the distance seaward seen in the beach profile associated with Alternative 4 (**Appendix E: Figures 2.1 and 2.4**). The extent of nearshore hardbottom adjacent to the north segment provides some storm protection through attenuation and dissipation of wave energy.

Life expectancy calculations provided by the applicant suggest that the initial advanced nourishment fill along the south segment should last approximately 10 years. Renourishment along the south segment should occur every 10 years to maintain the project throughout the 50-year project life. Based on best professional judgment, the life expectancy of the north segment (dune only) should fall within the range of two to four years.

2.1.8. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

During the scoping process for this EIS, regulatory agency staffs identified two alternatives that included beach fill with either breakwaters or groins. The potential benefit of structures in addition to beach fill focused on longer retention of the beach fill.

Unlike beach nourishment, hard structures do not add sand to the littoral system. Any sand accumulated by a hard structure such as a breakwater or groin results in erosion at another (typically downdrift) location. Exceptions to this generalization include structures located on the downdrift sides of inlets or significant natural promontory features. These locations form semi-contained littoral cells that generally isolate themselves from other larger littoral system cells. In these areas, the use of structures with additional fill often provides a cost-effective means to maintain a beach without the offset erosive consequence described above. The use of hard structures in the middle of a long littoral system generally does not result in net benefits equal to or greater than those of sand placement alone. However, structures in combination with nourishment could provide a means to achieve project objectives. This EIS considers two hard structure alternatives: breakwaters and T-head groins, each with beach nourishment. Consideration of beach nourishment with breakwaters led to a decision that the beach nourishment with breakwaters alternative should not receive detailed evaluation (see **Section 2.4.12.** below).

T-head groin structures consist of a shore-perpendicular structure (e.g., groin) with a shore-parallel breakwater at the seaward end. Many projects feature multiple T-head groins located along the shoreline. T-head groins offer benefits over traditional groins (those without shore parallel “heads”). T-head groins require a shorter shore-perpendicular length to hold the same shoreline position (Hanson and Kraus 2001) and the shorter length requires less armor stone (rock). Having a shorter shore-perpendicular length, the structures reduce potential hardbottom impacts. Additionally, the “head” section at the seaward end of the groin can significantly reduce offshore losses of sand. Optimization of the head section to match the predominant incident wave angle can improve project performance — shoreline stabilization and fill retention (Bodge 1998). Concerns over recreational activities near the T-head structures and aesthetics can counter the benefits of increased shore stabilization and beach fill retention. Some groups have suggested that T-head structures, like breakwaters, also cause detrimental impacts to marine turtles.

T-head groins with beach fill to “pre-fill” the compartments between the groins provide a viable coastal engineering solution to counter certain erosive conditions. These conditions typically locate downdrift of existing coastal structures or in areas that feature a sediment transport reversal or deceleration in transport volume. For “open coast” areas with generally uniform sediment transport (such as the proposed project beach), a T-head groin system would likely cause accretion on the updrift side and erosion on the downdrift side. As the structures themselves do not add any sediment to the system, any accretion (volume gain) caused by the structures must induce an equal amount of erosion (volume loss) at another location. In effect, T-heads groins would be anticipated to translate the erosion problem further downdrift. However, in many cases, periodic renourishment and modification of the structure’s design can mitigate for the downdrift erosion.

Specific to the south St. Lucie County project, T-head groins with beach fill could meet the project goals to increase storm protection, restore important coastal habitat for wildlife, and maintain recreational capacity of the beach. However, T-head groins could shift erosion to adjacent downdrift locations, negatively affect recreational activity on the

beach, and reduce access to nesting and recently hatched sea turtles. The T-head groin footprint would directly affect approximately 0.05 acre of hardbottom (personal communication, Applicant's consultant, October 2010). Similar impacts and benefits of a groin field would associate with each of the proposed dune and beach template. The groin design would scale to the desired beach width.

The applicant provided an analysis of a T-head groin alternative associated with the 35-ft berm design for general understanding of this alternative. A T-head groin design, similar to the T-head groins under consideration by the applicant for shoreline immediately south of Ft. Pierce Inlet (Olsen Associates 2009), provided the basis for consideration of this alternative. The groins, sized from empirical methods (Bodge 1998), were designed to maintain the design mean high water line (MHWL) for the equilibrated beach fill design.

Each of the T-head groins would have the following characteristics:

- Shore normal length of 275 ft extending from approximately 50 ft landward of the existing +3.0 ft NAVD contour to about 190 ft seaward of the design MHWL
- Crest elevation of +3.0 ft NAVD
- A seaward slope of 3H:1V from +3.0 ft NAVD out to a depth of approximately -5 ft NAVD
- Alongshore spacing of 200 ft (between the ends of the T-Heads)
- A "head" extending about 205 ft shore-parallel

Beach nourishment would accompany groin construction. Assuming that the groin system would apply to the applicant's preferred beach fill alternative (1972 dune with 35-ft berm), the required fill template and volumes would not change.

Direct nearshore hardbottom impacts associated with this alternative would total 2.93 acres (2.83 acres within the ETOF and 0.10 acre within the pipeline corridor). In addition, elevated turbidity during construction may temporarily impact up to 10.85 acres of nearshore hardbottom within the beach placement mixing zone.

The proposed project area could require as many as 25 groins with an estimated total cost of $14.2M (Coastal Tech 2010a). These costs, added to the beach fill cost estimate ($8.85M excluding hardbottom mitigation), would result in a project cost of $23.05M and an increased mitigation cost proportional to the increase in area of impact.

When groins perform as designed, they capture sand and increase erosion of the downdrift beach by preventing an equivalent volume of captured sand from moving into the downdrift beach. Beach fill is therefore necessary to offset the predicted volume of sand the groins would capture. The fill would replace the sand that the T-head groins would otherwise capture, eliminating the downdrift losses. During storms, groins could retain sand in the project area, but the volume of sand retained would likely erode downdrift beaches. Thus, presence of groins in the project area could require periodic fill of downstream beaches to offset this effect.

Florida Administrative Code (F.A.C.) identifies the conditions for state acceptance of structures such as groins or breakwaters. FDEP rules [62B-41.005(5), F.A.C.] prescribe that

> *Structures which interfere with the natural longshore and onshore/offshore movement of sediments shall not be allowed unless a net positive benefit to the coastal system can reasonably be expected to occur and mitigation is provided for any adverse impacts which may occur to the coastal system.*

Based on these rules, FDEP permits for groins require mitigation in the form of fill placement on the downdrift beaches to offset the sand they trap. FDEP rules assume that groins would not decrease beach nourishment requirements as any volume of trapped sand would cause a disruption of downdrift sand movement, leading to erosion of downdrift beaches. This would require mitigation by placement of an equivalent volume of sand. The proposed project locates along a stretch of beach between St. Lucie Inlet in Martin County and Ft. Pierce Inlet in St. Lucie County. Typically, groins are appropriate beach stabilization measures within areas of accelerated erosion, also called a “hot spots”, or along the end of a segment of beach near an inlet or other feature where a shift in dynamic coastal processes occur. Groins affect the sediment budget and natural littoral sand transfer by redistributing the sand within the system. Groins would typically interrupt the longshore sand movement and entrain sediments as the means of maintaining beach width. Sand is trapped in the updrift and groin area, and consequently the downdrift beach typically receives less sand since the groins have interrupted the natural transport. The Martin County Shore Protection Project is abutting and immediately downdrift of the applicant’s proposed project. Placement of groins immediately updrift of the Martin County Shore Protection Projection could increase erosion rates within that project area and decrease the lifespan of that project.

2.1.9. SAND SOURCE ALTERNATIVES

As part of the initial USACE permit application for the proposed project, the applicant presented two sand source alternatives. The first alternative (the applicant’s preferred alternative) comprises a borrow area located approximately three miles offshore in state waters (**Figure 1.3-1**). Seismic and core boring investigations have indicated that this area contains about 1.3 Mcy of beach quality sand. The site would provide more than sufficient sand for any of the proposed alternatives. The EIS scoping process identified two additional sources: upland sand sources from sand mines within the region, and an offshore source from a location in federal waters offshore of St. Lucie County. The second source, the borrow area currently proposed by the USACE for use in the Martin County Shore Protection Project, is the subject of a Supplemental Environmental Impact Statement for that federal project.

The applicant foresees the continued use of offshore sand shoals as a viable source of beach quality sand, but the quantity of sand needed in the long-term time horizon would likely require an expansion of dredging into federal waters. The applicant analyzed available sand quality data for St. Lucie Shoal and concluded that the shoal held sufficient sand for renourishment over the 50-year project horizon. The applicant has

estimated that renourishment would require 177,000 cy of sand about every ten years (see Coastal Tech (2009) and Taylor Engineering (2009) for a description of offshore sand sources in the St. Lucie County's offshore waters).

2.1.9.1. Sand Quality

Beach placement material must comply with the "sand rule" specified in Florida Administrative Code, Rule 62B-41.007(2)(j) and summarized in **Table 2.1-1**. These broad characteristics apply to all beaches in Florida. In addition, sand used for beach placement material must closely resemble the "native" sand (that exists now or at some time past when sand quality was first characterized) for biological, physical, and aesthetical purposes; these conditions may give rise to more stringent quality limits than those shown in **Table 2.1-1**. Offshore sources must meet these standards, as material processing to alter sand quality is not cost-effective. Upland mines often have the capability to process their material to meet a given set of standards. No additional standards exist for qualifying upland sand source material (as compared to other sources) for beach fill use (Taylor Engineering 2007).

Table 2.1-1. Florida Administrative Code Characteristics of Sand Placed on Beaches

Sand Source Sediment Characteristic	**Absolute Limits for Placement on Florida Beaches**
Composite grain size	Particle size distribution ranging between 0.062mm (4.0f) and 4.76mm (-2.25f) (classified as sand by either the Unified Soils or the Wentworth classification) similar in … grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the material in the existing coastal system at the disposal site
Composite Munsell color	Similar in color
Silt content (passing through sieve #230)	No more than 5% by weight in composite
Gravel content (passing through sieve #4)	No more than 5% by weight in composite
Coarse gravel (retained on ¾" sieve)	None in any sample greater than found on the native beach
Construction debris, toxic material, foreign matter	None in any sample
Material resulting in beach cementation	None in any sample

2.1.9.2. Sand Sources in State Waters

The applicant (Coastal Tech 2009: Design Document) proposed the extreme south end of the St. Lucie Shoals, located in state waters approximately 3 nautical miles offshore

the project beach (**Figure 1.3-1** and **Figure 2.1-1**), as a source of sand for the nourishment. The applicant selected the site based on geotechnical investigations reported in Coastal Planning & Engineering (2006). The selected area contains about 1.3 Mcy of beach compatible material, available by dredging to a maximum depth of about 10 ft below the existing surface. The dredging design includes initial cut areas expected to provide sufficient sand (485,900 cy for the applicant's revised plan). Volume estimates (Coastal Tech 2009: Design Document) included the FDEP-required 2-ft buffer at the bottom of the dredge cut and buffers around magnetic anomalies.

Best management design components for dredging include dredging no deeper than 10 feet, which would bring the bottom of the borrow area to about the same elevation as the surrounding benthic plain. The applicant has developed a plan that avoids disturbing the highest elevations of the shoal adjacent to the borrow area, and has reserved the top of the shoal as a refuge area (Figure 2.1-1) as recommended by Diaz et al. (2003) and CSA International et al. (2009a) to retain undisturbed areas for shoal fauna. Other best management practices include dredging first at locations farthest away from the highest elevations to avoid disturbance of higher shoal areas and maximize dredging in areas farthest down the slope of the shoal.

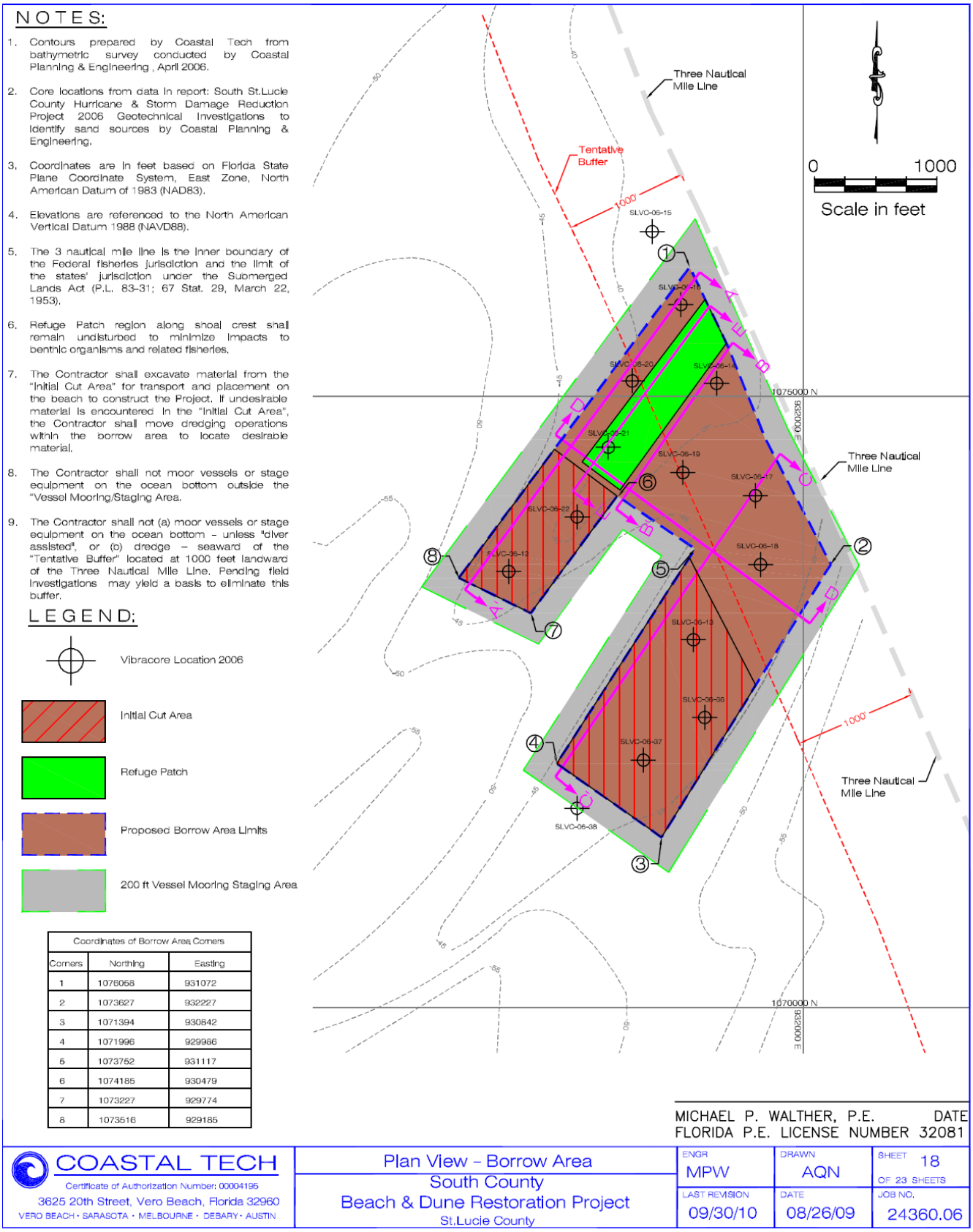

Figure 2.1-1. Proposed Borrow Area within State Waters, St. Lucie County South Beach and Dune Restoration Project. From Coastal Tech 2009: Design Document.

The existing project beach sand has a composite mean grain size of 0.49 mm. The composite of sand sampled from the proposed borrow area has a mean grain-size of 0.43 mm. The initial cut area sand samples showed a composite grain size of 0.42 mm and a median of 0.36 mm. The well-sorted borrow area sand contains <1% shell and 1.6% fines. These characteristics meet state standards for beach sand.

Should the sand quality require dredging of additional areas, the plan would require that dredging begin in areas farthest from the highest elevations. The dredging design avoids and preserves the highest areas of the shoal to retain refuge areas for shoal fauna, as recommended by Diaz et al. (2003) and CSA International Inc. et al. (2009a).

2.1.9.3. Sand Sources in Federal Waters

Atlantic Ocean waters under sole jurisdiction of the federal government begin 3 nautical miles off the coast of Florida (and extend seaward 12 nautical miles from the Atlantic Coast shoreline). Taylor Engineering (2009) detailed available sand resources in this region of the Atlantic Ocean off Florida south of Cape Canaveral (off the shores of Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward, and Miami-Dade counties). The applicant has identified 51 Mcy of potential sand in borrow areas located in the St. Lucie Shoal, also in federal waters (**Figure 2.1-2**), but proposes to use the very southwest end of the St. Lucie Shoal, located in state waters, for the proposed project. The applicant is considering sources in federal waters for the 50-year project life. Coastal Tech (2009: Design Document) estimated a project renourishment interval of about 10 years for a project requiring 177,000 cy.

Access to resources in federal waters requires a lease with the BOEM. The USACE has requested BOEM (and BOEM as agreed) to act as a cooperating agency for the St. Lucie County South Beach and Dune Restoration Project EIS (**Appendix F**). With BOEM as a cooperating agency for this EIS, in the future, the applicant should experience a streamlined lease process if it elects to access sand resources in federal waters. However, as the applicant can begin the federal lease process only after publication of the Record of Decision for the EIS, acquisition of a federal lease would significantly delay the project. Project delay could result in loss of grant monies that would make the project financially possible. The applicant therefore intends to use sand from state waters for the currently proposed project. Future beach restoration for a 50-year project could use sand from federal waters.

2.1.9.4. Upland Sand Sources

Upland sand sources have provided sand for beach nourishment projects in Florida for over a decade. Upland sand may provide a cost-effective alternative to offshore dredging, particularly for small projects (less than 50,000 cy) (USACE 2001) and have recently provided the primary source for larger projects in Indian River County and Brevard County. As offshore sand resources along the east coast of Florida start to dwindle, upland sources appear increasingly attractive (Taylor Engineering 2009). Taylor Engineering (2007) explored the possible use of upland sand mines for beach nourishment projects in St. Lucie County.

Beach restoration projects using upland sand have shown mixed results. A 2004 project constructed in St. Lucie County after Hurricanes Jeanne and Francis used upland sand

with inappropriate chemical and physical characteristics. The material became a consolidated, lithified layer of sand and coquina rock. The applicant removed the material shortly after installation since it did not meet the criteria for beach quality sand. The work was, however, not regulated by USACE since it was located landward of the mean high water line and seasonal high tide line. In this case, unwashed sand could have accounted for the observed chemical processes that occurred. By contrast, Indian River County has under DA authorization successfully nourished its beaches with washed upland sand. As a result, FDEP has recommended that upland suppliers wash all sand used in beach projects (Taylor Engineering 2007).

Mining operations in Florida utilizing upland borrow sources may produce sand by crushing limestone rock. The resultant material would be inappropriate for use as beach fill because its angular grains tend to compact over time and limestone (at whatever size) does not comprise a significant component of Florida beaches (USACE 2001). In this document, “sand from upland mines” refers to natural, non-manufactured sand that arrives at the beach in dump trucks. However, the mine may have to wash and grade the sand in order to create beach quality sand from the raw material.

Although the applicant views the offshore sand in state waters as the preferred source for the proposed project, maintaining the option of upland sand use would allow the greatest flexibility in project planning. Understanding the effect of upland sand use on project execution, and comparing the project impacts of upland versus offshore sand source use provides a means to assess the overall potential for upland sand source use as part of the South St. Lucie South Beach and Dune Restoration Project.

2.1.9.4(a). Upland Sand Source Locations

Taylor Engineering (2007) identified 14 upland sand sources within 150 miles of the project location in south St. Lucie County (**Table 2.1-2** and **Figure 2.1-3**). The applicant currently contracts with three firms using three of the mines (**Table 2.1-2**: Stewart, Fischer 86th and Ranch Road Mines) that can provide acceptable beach-quality sand for the St. Lucie County South Beach and Dune Restoration Project (personal communication, Applicant’s consultant, November 2010). Before tapping any source, the applicant must submit laboratory reports to FDEP documenting the sand quality and additional documentation to detail available volumes of acceptable quality sand.

2.1.9.4(b). Sand Purchase and Delivery

The applicant has awarded contracts in the past for the supply, transport, and placement of upland sourced sand compatible with the beach environment for emergency beach and dune restoration following storms. These occurrences are typically smaller in scale when compared to a beach nourishment project, and are commonly performed when upland infrastructure such as roads or utility lines are in imminent threat of failure due to erosion. For a beach project, the applicant might contract with a transport company partnering with a mechanized construction contractor. As part of the contract, the applicant would request a supply of beach quality sand material meeting specific grain size and physical property characteristics.

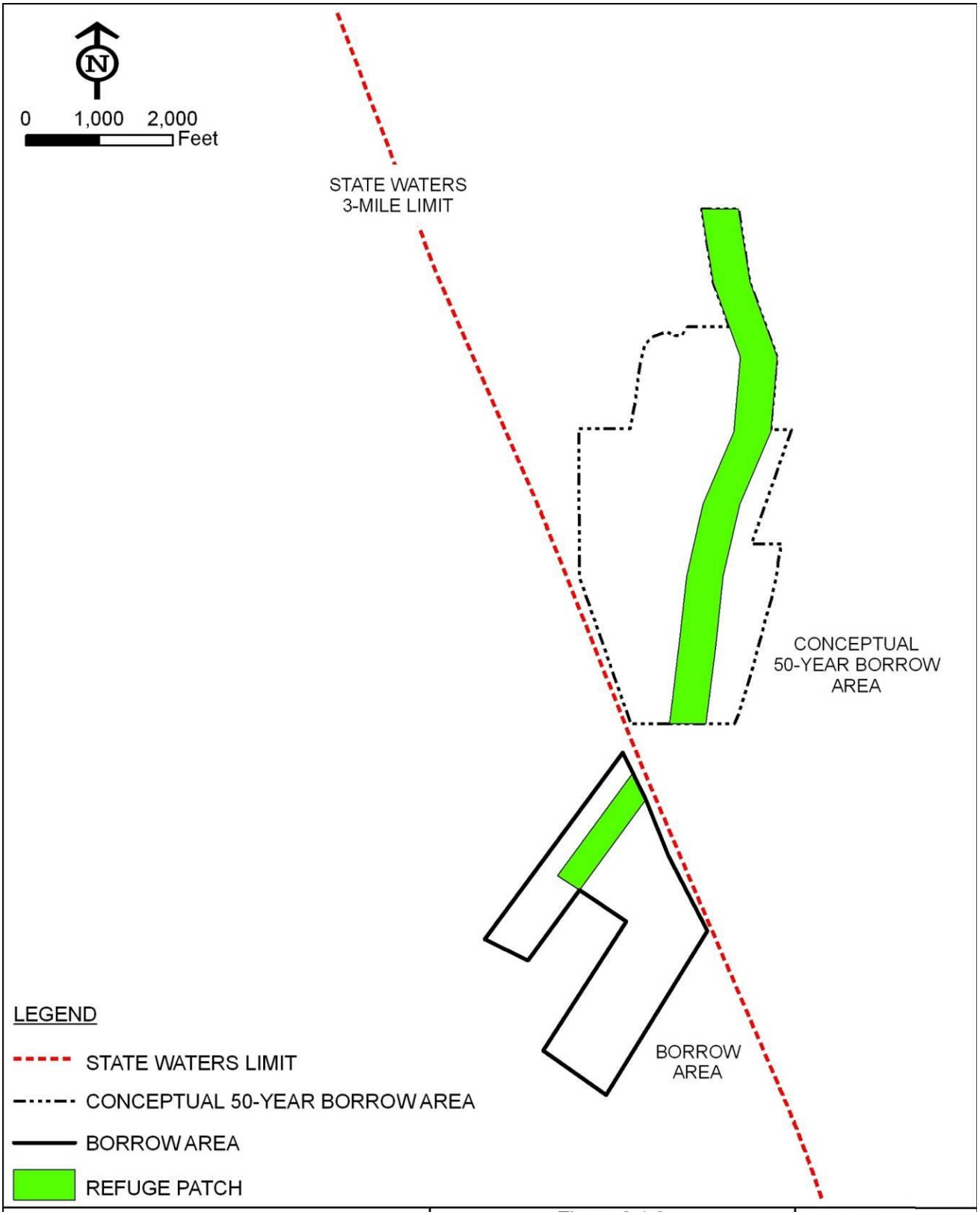

Figure 2.1-2. Offshore Borrow Area and Conceptual 50-year Borrow Area, St. Lucie County South Beach and Dune Restoration Project

Figure 2.1-3. Upland Sand Mine Locations, St. Lucie County South Beach and Dune Restoration Project

Table 2.1-2. Upland Sand Sources

Mine	Address	City	Zip	County	Distance from Project (Est. Miles)	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
Palm City Sand	1790 SW Poma Drive	Palm City	34990	Martin	15	27.1735	-80.248
Indiantown	West Farms Road	Indiantown	34956	Martin	25	27.0315	-80.5108
Stewart Mine* (Indrio Pit)	13575 Indrio Road	Ft. Pierce	34945	St. Lucie	27	27.5218	-80.462
Dickerson's Indrio Pit	14885 W. Indrio Road	Ft. Pierce	34945	St. Lucie	27	27.5218	-80.4805
Fischer 86th*	1900 86th Ave SW	Vero Beach	32968	Indian River	33	27.5779	-80.5010
Ranch Road*	5915 82nd Ave/Co Road 619	Vero Beach	32960	Indian River	39	27.70307	-80.4979
Palm Beach Aggregates	20125 Southern Blvd.	Loxahatchee	33470	Palm Beach	43	26.6856	-80.3721
Star Pit	12201 US Hwy 27 S	South Bay	33493	Palm Beach	66	26.5046	-80.6696
Palmdale Sand Mine	5990 U.S. Highway 27 Northwest	Palmdale	33944	Glades	70	26.9161	-81.2711
Witherspoon Sand Plant	11655 W SR 78	Moore Haven	33471	Glades	73	26.813	-81.2786
E.R. Jahna Mine (Ortona Sand Mine)	12535 W SR 78	Moore Haven	33471	Glades	74	26.8159	-81.2965
Lake Wales Sand Mine	534 Story Road	Lake Wales	33859	Polk	90	27.9019	-81.5061
Gator Sand Mine	2200 Dean Still Road	Davenport	33868	Polk	114	28.2764	-81.7056
474 Sand Mine	11945 County Road 474	Clermont	34714	Lake	114	28.3579	-81.6509

***** Local sand mines with beach-quality sand contracted by the applicant (personal communication, Applicant's consultant, November 2010)

2.1.9.4(c). Sand Transport and Placement

Trucks would be loaded at the mines with approximately 20 cubic yards of sand, the maximum allowed by state law (Taylor Engineering 2007), and haul the material to staging areas adjacent to the project beach. Beachfront staging areas (**Table 2.1-3**) for offloading the sand are required before distribution and placement on the beach. Potential staging locations include applicant-owned parks in the project area. The St. Lucie County Office of the Property Appraiser website (http://www.paslc.org/) provided the zoning classification of each park.

Table 2.1-3. Potential Upland Sand Source Staging Locations within Public Parks

Park Name	R-Monument Location	Zoning
Walton Rocks Beach Park	R-86	Residential Conservation (R/C)
Normandy Beach Park	R-98	Institutional (I)
Dollman Beach Park	R-102	Conservation Public (CPUB)
Waveland Park	R-111	Conservation Public (CPUB)

Staging areas provide space to transfer fill material from road-trucks to off-road-trucks and for short-term storage of materials. Off-road-dump trucks would move the fill material from the staging areas to the beach and dump the sand within the construction template for grading by mechanized machinery to appropriate template elevations. The staging areas off the beach may provide temporary storage of equipment during construction. All equipment maintenance would occur off the beach and dune environment at an appropriate off-site location. Timing and sequencing of the project would include considerations of minimizing traffic disruptions, public park access control, and adjacent property owners. The project could potentially occur 24 hours per day, seven days per week, until project completion.

2.1.9.4(d). Project Schedule

Fill placement would occur from November 1 through April 30 (outside the peak turtle nesting season) as would occur with any other source of sand. A construction period of 120 – 160 days (November 1 – March 1 or November 1 – April 30) would provide time to transport and place 24,295 truckloads of 20 cubic yards per truck. A construction period of 120 days would require transport, placement, and grading a daily average of at least 5,200 cubic yards of material (202 truckloads) within the project area. The applicant has stated that “based on experience with the Indian River County Sector 3 Beach and Dune Restoration Project, the above daily production is feasible with work occurring only during daylight hours” (personal communication, Applicant’s consultant, November 2010). In comparison, use of the offshore sand source would likely require fewer than 90 days to complete fill placement activities.

2.1.9.4(e). Opinion of Probable Costs

Cost differences between the build alternatives are primarily a result of the differing amounts of sand required, regardless of the sand source. **Table 2.1-4** shows the cost differences between using an offshore or upland sand source based on the applicant's preferred alternative. Cost information to develop the opinion of probable cost included information provided by the applicant (Coastal Tech 2009) for an offshore sand source, costs associated with existing contracts for sand fill held by the applicant (data provided by Applicant's consultant, January 2011), and recent applicant costs for beach tilling (personal communication, Applicant, St. Lucie County, January 2011).

Table 2.1-4. Opinion of Probable Costs for Using Offshore and Upland Sand Sources

Item	Description	Sand Source	Quantity	Unit Price	Cost
1	Mobilization / Demobilization	Offshore	1 LS*	$2,075,000	$2,075,000
		Upland	1 LS	$10,166	$10,166
2	Furnish and Install Sand	Offshore	485,900 cy	$10.07	$4,893,013
		Upland	485,900 cy	$22.48	$10,923,032
3	Permit Compliance	Offshore	1 LS	$140,000	$140,000
		Upland	1 LS	$292,000	$292,000
4	Beach Tilling	Both	1 LS	$50,000	$50,000
5	Furnish and Install Plants	Both	440,000 plants	$0.90	$396,000
6	Mitigation Reef	Both	0.78 acres	$500,000	$390,000,
7	Site Restoration	Both	4 each	$3,500	$14,000
Total Construction Cost		**Offshore**			**$7,958,013**
		Upland			**$12,075,198**

*LS - Lump Sum

2.1.9.4(f). Cost Comparison

Compared to an offshore sand source, use of upland sand sources would increase the total project cost in the neighborhood of 52%. Cost differences accrue primarily due to the difference between offshore and upland sand delivery and installation costs (**Table 2.1-4**). Actual bids for sand supply (offshore or upland) are very sensitive to the state of the industry (amount of ongoing work involving dredging or trucking of sand) and key cost components such as fuel. Thus, actual cost may vary significantly. In 2011, the applicant paid about $20/cy for 65,000 cy of trucked sand placed in an emergency nourishment project immediately south of Ft. Pierce Inlet. For the 2009 Ft. Pierce Shore

Protection Project renourishment, the unit cost for sand dredged from an offshore source was slightly less than the unit cost presented in **Table 2.1-4**.

The applicant has stated that if the preferred alternative was authorized for winter 2012, considerable cost savings could be realized based on the timing of the adjacent Martin County beach stabilization project. Savings would depend upon the federal and state approval of the Martin County Beach Stabilization Project for the same construction window, and execution of two different county contracts with a single mutually preferred contractor. This would allow one contractor to construct the two projects sequentially and would provide the cost savings by splitting, among other things, the mobilization/de-mobilization construction costs. Project implementation and construction efficiencies would benefit both projects if the counties constructed the two projects sequentially in a single season. Also, constructing both projects within the same season would likely enhance the performance (lifespan) of both projects.

2.1.9.4(g). Comparison of Impacts Related to Sand Source

Avoidance of all potential adverse effects on the offshore borrow environment comprise the most significant difference between the use of an upland and offshore sand source. The ecological benefits provided by sand shoals offshore the Florida coast have received little study but may include a variety of important functions for a range of marine species (Gilmore 2009). The lack of understanding of shoal functions suggests cautious use of these non-renewable resources.

The anticipated impacts of the proposed fill template to dune, beach, and nearshore resources associated with use of an upland sand source are almost identical to those anticipated with use of an offshore sand source. The anticipated environmental effects associated with filling the nourishment template with either offshore shoal derived sand or upland sand remains the same. The use of an upland source would avoid all potential nearshore hardbottom impacts associated with pipeline corridors.

Use of an upland sand source would require about the same construction ingress/egress route(s) and slightly larger beachside staging areas than those necessary when using offshore sand sources. Therefore, impacts associated with these project components could increase slightly compared to the offshore sand source. However, these impacts occur in the upland area and remain relatively minor regardless of the sand source. In addition, both upland and offshore sources would temporarily (a) discourage birds from using the fill site during construction and (b) pose safety concerns for the public using the fill site for walking, fishing, sunning, surfing, or other beach related activities.

Truck haul through urban and residential areas creates noise, pollution, traffic congestion, road damage, spilled sand along roadways, and numerous other safety and aesthetic concerns (USACE 2001). Use of upland sand source(s) is anticipated to result in greater adverse effects on infrastructure facilities. The project would require approximately 260 trucks, or more, per day. This number represents a significant

increase in large truck traffic along south Hutchinson Island roads and on roads from the selected sand mine or mines to Hutchinson Island. The City of Ft. Pierce and Florida Department of Transportation recently completed major roadway, landscaping, lighting, and stormwater improvements along SR A1A, which provides the only road access to the proposed staging areas. Effects of the associated increase in vehicular traffic may include:

- air quality degradation
- increased petroleum products in stormwater runoff from the roads
- increased noise
- greater potential for collision with upland wildlife
- increased traffic congestion
- spilled sand along roadways
- reduced vehicular and pedestrian safety as a result of increased truck traffic

Ongoing public education and readily available means of contact with the applicant to answer questions and resolve project-related issues would help manage public concerns associated with increased truck traffic and other project-related issues to which the public may react.

Use of upland sand would also provide a potential local economic stimulus, assuming that the cost of using upland sand (either as partial or total source) provided a more cost-effective project than the sole use of offshore sand. Businesses within the county have clearly indicated during the EIS scoping process and to county officials (personal communication, Applicant, St. Lucie County, May-June 2010) their belief that use of a local (St. Lucie County) upland sand source would help stimulate the local economy.

The upland sand source alternative is not expected to provide the most cost-effective project and may likely not meet the schedule requirements for completion of work within a single construction season. For these reasons, this alternative did not receive further, detailed evaluation. The proposed offshore sand source remains the applicant's preferred alternative sand source. However, allowing project bids based on offshore and/or upland sand sources would help identify and select the most cost-effective project.

The modes of transportation for delivering sand from sand mines to the beach is limited to the truck haul method. Rail delivery alternatives are not available. Delivery through a port would still require truck hauling sand from the mine to a nearby port. Port usage comes with its own costs and technical difficulties (Taylor Engineering 2009). Rail and port delivery are considered non-viable and were not considered further as part of this study. No project in Florida has yet used either of these alternate modes of transportation for upland mined sand.

2.2. ISSUES AND BASIS FOR CHOICE

This EIS compares formulated beach and dune restoration alternatives to the existing conditions of each characteristic area. **Section 1.9.6** lists the issues that provide the foundation for this comparison.

2.3. APPLICANT'S PREFERRED ALTERNATIVE

The applicant's preferred alternative, as detailed in **Section 2.1.5**, comprises beach and dune restoration of the 3.4-mile south segment project area from FDEP Monument R-98 to R-115+1,000 ft (St. Lucie/Martin County line). Within those boundaries, the project would restore the 1972 dune profile with a 35-ft beach berm extending seaward from the dune toe along the length of the south segment. No USACE regulated work would occur in the north segment.

2.4. ALTERNATIVES ELIMINATED FROM DETAILED EVALUATION

With the exception of the No Action alternative, all non-structural alternatives were eliminated from detailed evaluation because they did not meet the project goals. All of the structural alternatives, with the exception of beach and dune restoration and T-head groins with sand fill, were also eliminated. The following subsections provide the reasons for eliminating specific alternatives from detailed consideration.

2.4.1. REZONING OF BEACH

In some areas, rezoning of the beach area to restrict or limit future upland construction could effectively reduce the risk of storm damage to upland structures associated with shoreline retreat. In the project area, upland development has already occurred and rezoning the area would not result in any substantial reduction in potential risks to upland property. This alternative fails to achieve the project purpose and needs, and does not warrant detailed evaluation.

2.4.2. CONSTRUCTION MORATORIUM OR NO-GROWTH PROGRAM

Assuming local interests would accept a moratorium on future construction, implementation of such a policy would have little impact on the level of storm risk associated with the current erosion affecting the project area, and would not achieve the project purpose or need relative to the recreational beach or sea turtle nesting habitat. More importantly, a no-growth program would prove ineffective in this area because the majority of the area has already undergone development and the remainder has permanent status as public land. This alternative is currently insufficient to fulfill the project purpose and needs, and for those reasons does not warrant further detailed evaluation.

2.4.3. EVACUATION PLANNING

Similar to other extra-jurisdictional alternatives, improved evacuation could potentially reduce the loss of life during severe storms. Appropriate state and local emergency management officials may pursue such planning. However, this alternative does not address the project purpose and needs, and for those reasons will not receive detailed evaluation.

2.4.4. CONDEMNATION OF LAND STRUCTURES

Local governments have the power, under certain conditions of public interest, to condemn land or structures. In limited circumstances, public agencies can also justify removal of condemned structures. Assuming the application of such a policy in the upland areas adjacent to the project area, a public agency could remove all upland structures. In that case, the condemnation alternative would allow the shoreline to erode naturally. This alternative may prove acceptable along undeveloped shorelines, but remains inappropriate in this case because of extensive upland development and the likelihood that, at this time, no public agency would receive the legal authority for such an action. The alternative is not reasonable and did not receive detailed evaluation.

2.4.5. RELOCATE OR RETROFIT STRUCTURES

Appropriate retrofit and/or relocation of structures to provide flood-proofing could protect infrastructure. Flood-proofing and/or moving existing structures would likely necessitate complete cooperation by private entities and failing that, some condemnation of the land and structures in highly developed areas such as the project beach. As discussed above, condemnation is unlikely to prove feasible. No cost-effective means exists to move many of the structures in the affected area. This alternative would do nothing to alleviate beach erosion, which could result in the loss of valuable wildlife habitat and recreational beach. This alternative would not fulfill the project purpose and need. Therefore, this alternative did not receive detailed evaluation.

2.4.6. MODIFICATION OF BUILDING CODES

Existing Florida building codes include structural requirements intended to minimize potential impacts to the beach-dune system and reduce building damage in severe storms. In the extensively developed project area, many of the structures do not conform to current building standards. These non-conforming buildings are generally exempt from existing codes unless substantially modified. Modification of the building codes could reduce storm risks associated with the current condition of the shoreline; however, modification fails to achieve the project purpose. Therefore, this alternative did not receive detailed evaluation.

2.4.7. CONSTRUCTION SETBACK LINE

A construction setback line would not affect existing development and could only become effective in the unforeseeable future as new buildings replace those razed or destroyed by storms. Florida has established construction control lines along the shores of coastal counties. Based on these lines, a construction permit program controls development along Florida's coastline. Like the modification of building codes, this alternative is insufficient to achieve the project purpose and need. Thus, this alternative did not receive detailed evaluation.

2.4.8. REVETMENT

Revetments typically prevent erosion landward of the revetment. However, they most often result in an increased beach slope and decreased beach width as waves carry sediment off the beach. Alternatively, revetments could act as wide groins and capture sand, causing erosion to downdrift beaches. Construction of a revetment may protect upland development during storms; however, it would not achieve the project purpose of stabilizing the beach. Revetments located landward of the mean high water line and the seasonal high tide line would not be regulated by USACE. Consequently, this alternative did not receive detailed evaluation.

2.4.9. SEAWALLS

Seawalls would provide a significant degree of upland storm damage protection. However, wave energy reflecting off seawalls and bulkheads often has resulted in steepening of the beach profile and consequent loss of beach width. Seawalls may create hazardous bathing conditions due to minimal beach area, increased undertow currents, and run outs (rapidly flowing current running from the beach out to sea). Construction of seawalls would likely result in loss of the sea turtle nesting habitat and recreational beach. Seawalls would present an increased hazard for bathers and others in the water. These seawall effects would result in substantial environmental impact and economic loss to the area. In addition, St. Lucie Code prohibits seawall construction in this area. Seawalls would not serve the project purpose and needs. Consequently, this alternative did not receive detailed evaluation.

2.4.10. NEARSHORE BERM

This alternative entails placing material dredged from an adjacent inlet or offshore borrow area into the nearshore ocean adjacent to the beach, typically in less than about 30 ft of water. Recent improvements in dredging technology allow construction of nearshore berms in water depths of <15 ft. In some areas, construction of a nearshore berm can help reduce beach erosion and provide a measure of storm protection to upland property. However, a berm would not restore the width of the beach (the primary storm protection aspect of the beach and basis of recreational opportunities) or restore turtle nesting habitat. Construction of a nearshore berm could result in direct impacts to hardbottom resources, likely in this case due to extensive hardbottom

exposure over much of the nearshore bottom area. In addition, berm erosion through time could result in impacts to downdrift hardbottom habitat. This alternative did not receive detailed evaluation because it failed to satisfy the project purpose and needs.

2.4.11. BREAKWATERS

The USACE provides this general description of breakwaters:

> *Breakwaters are generally shore-parallel structures that reduce the amount of wave energy reaching the protected area. They are similar to natural bars, reefs, or nearshore islands and are designed to dissipate wave energy. The reduction in wave energy slows the littoral drift, produces sediment deposition and a shoreline bulge or "salient" feature in the sheltered area behind the breakwater. Some longshore sediment transport may continue along the coast behind the nearshore breakwater.* (http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=ARTICLES;187)

Breakwaters entail placement of hard materials (rocks or prefabricated structures, usually concrete) to reduce beach incident wave energy and thus reduce cross-shore erosion by sediment capture in the lee of the structure. Submerged breakwaters may function similarly to a nearshore berm (**Section 2.4.10**) but provide a more permanent structure. PEP (prefabricated erosion prevention) reefs and submerged artificial reefs comprise different forms of submerged breakwaters. Emergent breakwaters extend above the water surface and generally reduce wave energy more than submerged breakwaters.

Emergent or submerged offshore breakwaters — structures placed parallel to the shoreline — act to dissipate incoming wave energy and can reduce the potential for both longshore and cross-shore sediment transport in their lee. Submerged breakwaters do not greatly degrade recreation or aesthetic aspects of the beach, but dissipate less incoming wave energy than an emergent breakwater. Compared to submerged structures of similar size, emergent breakwaters dissipate more incoming wave energy but can induce greater negative impacts to recreation — through more extreme changes to local current patterns and to beach aesthetics. The lower crest elevation of a submerged breakwater requires less material and results in a smaller structure footprint on the seafloor. In addition, some groups have suggested that the presence of breakwaters (emergent or submerged, depending on maximum elevation) can reduce beach access to nesting turtles, impede ocean access for recently hatched turtles, and cause increased turtle predation.

The complex interaction of waves, water levels, and currents near breakwaters adjacent to the beach causes difficulty predicting breakwater effects on sediment dynamics and shoreline responses. Difficulties relate to the appropriate distance of the breakwater from the shoreline, the best size of the breakwater gaps (spacing between adjacent breakwaters), and the effective prediction of the relationship between incident wave

conditions and the corresponding level of shore protection. In addition, questions arise regarding how much sand these structures would accumulate from adjacent beaches owing to the interruption of longshore sediment transport or diffraction around the breakwaters and whether they would bypass some sand or act as a complete littoral barrier. Typically, engineers design nearshore breakwaters to maintain existing shoreline positions or to induce modest shoreline advancement. The presence of breakwaters does not increase the sediment supply to the project area. Therefore, any shoreline advancement (gain in volume) must result in erosion (volume loss) at another location.

PEP (prefabricated erosion prevention) reefs previously installed along the southeast Florida coastline at locations near the proposed project have failed to prevent shoreline erosion or restore the recreational beach and sea turtle nesting habitat. PEP reef construction entails the placement of prefabricated (usually concrete) structures intended to reduce incident wave energy, allowing accretion of sediment in the lee of the structure. Such reefs have had minimal success reducing beach erosion in Florida. In May 1988, Willis DuPont installed approximately 552 ft of PEP reef at the DuPont Property between R-114 and R-116 in the Town of Palm Beach. Based on more than two years of monitoring data, these structures proved ineffective in reducing shoreline erosion; the state ordered the PEP reef removed (Stauble and Tabar 2003). In December 1991, the Town of Palm Beach received authorization to construct 4,000 ft of experimental PEP reef in the mid-town beach area. In August 1992, the town installed 57 structural units, some 684 ft in length along the approximate 9-ft depth contour. The town installed the remainder of the reef by August 1993. Three years of monitoring data demonstrated that the PEP reef exacerbated erosion. The Town of Palm Beach elected to voluntarily remove the PEP reef and use the materials for groin construction (Martin and Smith 1997; Stauble and Tabar 2003). In 1995, Indian River County constructed a PEP reef in Vero Beach. Subsequent monitoring data indicated that the PEP reef had not significantly affected (improved or impacted) the adjacent beach (FDEP 2008).

Specific to the St. Lucie County South Beach and Dune Restoration Project area, offshore breakwaters with beach fill, though maintenance of the design project shoreline, could serve to meet the project goals to increase storm protection, restore important coastal habitat for wildlife, and maintain recreational capacity of the beach. However, this conjecture assumes that the constructed breakwater system performs as predicted; the large uncertainty associated with performance within littoral systems may result in over or under capture of sand. In addition to the difficulty of accurately predicting breakwater performance within a littoral system, the breakwaters could cause erosion to adjacent downdrift locations, negatively impact recreational activity on the beach, and result in coverage of nearshore ephemeral hardbottom. For these reasons, in particular the uncertainty in breakwater performance in this setting, the breakwaters with beach fill alternative fails to achieve the project purpose and needs and does not warrant detailed evaluation.

2.4.12. BREAKWATERS WITH DUNE AND BEACH FILL

Construction of breakwaters with an associated beach fill would increase the sediment supply in downdrift beaches and advance the beach width with the structures acting to modify incoming wave energy. However, in an area that features nearshore ephemeral hardbottom (such as the nearshore of the proposed project area), construction of offshore breakwaters (submerged or emergent) could cause impacts to the hardbottom that require mitigation. The cost to determine appropriate mitigation sites and to construct the required mitigation may offset the benefit accrued by the structures (e.g., reduced sediment transport and erosion leeward of the structures).

A series of segmented breakwaters constructed along the beach might reduce sand losses and retain sand placed in the project area. As with groins, the potential benefit of breakwaters in addition to beach fill focuses on longer retention of the beach fill.

The breakwater conceptual design (provided by the applicant and considered here) is similar to a design currently under review by FDEP (FDEP Permit Application No. 0267233-001-JC). Note that the design presented here provides only a means to evaluate "typical" breakwater design, and is not intended to suggest or propose specific design criteria. The combination of a breakwater field with a dune and beach template alternative would not alter the fill template design or required volume. For the level of detail considered in this analysis, changes in the breakwater design (e.g., emergent or submerged breakwater) would not greatly alter the effects (impacts or benefits) offered by the structures.

For this analysis, each breakwater would have the following characteristics:

- Offshore Distance (from MHWL) – 225 ft
- Crest Length (shore parallel) – 255 ft
- Crest Width (shore normal) – 15 ft
- Crest Elevation – +2.0 ft NAVD
- Seaward slope (from crest to seaward toe) – 3H:1V
- Landward slope (from crest to landward toe) – 2H:1V
- Alongshore spacing between breakwaters – 200 ft

Each breakwater would cost an estimated $493,000. The proposed project area could require up to 36 breakwaters at a total initial cost of $17.7M. Added to the cost of dune and beach fill ($8.85M), the alternative would cost about $26.5M (excluding mitigation).

Breakwaters reduce littoral drift and trap sand or prevent erosion, causing accretion or reduced erosion in the lee of each breakwater and along the updrift shoreline. However, these structures concurrently increase erosion of the downdrift beach by preventing an equivalent volume of sand from moving into the downdrift beach. As with groins, breakwaters may retain sand in the project area during storms, but an equivalent volume of sand would erode from downdrift beaches.

FDEP rules and policies require mitigation for the effects of breakwaters in the form of fill placement on the downdrift beaches to offset the sand trapped by the breakwaters. Breakwaters would not decrease beach nourishment volume requirements, as any volume of trapped sand would erode the downdrift beaches and require mitigation via placement of an equivalent volume of sand on the downdrift beach — in this case, the Martin County Shore Protection Project.

Due to the uncertainty of an expected net positive benefit for this alternative, the level of impacts likely associated with this alternative, and the significantly increased costs associated with the alternative, breakwaters with dune and beach fill did not receive detailed evaluation.

2.4.13. GROIN FIELD WITHOUT BEACH NOURISHMENT

The USACE provides this general description of groins:

> *Groins are the oldest and most common shore-connected, beach stabilization structure. They are structures that extend, fingerlike, perpendicularly or nearly right angles from the shore and are relatively short when compared to navigation jetties at tidal inlets. Usually constructed in groups called groin fields, their primary purpose is to trap and retain sand, nourishing the beach compartments between them. A series of groins along the project beach (a groin field) might reduce sand losses and retain sand placed in the project area* (http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=ARTICLES;188&g=41).

Under some conditions, groins and other sand trapping structures installed in the absence of beach nourishment can trap longshore sediment transport; the sediment trapped can help restore a beach. Installation of a multiple-groin system (a groin field) typically provides a more favorable shoreline response than a single-groin alternative because the shoreline exhibits a more uniform beach fill response to a groin field than to a single groin. The creation or maintenance of a beach creates, maintains, or increases turtle nesting habitat. The groins typically provide hard substrate that develops biological productivity similar in some ways to that occurring on natural nearshore hardbottom substrate.

Installation of a groin field without beach nourishment likely would trap sand sufficient to restore the recreational beach partially and to create some additional turtle nesting habitat. The volume of sediment subsequently eroded from downdrift beaches would equal or exceed volume of trapped sediment by the groin or groin system. In addition, the placement of groins would likely incur several environmental impacts. The groin footprint would decrease the beachfront area for turtle nesting and could increase dangers to hatchling turtles moving into the ocean. The groin would cover more hardbottom than alternatives without a groin and create dangers to swimmers from the presence of the structures. Given the level of impacts to natural resources likely associated with this alternative and the likelihood that a groin system would transfer

erosion to the downdrift beach rather than not solve the problem, the installation of groins in the absence of beach fill did not receive detailed evaluation.

2.5. COMPARISON OF ALTERNATIVES

Table 2.5-1 lists the alternatives and summarizes the major features and effects of each alternative selected for detailed evaluation. **Section 4 – Environmental Effects** provides a more detailed discussion of the impacts associated with each alternative.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
PROTECTED SPECIES	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Direct impact to 0.57 acre of nearshore hardbottom used as foraging habitat by juvenile sea turtles. Elevated turbidity during construction may temporarily impact up to 1.0 acre of nearshore hardbottom within mixing zone.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Direct impact to 0.10 acre of nearshore hardbottom within pipeline corridor.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Direct impact to 0.77 acre of nearshore hardbottom used as foraging habitat by juvenile sea turtles. Elevated turbidity during construction may temporarily impact up to 9.83 acres of nearshore hardbottom within mixing zone.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Direct impact to 2.73 acres of nearshore hardbottom used as foraging habitat by juvenile sea turtles. Elevated turbidity during construction may temporarily impact up to 10.85 acres of nearshore hardbottom within mixing zone.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging Direct impact to 3.48 acres of nearshore hardbottom used as foraging habitat by juvenile sea turtles. Elevated turbidity during construction may temporarily impact up to 11.03 acres of nearshore hardbottom within mixing zone.	Sea turtle nesting area increased; potential for incidental "take" of sea turtles; potential for increased hatchling predation due to presence of T-head groins; potential encounters with sea turtles, manatees, and North Atlantic right whales during dredging. Direct impact to 2.93 acres of nearshore hardbottom used as foraging habitat by juvenile sea turtles. Elevated turbidity during construction may temporarily impact up to 10.85 acres of nearshore hardbottom within mixing zone.	Sea turtle nesting would continue to decrease as beaches erode; Continued dune erosion may threaten protected dune species.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
HARDGROUNDS	Direct impact to 057 acre of nearshore hardbottom habitat; Elevated turbidity during construction may temporarily impact up to 1.0 acre of nearshore hardbottom within mixing zone.	Direct impact to 0.10 acres of nearshore pipeline corridor hardbottom habitat Elevated turbidity during construction may temporarily impact up to 10.85 acres of nearshore hardbottom within mixing zone.	Direct impact to 0.77 acre of nearshore hardbottom habitat; Elevated turbidity during construction may temporarily impact up to 9.83 acres of nearshore hardbottom within mixing zone.	Direct impact to 2.73 acres of nearshore hardbottom habitat; Elevated turbidity during construction may temporarily impact up to 10.85 acres of nearshore hardbottom within mixing zone.	Direct impact to 3.48 acres of nearshore hardbottom habitat; Elevated turbidity during construction may temporarily impact up to 11.03 acres of nearshore hardbottom within mixing zone.	Direct impact to 2.73 acres of nearshore hardbottom habitat; Indirect impact (turbidity during construction) to 10.85 acres of nearshore hardbottom habitat	Additional hard grounds may become exposed.
SHORELINE EROSION	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Minimizes erosion losses over the life of the project; maintains a high quality beach for recreation and storm protection.	Shoreline would continue to erode at its present rate.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
FISH AND WILDLIFE RESOURCES	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; Impacts to nearshore hardbottom habitat (0.57 acre direct and up to 1.0 acre temporary) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement. Impacts to nearshore hardbottom habitat within pipeline corridor (0.10 acre direct) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; Impacts to nearshore hardbottom habitat (0.77 acre direct and up to 9.83 acres temporary) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; Impacts to nearshore hardbottom habitat (2.73 acres direct and up to 10.85 acres temporary) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; Impacts to nearshore hardbottom habitat (3.48 acres direct and up to 11.03 acres temporary) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Temporary impacts to infaunal populations at the dredging and beach placement sites; potential temporary disturbance to foraging and resting shorebirds during beach placement; Impacts to nearshore hardbottom habitat (2.93 acres direct and up to10.85 acres temporary) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species.	Continued erosion would decrease habitat for faunal populations that use beach and dune habitats.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
VEGETATION	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Temporary impact during dune and beach fill placement; Increase in plant density where planting occurs; Increased protection of dune vegetation during storms due to wider beach	Continued erosion could further impact dune vegetation.
WATER QUALITY	Temporary, localized increase in turbidity at the dredging and beach placement sites. Turbidity monitoring would provide data necessary to maintain water quality standards identified in the permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. Turbidity monitoring would provide data necessary to maintain water quality standards identified in the permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. Turbidity monitoring would provide data necessary to maintain water quality standards identified in the permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. Turbidity monitoring would provide data necessary to maintain water quality standards identified in the permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. Turbidity monitoring would provide data necessary to maintain water quality standards identified in the permit conditions.	Temporary, localized increase in turbidity at the dredging and beach placement sites. Turbidity monitoring would provide data necessary to maintain water quality standards identified in the permit conditions.	No impact.
HISTORIC PROPERTIES	No impact.	No impact.	No impact.	No impact.	No impact.	No impact.	No impact.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
RECREATION	Restored beach and dune would provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune would provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune would provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune would provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune would provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Restored beach and dune would provide increased area for recreational use; temporary disturbance during project construction due to site restriction; increases in turbidity may decrease snorkeling and diving visibility conditions adjacent to the beach placement area; turbidity and dredging disturbance may temporarily affect fishing conditions adjacent to the dredging site.	Beaches would continue to erode resulting in decreased beach width for recreation; potential increase in nearshore snorkeling and diving opportunities due to increased hardbottom exposure.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
AESTHETICS	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach.	Temporary impact associated with presence of dredging and construction equipment; Long-term improvement by providing a wider, more visually-attractive beach. Presence of T-head groins may detract from visual aesthetics as they become exposed.	Continued erosion could result in degraded aesthetics due to a decrease in beach width and advancement of the surf zone.
NAVIGATION	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	Temporary, minor impacts to navigation due to the presence of dredging equipment at borrow site.	No Impact.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
ECONOMICS	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Short-term impacts to beach-associated tourism revenues during project construction; Short-term impacts to recreational and commercial diving and fishing within the offshore borrow site; Long-term benefits due to storm damage reduction and wider beach for recreation.	Adverse effects due to continued erosion of existing beach. Potential loss of tourism revenues due to decreased beach width and recreational opportunities. Increased potential for storm damages including loss of buildings and infrastructure.

Table 2.5-1. Summary of Direct and Indirect Impacts

Alternative Environmental Factor	Alternative 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm (Applicant's Preferred Alternative)	Alternative 2 Beach Fill with No Impact to Existing Hardbottom	Alternative 3 Beach Fill to Restore the 1972 Beach and Dune	Alternative 4 Beach Fill to Restore 1972 Dune with 35-ft Berm	Alternative 5 Beach Fill to Restore the 1972 Dune with 70-ft berm	Alternative 7 Beach and Dune Restoration with T-Head Groins	Alternative 1 No Action Status Quo
ESSENTIAL FISH HABITAT	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Impacts to nearshore hardbottom EFH (0.57 acre direct and up to 1.0 acre temporary) may cause relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could impact EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Impacts to nearshore hardbottom EFH within pipeline corridor (0.10 acre) may cause relocation of motile faunal populations, reductions in fish recruitment and feeding success; and mortality of demersal fish species. Sand removal from offshore shoal could impact EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Impacts to nearshore hardbottom EFH (0.77 acre direct and up to 9.83 acres temporary) may cause relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could impact EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Impacts to nearshore hardbottom EFH (2.73 acres direct and up to10.85 acres temporary) may cause relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could impact EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Impacts to nearshore hardbottom EFH (3.48 acres direct and up to11.03 acres temporary) may cause relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could impact EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	Short-term infaunal diversity changes in the nearshore and offshore soft bottom habitats; Impacts to nearshore hardbottom EFH (2.93 acres direct and up to 10.85 acres temporary) may cause relocation of motile species, mortality of demersal species, reductions in feeding success; Sand removal from offshore shoal could impact EFH for coastal pelagic fishes, dolphin and wahoo, and highly migratory species; Sand mining impacts include elevated turbidity, sedimentation, disruption of feeding activities and migratory routes, and entrainment.	No Impact.

2.6. MITIGATION AND MONITORING

Any project proposing sand fill to restore the dune would unavoidably impact dune vegetation; alternatives nourishing the beach would, with one exception (Beach Fill with No Impact to Hardbottom alternative), impact nearshore hardbottom habitats. Unavoidable impacts to nearshore hardbottom would require compensatory mitigation, and dune vegetation impacted during construction would likely be replaced in-kind. The applicant has submitted a Draft Mitigation Plan (**Appendix G**) that describes its proposed mitigation. For the applicant's preferred alternative, mitigation would create about 0.78 acres of nearshore artificial hardbottom habitat to offset 0.57 acres of hardbottom impacts. In addition, the applicant has proposed physical and biological monitoring to track project performance over a period of 5 years (**Appendix H** and **Appendix I**). The monitoring plans should provide the means to assess project impacts from a physical and biological perspective. Monitoring would reveal the actual extent of fill equilibration, and the biological response of nearshore hardbottom resources to detect unauthorized adverse effects.

Avoiding and minimizing aquatic resource impacts may be accomplished by implementing BMPs described in **Section 2.1.1.1** and **Section 2.1.9.2**.

2.6.1. MITIGATION

2.6.1.1. Dune Vegetation

Due to the severe impact of the 2004 hurricanes Frances and Jeanne, the applicant implemented a dune restoration/revegetation project in southern St. Lucie County. Replanted areas included the dune system from R-87.7 to R-90.3 and from R-98 to the St. Lucie/Martin County line (R-115+1000). Plantings included sea oats and other native coastal dune species. The revegetation project covered much of the south segment of the currently proposed project. Plant survival and expansion has demonstrated successful establishment and proliferation of plant species proposed for use in the applicant's proposed mitigation for impacts to dune vegetation.

The project may place fill over vegetation located within the upper beach/pioneer zone of the dune system, but beach fill would not occur landward of the dune crest. The upper beach/pioneer zone typically contains halophytic species that also tolerate xeric conditions; many of these species have high growth rates and spread rapidly as they grow. Typical species found in the upper beach/pioneer zone include railroad vine (*Ipomoea pes-caprae*), seashore paspalum (*Paspalum distichum*), sea purslane (*Sesuvium portulacastrum*), and sea oats (*Uniola paniculata*). Pioneer species trap wind-blown sand, resulting in sand accumulation which is an integral process to establishment of a dune system.

After project construction, the applicant proposes to plant the restored dune with a mix of native coastal dune pioneer plants, which may include sea oats (*U. paniculata*), beach sunflower (*Helianthus debilis*), railroad vine (*I. pes-caprae*), and dune panic grass

(*Panicum amarum*), depending upon nursery availability at the time of planting. Roughly 360,000 planting units would be installed 18 inches on center in staggered rows on the dune crest (**Table 2.6-1)**.

Table 2.6-1. St. Lucie County South Beach and Dune Restoration Project Proposed Dune Plantings

Common Name	Scientific Name	% of Total	Quantity	Size
Sea Oats	*Uniola paniculata*	80	192,000	Liner
Dune Panic Grass	*Panicum amarum*	13	31,200	Liner
Railroad Vine	*Ipomoea pes-caprae*	4	9,600	Liner
Dune Sunflower	*Helianthus debilis*	3	7,200	Liner

2.6.1.2. Nearshore Hardbottom

Nearshore hardbottom direct impacts include burial by beach fill and scraping by the dredge subline that brings the sand from the hopper dredge to the beach. Burial during fill placement accounts for most of the impacts.

In addition, temporary impacts to hardbottom may occur as result of elevated turbidity within the fill placement mixing zone during construction.

Hardbottom impact quantification included mapping hardbottom from aerial photographs, performing field surveys to define the hardbottom community at different locations, and comparing the footprint of each alternative to mapped hardbottom communities.

For each alternative evaluated in detail, the applicant used aerial photographs (flown October 21, 2010), the estimated project ETOF location, and when appropriate the footprint of structures (groins), to estimate hardbottom impacts. GIS professionals interpreted and quantified the hardbottom areas visible in the photographs and calculated the amount of hardbottom area landward of the equilibrium toe of fill. Aerial imagery was analyzed utilizing both manual and automated techniques in order to delineate the extent of hardbottom resources in the study area. High-resolution aerial photographs were examined for presence of visually identifiable hardbottom features and all terrestrial reflectance data were masked out of the imagery so that the software could focus only on marine data. Subdividing the remaining marine image data into nearshore and offshore areas allowed for further separation of spectral characteristics. The Iterative Self-Organizing Data Analysis Technique Algorithm (ISODATA) was utilized in the classification process and each classification was manually inspected to identify hardbottom. Finally, vector polygons were generated and overlaid on the imagery and reviewed to delineate hardbottom areas further. A detailed description of the hardbottom mapping and classification methodology is provided in **Appendix J**.

Total acreage of hardbottom in the immediate project area ranged from 10.4 acres based on analysis of August 2008 aerial photographs to 12.97 acres based on October 2010 analysis of aerial photographs. Impacts to hardbottom referenced within this report are based on analysis of the most recently acquired (2010) aerial imagery. Ephemeral in nature, the nearshore hardbottom exposure varies year to year based on storms and other naturally occurring coastal processes. However, some of the differences in the hardbottom acreage between 2008 and 2010 are likely the result of meteorological systems and the sea state prior to the aerial photographs. Late summer/fall storms often erode the beach and may expose nearshore hardbottoms. Summertime surveys typically capture the hardbottom exposure when the sea state is calm and when sand within the littoral zone has been naturally redistributed. This phenomenon may result in a naturally occurring seasonal decrease in exposed nearshore hardbottom.

Field survey data were used to categorize the hardbottom communities as Community One or Community Two (**Appendix J**). Survey methods used to categorize benthic community types follow:

- Twenty-two permanent transects were installed perpendicular to shore near FDEP range monuments. Final transect locations varied slightly from the initial locations to avoid areas devoid or largely devoid of hardbottom and to ensure transect installation near identified candidate pipeline corridor routes. Permanent transects were installed at R-77.7, R-78.7, R-80.4, R-82.8, R-85, R-86.3, R-88.7, R-90.4, R-92, R-93.5, R-100, R-101, R-102, R-103.2, R-104.5, R-105.9, R-109.2, R-110, R-110.5, and R-112 in St. Lucie County and R-1 and R-3 in Martin County. Each transect extended from the landward edge of exposed nearshore hardbottom to the easternmost extent of exposed hardbottom along the transect not exceeding 150 m in total length.

- Scientists collected quantitative and qualitative video data along the entire length of each transect to determine percent cover of benthic flora, fauna, and substrate components. In addition, *in situ* quadrats were sampled at 10 to 12 point-intercept locations along each transect. The nearshore hardbottom edge was mapped to document the position of the nearshore edge of exposed hardbottom and characterize associated benthic communities within the survey area.

- Percent cover of each taxa as well as major categories (macroalgae, fauna, substrate, and biotic turf) was calculated from quantitative video using the point count method and from raw *in situ* quadrat data. Percent cover data sets were log transformed and subjected to nonparametric statistical analyses with PRIMER 6.1.6 statistical software to investigate potential patterns in datasets.

- Community types were based on a combination of physical (water depth, distance from shore, hardbottom relief) and compositional (dominant floral and faunal species) characteristics.

Hardbottom Community One consists of low- to medium-relief hardbottom with a significant wormrock (*Phragmatopoma lapidosa*) component (approximately 10% coverage along monitoring transects) relatively close to shore. This community supports biota such as hydroids, encrusting sponges, macroalgae, and turf algae (**Figure 2.6-1**). The physical characteristics of this community type facilitate the establishment and proliferation of *P. lapidosa*, while also supporting a large percent cover of robust, canopy-forming red algae. This community type provides shelter and nutrient source to many invertebrate, fish, and turtle species. Additionally, wormrock builds reef and contributes to the biological diversity of the nearshore environment. This community occurred between R-82.2 and R-94, coinciding with the northern project segment. Wormrock also occurs in the intertidal zone near R-101, R-104.5, and R-105.9, but with evidence of sand scouring and a reduced algal community. These hardbottom habitat patches did not appear in the 2008 aerial photography, and were characterized based on in-situ monitoring and video analysis. (personal communication (email), Applicant's consultant, October 18, 2011).

Hardbottom Community Two consists of less biologically complex, low relief, consolidated coquina rock ledges. The well-defined, undercut ledges include exposed coquina rock with little or no biotic cover. The habitat mostly provides physical refuge space (**Appendix J**). This community did not have the wormrock component or robust macroalgae evident in Hardbottom Community One. The applicant concluded that the Hardbottom Community Two represented hardbottom substrate located in areas subject to the relatively constant physical dynamics of the nearshore environment, specifically sand movement, scouring, and alternating sand burial and subsequent re-exposure (**Figure 2.6-2**). Field surveys and review of videos collected along the length of each transect identified this community primarily between R-99.5 and R-107.

Hardbottom Community Three consists of faunal species not observed in the more nearshore hardbottom areas including spiny lobster (*Panulirus argus*), octocorals (*Leptogorgia sp.*), holothuroids, and a variety of encrusting sponges. The hardbottom is characterized by large (1 to 3 m diameter), flat rock structures found in deeper (3 to 4 m) water farther from the shoreline than Communities One and Two. Octocorals were observed in Community Three, which is located further offshore than Communities One or Two and would not be impacted by the implementation of the project.

Furthermore, six (6) proposed pipeline corridors were diver-surveyed in 2009 (R-89.5, R-100, R-101, R-104, R-108, and R-114). These dives resulted in the elimination of one proposed corridor at R-101 due to a 62 m (203 ft) extent of hardbottom in the nearshore region of that proposed pipeline corridor. Using the diver survey results, selection of the pipeline corridors avoided, to the extent practicable, impacts to hardbottom. Of the five (5) selected pipeline routes, the northernmost pipeline corridor (approximately at R-89.5) contains variable presence of hardbottom and partially-exposed hardbottom. Pipeline Corridor R-89.5 included patches of Hardbottom

Community One (0.08 acre) and Hardbottom Community Two (0.02 acre). No practicable alternative (i.e. other route that would result in lesser impact) could be found in the northern portion of the project area served by the corridor at R-89.5. The remaining four (4) proposed pipeline corridors (R-100, R-104, R-108, R-114) consist almost completely of sand and shell hash, with some interspersed small expanses of hardbottom or partially exposed hardbottom. This small expanse provided little biotic cover and may be an area of ephemeral hardbottom exposure (CSA 2010a), or an area experiencing accretion effects from the migration of Pierce Shoal.

To conservatively manage the uncertainties in assigning a community type to each patch, wherever the adjacent nearshore hardbottom edge data indicated the presence of Community One, that patch was assigned that type. This solution was based on the observation that transects that contained hardbottom Community One at the nearshore edge most often changed moving seaward along the transect to Community Two (that less biologically complex community without the wormrock). Since the area of the different communities could not be accurately estimated, assigning the patch to the more complex community ensured that UMAM calculations would not undervalue that community.

In addition, the applicant has assumed that all hardbottom within the 50-ft pipeline corridor at R-89.5 would incur impact. Daily monitoring would allow direct assessment of pipeline location and related impacts.

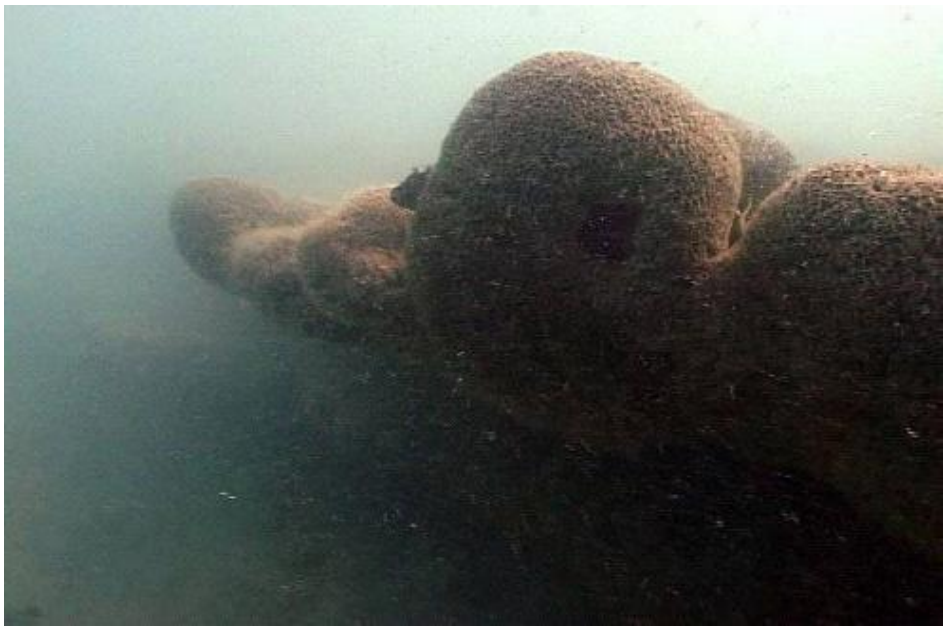

Figure 2.6-1. Representative photograph of Hardbottom Community One with Well-Developed Worm-Rock Community (from **Appendix J**)

Figure 2.6-2. Representative photograph of Hardbottom Community Two (from **Appendix J**)

Based on fieldwork and imagery analysis reported by CSA International (**Appendix J**) the applicant estimated hardbottom impacts by community type for each alternative considered in detail (**Table 2.6-2**). USACE UMAM scores and the applicant-estimated impact acres provided the basis for the calculation of estimated mitigation acres (**Table 2.6-2**). A time lag factor of 3.0% and a risk factor score of 1.25 were incorporated into the equations to estimate the amount of compensatory mitigation.

Table 2.6-2. Estimated Impact and Mitigation Acres for Each Alternative Evaluated in Detail

		Alternatives						
	Hardbottom Community Type	**Alt 6 Beach Fill South Segment Only to Restore 1972 Dune with 35-ft Berm**	**Alt 2 Beach Fill with No Impact to Existing Hardbottom**	**Alt 3 Beach Fill to Restore the 1972 Beach and Dune**	**Alt 4 Beach Fill to Restore 1972 Dune with 35-ft Berm**	**Alt 5 Beach Fill to Restore the 1972 Dune with 70-ft Berm**	**Alt 7 Beach and Dune Restoration with T-Head Groins**	**Alt 1 No Action**
Impact Acres (ETOF)	Community 1	0	0	0.67	2.08	2.55	2.27	0
	Community 2	0.55	0	0	0.55	0.83	0.56	0
	Total Impact Acres	0.55	0	0.67	2.63	3.38	2.83	0
Impact Acres (Pipeline)	Community 1	0	0.08	0.08	0.08	0.08	0.08	0
	Community 2	0.02	0.02	0.02	0.02	0.02	0.02	0
	Total Impact Acres	0.02	0.10	0.10	0.10	0.10	0.10	0
Mitigation Acres	For Community 1	0	0.03	0.97	2.94	3.60	3.21	0
	For Community 2	0.78	0.01	0.01	0.78	1.17	0.79	0
	Total Mitigation Acres	0.78	0.04	0.98	3.72	4.77	4.00	0

To offset unavoidable impacts to nearshore hardbottom, the applicant has proposed construction of low relief mitigation reefs at several possible locations in the general project area. The applicant intends to locate the reefs at depths similar to the impacted areas, though “due to the nebulous logistics in constructing artificial structures in depths less than 4m as well as the public safety hazard and reduced probability of success in very nearshore regions, the mitigation reef(s) may be constructed in depths exceeding those at impacted areas.” (**Appendix G**).

The following criteria guided selection of potential mitigation locations:

- Veneer of sand over rock substrate (no coverage of exposed or likely exposed hardbottom
- 15m (50 ft) buffer between constructed reef and surrounding hardbottom
- Proximity (approximately one-quarter mile) to county park(s) to facilitate public use
- Water depths between about 3.7 and 4.6m (12 and 15 ft)

- Locations between the two impact sites to facilitate recruitment from the two community types, as well as to house fleeing motile fauna during project construction

The applicant proposed the use of jet probes to identify appropriate locations for mitigation reef placement (personal communication, Applicant, St. Lucie County, January 2011).

The applicant identified a low relief design (**Figure 2.6-3)** to mimic the impacted habitats. However, the applicant has also indicated that to achieve success, the mitigation efforts may require strategies not yet identified:

> *As identified within the Department-commissioned literature synthesis of hardbottom habitat ecological functions (CSA 2009, page 8-11), "Because of the stability and logistic issues stated above, it is apparent that NHB [nearshore hardbottom] cannot be mitigated for in like-kind fashion, given present technology and budgets". Given all these limitations in constructing acceptable like-kind mitigation, the county intends to remain flexible in developing strategies for success.* (**Appendix G)**

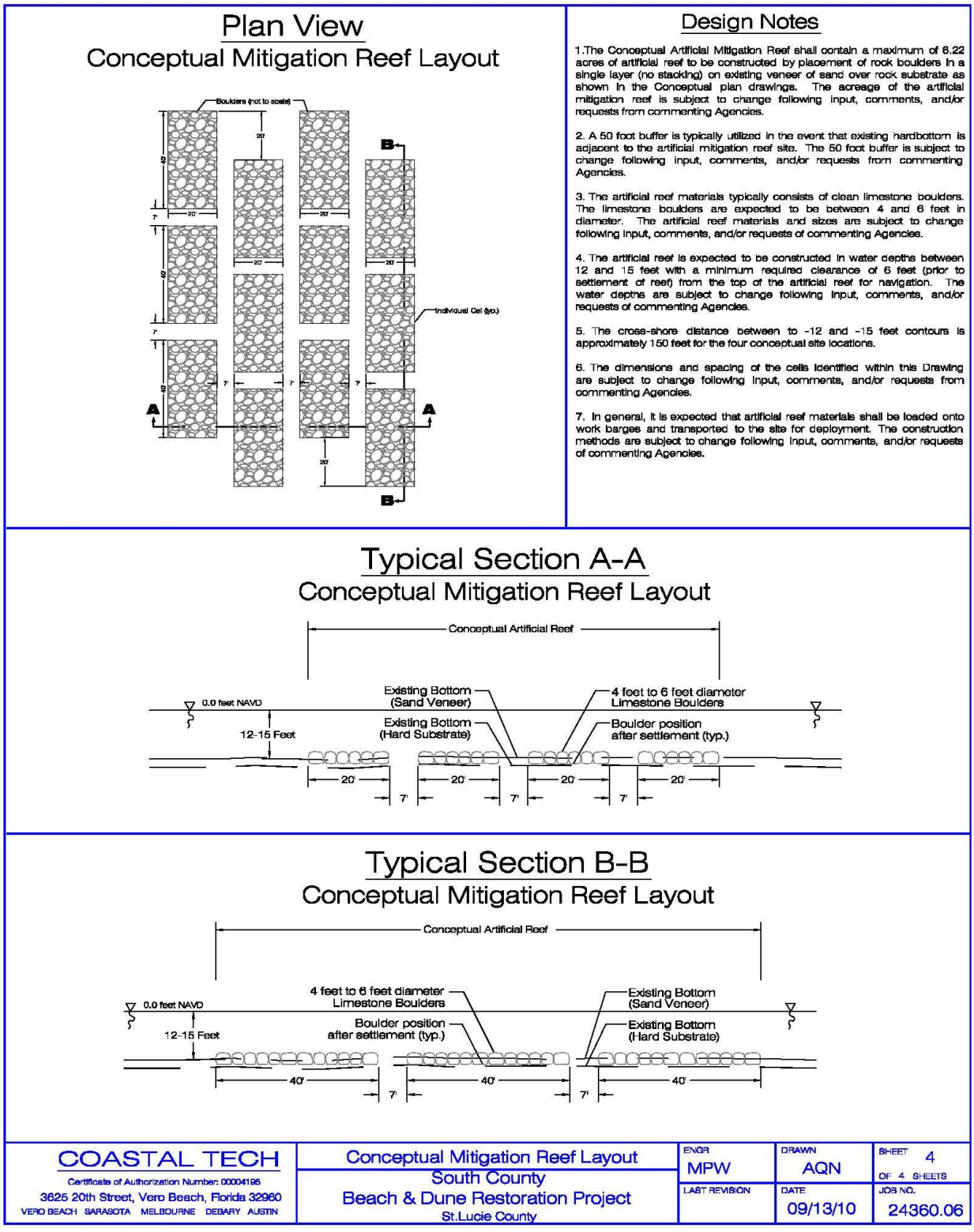

Figure 2.6-3. Conceptual Reef Mitigation Design
(from **Appendix G**)

2.6.2. MONITORING

2.6.2.1 Physical

Physical monitoring provides the data necessary to assess the accuracy of the predicted modeling results for the seaward extent of fill placement and the actual extent off equilibration. Monitoring can also accomplish the following objectives:

- Identify erosion and accretion patterns (shoreline and volumetric changes) along the project and adjacent shorelines
- Provide data to facilitate an engineering evaluation of the beach nourishment performance based upon pre- and post-construction surveys and subsequent monitoring surveys
- Identify beach segments that have lost sand in quantities that may require corrective actions
- Identify location of the equilibrated toe of fill (ETOF)
- Determine whether the borrow area is experiencing infilling under post-construction conditions.

The primary components of physical monitoring plans include:

- Beach profile and hydrographic surveys of the project area and adjacent beaches
- Hydrographic surveys of the borrow area
- Vertical aerial photography along the limits of the surveyed beach

Surveys conducted before, immediately after, and annually after construction comprise the typical schedule of physical data collection for monitoring project performance. Timely reports summarizing the data collection and analysis results submitted to the lead state and federal regulatory agencies would demonstrate project permit compliance (or lack thereof). Long-term, these data would provide a basis to track requirements for any further beach nourishment activities. Monitoring of the post-nourishment beach and nearshore areas would assess physical impacts (burial of hardbottom by sand) resulting from the project.

Aerial photography also provides information linking physical conditions and biological conditions at the project site. The FDEP guidance document, *Monitoring Standards for Beach Erosion Control Projects*, provides guidance for aerial photography with the following exceptions:

- Part II – Execution, Section B. Flight 16: To provide for best visibility of hardbottom features, the applicant will require that the photographs capture conditions during an incoming tide.
- Part II – Execution, Section B. Flight 17: The photographs will capture the entire project area during one flight rather than during a “schedule” of flights.

Aerial photography of the beach should be performed as closely as possible to the other post-construction surveys and each annual monitoring period.

This monitoring produces controlled, vertical, color aerial photography along the coastline for the primary purpose of mapping and quantifying exposed nearshore hardbottom and natural/artificial reefs. Aerial photography and biological survey work should occur as close together as reasonably possible.

The photographs allow documentation and consistency between conditions identified along surveyed profile lines and the field delineation of the exposed nearshore hardbottom. **Appendix H** provides a draft version of the St. Lucie South County Beach and Dune Restoration Project Draft Physical Monitoring Plan.

2.6.2.2. Dune Vegetation

Dune monitoring evaluates initial survival and ensures the installation of the plants followed the plans and specifications. Typically, monitoring occurs one year following planting completion and determines plant survivorship and overall success. **Appendix I** provides the applicant's draft Biological Monitoring Plan, including those for monitoring of dune planting success.

- To assess total areal plant cover at completion of planting, monitoring would occur within 30 days of planting completion. The simple *Flat Vegetative Cover Test Method* would provide the cover estimate approach. Field biologists would establish several representative photo-reference points. Photographs depicting the completed planting would provide a visual record of initial post-construction conditions. The field biologist performing the monitoring would record the number, size, and location of all species planted, as well as the planting dates and any variation to the planting plan
- One year after planting completion, planted area monitoring would use methods consistent with the immediate post-construction monitoring. The field technician would record the number, size, and location of all species planted, and any necessary re-plantings. If any of the planted species are not proliferating, the applicant would propose other appropriate coastal dune pioneer species. After approval of regulatory agencies, the applicant would replace the failed plants. If plant mortality occurs due to human encroachment, the applicant would erect temporary fencing to remain until the planting project meets the success criteria.
- At the end of the one-year post-construction monitoring period, starting from the time the last plant was installed (or replaced at any time after the initial planting), 80% or greater survival of the initial plantings would constitute project planting success and the end of monitoring and maintenance activities. Mortality as a result from loss of dune structure (e.g., slumping due to escarpment formation) would be noted and would not be included in the required planting survivorship. If at the end of the first year, the monitoring data show less than 80% survival, replanting and monitoring shall continue until monitoring demonstrates 80% survivorship of native dune plants over a full year.

2.6.2.3. Nearshore Hardbottom

Monitoring nearshore hardbottom includes the resources within the project footprint, as well as the mitigation site(s). The requirements for annual monitoring are dependent on the extent of uncertainty associated with the anticipated project effects related to the coastal system, and/or the level of ecological functionality of the aquatic resources. The data serve to document the ecological functions and services. Monitoring results are compared with the anticipated effects of the project to identify unanticipated adverse effects or unauthorized impacts. Mitigation site monitoring documents trends toward success or failure, and may provide a basis to implement remedial or corrective actions. Regulatory agencies may extend monitoring periods until the mitigation has obtained ecological success or met the prescribed performance standards. The applicant's Draft Biological Monitoring Plan (**Appendix I**) and Draft Mitigation Plan (**Appendix G**) are included as references.

Monitoring typically occurs during favorable weather and relatively clear water. In general the most favorable conditions occur between May 1 and September 30. The monitoring includes the following:

- Monitoring and control transect video recording, with video or photographs of example species and hard corals along each transect
- Voucher samples of macroalgae
- *In situ* quadrat data collection including visual estimate of percent cover and genus/species identifications
- Diver video survey of pipeline corridors used as dredge pipeline routes
- Nearshore hardbottom edge mapping
- Nearshore fish observations during transect monitoring

Note that the biological monitoring plan (**Appendix I**) includes methods for quantifying corals and octocorals in addition to the other methods used to characterize the system, in spite of the fact that the baseline hardbottom survey identified only one scleractinian and three octocorals in the project area. These methods provided appropriate data recording for the four individuals already identified and would provide appropriate data should corals increase in number in future surveys of the project nearshore.

Monitoring the mitigation reef ecosystem provides a basis for assessing the degree to which the system has achieved ecosystem organization and function comparable to the natural system impacted by the project. In the proposed mitigation plan (**Appendix G**), the applicant has indicated that the monitoring results would form the basis for any adaptive management necessary.

In addition, monitoring of the pipeline corridors would occur within 30 days, but no later than 48 hrs. prior to pipeline placement to identify existing hardbottom areas. These documented hardbottom areas would be avoided to the maximum extent possible. During construction, the pipelines are routinely inspected by divers to ensure the

pipelines remain sealed and to record the pipeline location. Monitoring is used to compare the original and current location, and documents the pipeline remains within the 50 ft corridor. Monitoring would also identify any unauthorized impacts or discharges and allow implementation of corrective measures. Use of DGPS equipment would allow immediate location assessment and quantification of impacts, if necessary.

2.6.2.4. Sea Turtles

The applicant would conduct sea turtle monitoring consistent with requirements the U.S. Fish & Wildlife Service (USFWS) and Florida Fish & Wildlife Conservation Commission (FWC). The following monitoring for nesting sea turtles would be required during any authorized construction activity, the nesting season immediately post-construction, and three nesting seasons thereafter.

- Daily early morning surveys for sea turtles would be required if any portion of the sand placement construction occurs during the period from March 1 through April 30, or November 1 through November 30.
- Nesting surveys would begin 65 days before construction activities start or by March 1, whichever occurs later.
- Nesting surveys would continue through the end of the project or through September 30, whichever ends earlier.
- Nighttime surveys for leatherback sea turtles would occur from March 1 through April 30 or until completion of the project (whichever ends earlier). Each night in the project area nesting surveys would occur at one-hour intervals from 9 p.m. until 6 a.m. Because leatherbacks require at least 1.5 hours nesting, this schedule would ensure that the surveyor encounters all nesting leatherbacks.

If turtles construct nests in areas where construction activities may impact them, an FWC-authorized agent must relocate eggs per the FWC requirements.

The applicant proposes five in-water turtle monitoring events, including one immediately after construction and four more events at three-month intervals over the first post-construction year. Surveys conducted from a boat equipped with an elevated observation platform and a GPS navigational system would allow constant monitoring of speed and location during each monitoring effort. Surveys conducted only during periods of calm seas would provide the best conditions for viewing turtles.

2.6.2.5. Shorebirds

The applicant has proposed shorebird monitoring to comply with FWC requirements. Shorebird surveys conducted by trained, dedicated individuals with proven shorebird identification skills and avian survey experience would provide accurate assessments. Nesting season surveys will encompass all potential beach-nesting bird habitats within the project area that construction activities may impact. The nesting season surveys would not include portions of the project area with no potential for project-related activity between the date of the current survey and the next survey. Surveys for detecting new

nesting activity would occur on a daily basis before movement of equipment, operation of vehicles, or other activities that could potentially disrupt nesting behavior or cause harm to the birds, to their eggs, or to their young. Surveys would also document the presence of any piping plovers, or other federally listed shorebirds, within or adjacent to the fill site.

2.6.2.6. Benthic Infauna

Pre- and post-construction infaunal taxa surveys within the offshore borrow area provide data that may be useful to assess changes that occur because of dredging at the site. Samples in the dredging area, the refuge area, and a control location outside the dredging area in similar, adjacent, undisturbed area of shoal habitat would provide data to assess measureable changes in benthic infauna. The methodology to assess the changes can include counts of fauna sorted into five major taxonomic groupings (annelids, crustaceans, mollusks, echinoderms, and miscellaneous) and ash free dry weight of each group in each sample. The monitoring provides an assessment basis for standing stock changes over time. The applicant has submitted a document including baseline information on infaunal taxa (**Appendix K).**

2.6.2.7. Escarpments and Compaction

Visual surveys for escarpments along the project area would be required for any beach nourishment project. Monitoring would occur

- Immediately after completion of the project
- Before March 1 for three subsequent years if post-construction tilling does not occur before sea turtle nesting season
- Weekly during the three nesting seasons following completion of beach nourishment

The escarpment survey technician would record the number of escarpments and their location relative to FDEP reference monuments during each weekly survey. In addition, the technician would report the total length of the scarps relative to the length of the beach surveyed (e.g., 50 percent escarpments). Notations on the height of these escarpments would include ranges (0 to 2 ft, 2 to 4 ft, and 4 ft or higher) as well as the maximum height of escarpments. If escarpment exceeds permit standards, the applicant would immediately consult with FWC and FDEP to determine the appropriate action.

Immediately after completion of project construction (April 30) and before March 1 for three subsequent years, the applicant would either till the beach to improve sand density or monitor sand compaction in the area of sand placement in accordance with a protocol agreed upon by USFWS, USACE, and the applicant. Monitoring at 500-ft intervals along the project area would test sand density at multiple depths at each sampling location. If the applicant monitors and finds areas of excessive density, the applicant would till the affected area.

2.6.2.8. Beachfront Lighting

Following standard techniques, lighting surveys conducted in accordance with the applicant's lighting ordinance, U.S. Fish & Wildlife Service Biological Opinion, and JCP specific permit conditions would document all artificial lighting visible from the nourished beach. The applicant would follow the lighting ordinance. The monitoring is required since the changes in beach profile can cause changes in light visibility which may have adverse effects on nesting and hatchling sea turtles

2.6.2.9. Monitoring Schedule

Tables 2.6-3 and **2.6-4** provide an applicant-proposed monitoring program for nourished beaches

Table 2.6-3. Physical Monitoring Schedule (**Appendix H**)

Activity	Pre-construction	During Construction	Post-construction				
			Immediate	Year 1	Year 2	Year 3	Year 5
Beach and Offshore Profiles	X		X	X	X	X	X
Aerial Photography			X	X	X	X	X
Bathymetric Surveys of Borrow Area	X		X			X	
Sand sampling	X	X			X		
Monitoring Reports			X	X	X	X	X
Turbidity Monitoring		X	Storm-related sampling in Year 1				

Sand sampling would occur during construction as part of quality assurance and quality control activities. Two additional annual sampling efforts would verify that the long-term distribution of sand size and qualities remains appropriate.

Table 2.6-4. Biological Monitoring Schedule (**Appendix I**)

Monitoring Activity	Pre-Construction	During Construction	Post-construction			
			Immediate	Year 1	Year 2	Year 3
Dune Vegetation			X	X		
Nearshore Hardbottom, Fish Observations	Completed		X	X	X	X
In-Water Turtles	Required		X	X		
Turtle Nesting	Ongoing	X	X	X	X	X
Shorebirds		X	X			
Offshore Benthic Infauna	Completed				X	

Table 2.6-4. Biological Monitoring Schedule (**Appendix I**)

Monitoring Activity	Pre-Construction	During Construction	Post-construction			
			Immediate	Year 1	Year 2	Year 3
Compaction			X	X	X	X
Escarpment			X	X	X	X
Lighting	Required		X			

3. AFFECTED ENVIRONMENT

3.1. GENERAL ENVIRONMENTAL SETTING

The project area is located along the shoreline of Hutchinson Island, an Atlantic Ocean barrier island, on the southernmost five miles of St. Lucie County beaches (**Figure 1.3-1**). The St. Lucie County Atlantic shoreline is composed of barrier islands separated from the mainland by tidal wetlands, the Indian River Lagoon, and inland bays, all linked by the Atlantic Intracoastal Waterway (ICW). The barrier island, with elevations ranging from 5 to 25 ft above mean sea level, varies in width from less than 200 ft to more about a mile. This combination results in a tendency for hurricanes to overwash some areas, particularly the lowest areas along narrower portions of Hutchinson Island. Ft. Pierce Inlet at the north end of the Hutchinson Island and St. Lucie Inlet at the south end of the island provide pathways for physical, chemical, and biological exchanges between the Atlantic Ocean, Indian River Lagoon, and the mainland of the Florida peninsula.

The general project area comprises primarily condominium complexes, multifamily and single family homes, and hotels with interspersed public lands and public parks providing access to the Atlantic Ocean beaches. A significant portion of the shoreline and island lie within Coastal Barrier Resources System (CBRS) Unit P-11, a federal designation that prohibits the use of federal funds in those areas, with the intent to afford protection against development to significant sections of remaining natural barrier island resources. The Florida Power and Light Nuclear Power Plant, the major industrial facility on the island, lies less than two miles north of the project area.

Beaches lining the eastern (Atlantic Ocean) side of the island are composed of mineral sands and shell fragments. Coquina rock outcroppings also occur periodically along the shoreline and in the nearshore waters. Mangroves and residential development dominate the western (lagoon) shoreline of the island, and some areas, particularly those narrowest and most prone to complete overwash, are hardened to resist storm erosion.

Storm tides, waves, winds, and currents comprise the major factors driving coastal processes along the St. Lucie County shoreline.

3.1.1. REGIONAL GEOGRAPHIC SETTING AND CLIMATE

Hutchinson Island, bounded on the west by the Indian River Lagoon, enjoys a subtropical climate with project area temperatures and winds modulated by the water bodies. St. Lucie County has long, hot summers including regular convection storm and infrequent hurricane rains and winds with temperatures averaging between 80 and 90 degrees. Short mild winters include drier conditions and temperatures typically ranging between 60 and 70 degrees, rarely dropping to freezing (http://www.visitstlucie fla.com/weather.html).

3.1.2. PHYSICAL CONDITIONS

The project area covers the Florida Atlantic coast in the southern region of St. Lucie County, from FDEP reference monuments R-87.7 to R-90.3 and from R-98 to R-115+1,000 ft (St. Lucie/Martin County line) (**Figure 1.3-1**). The project area comprises the Atlantic Ocean shoreline on a barrier island of Florida, and a borrow area located approximately three miles offshore of the project beach. The south St. Lucie County project area will not likely experience a significant amount of further development. Zoning maps for the project area show 83% of the shoreline zoned multifamily, 14% of the shoreline zoned conservation, and 3% zoned commercial. A few vacant lots zoned for development occur. Notably, the general project area includes no shoreline armoring structures such as seawalls or groins.

The following documents provided as part of the JCP application offer detailed discussion on the physical characteristics of the project area:

- St. Lucie County South Beach and Dune Restoration Project Revised Design Document (Coastal Tech 2009, 2010b)
- Conditions Assessment Report (Coastal Tech 2009)
- Analysis, Modeling, and Impact Assessment (Coastal Tech 2009)

3.1.3. WAVES

Waves, primarily driven by local winds, provide an important sediment transport mechanism along the open coast of the project area. Analyses of hindcast wave data along the southeast Florida coast indicate seasonal effects on the wave climate. On average, higher wave heights occur during the winter months — storm season — and smaller wave heights occur during the summer months. Waves of greater height and period than those that occur during the winter months rarely occur, except during major storm activity. The majority of waves higher than 1.5 ft arrive from the northeast and east-northeast (**Figure 3.1-1**).

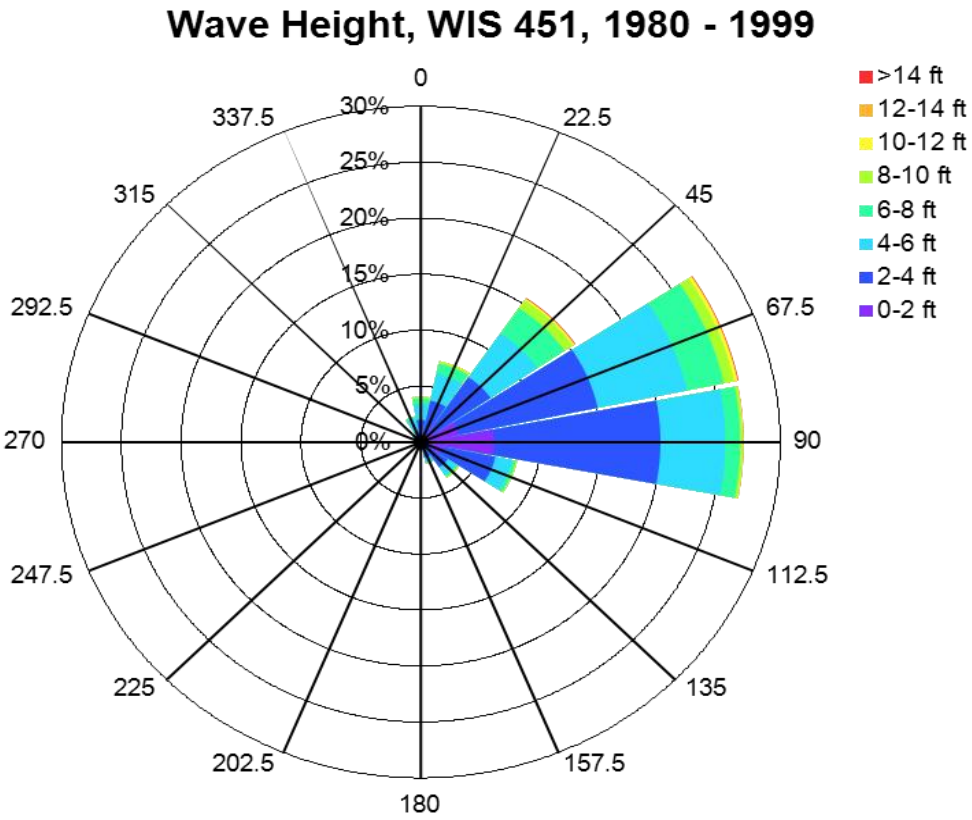

Figure 3.1-1. Wave Height Rose of WIS Station 451 (1980 – 1999)

3.1.4. WINDS

Winds directly transport sand onto the dry beach. They also generate waves, which transport sand on both the dry and wet beach. Characterizing a coastal site typically requires wind measurements on the beach because inland- and offshore-based wind measurements generally prove poor indicators of nearshore wind conditions. In the absence of wind data at the project site, the wind climate station at inland Vero Beach Municipal Airport (station KVRB) provided the data used to characterize local wind conditions. The KVRB wind data showed that winds in the general project area likely originate mostly from the east and southeast, and reach speeds from 10 – 20 mph about 34% of the time (**Figure 3.1-2**).

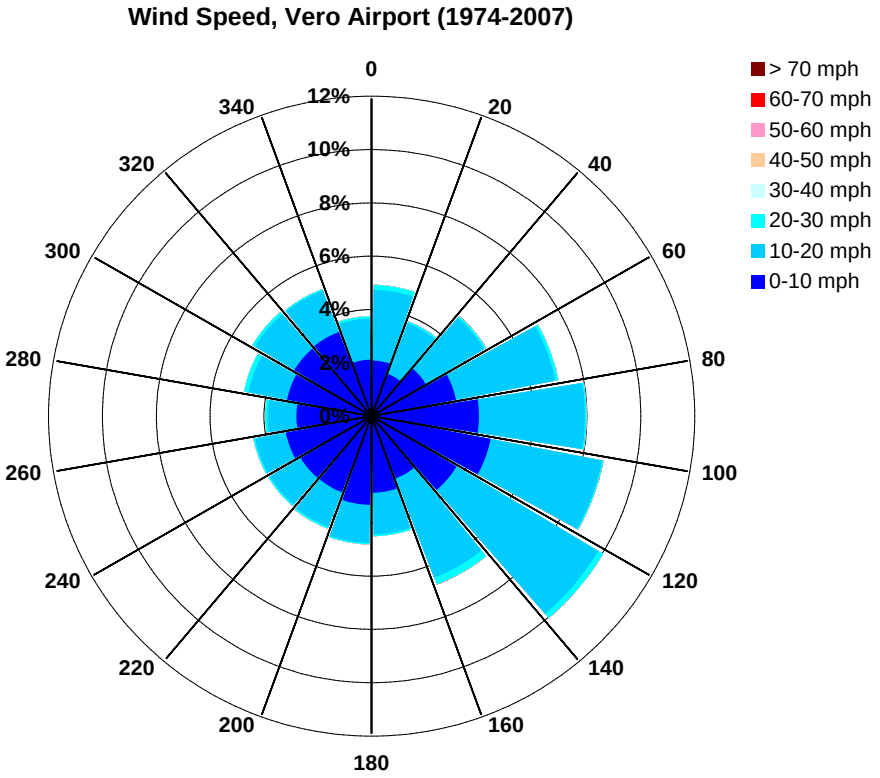

Figure 3.1-2. Wind Speed Rose at Station KVRB from 1974 – 2007

3.1.5. STORMS

Although tropical storms (i.e., tropical depressions, tropical storms, and hurricanes) generally move rapidly through an area, they can devastate a beach. Large wave heights, above-average water levels (i.e., storm surge), and high winds associated with hurricanes and tropical storms can cause significant erosion of the beach and dunes. On average, tropical storms or hurricanes pass near the study area about twice every three years. The most recent severe storms occurred during the 2004 and 2005 hurricane seasons. In August and September 2004, four hurricanes affected the project area: Frances and Jeanne passed through the project area; Charley passed through Florida west of the project area; and Ivan passed west of the Florida peninsula and project area and then returned east of the project area in the Atlantic Ocean. These hurricanes caused different extents of beach and dune erosion.

3.1.6. NATURAL PROCESSES

Aligned northwest-southeast, several beach morphologic regimes occur along the 3.8-mile project shoreline: some areas (R-80 to R-90.3; R-98 to R-115 +1000) have experienced critical erosion, while the other areas have reached a near-equilibrium or accretive state (FDEP 2007). Coastal Tech (2009: Attachment P: Conditions

Assessment Report) evaluated the historical shoreline — mean high water (MHW) location of +0.4ft NAVD — and volume changes for the Study Area (R-77 to R-115) from February 1972 to September 2008. The analysis showed that from 1972 to 2008

- A general erosion trend occurred throughout most of the Study Area.
- From R-77 to R-102, the beaches generally eroded and the shoreline generally retreated.
- The greatest volumetric losses and shoreline retreat occurred between R-90 and R-100.
- From R-103 to R-109, beaches slightly accreted and advanced slightly seaward.
- The significant amount of erosion and shoreline retreat between R-90 and R-100 corresponds to a change in shoreline orientation and a slight “embayment”.

3.1.7. SEA LEVEL RISE

Taylor Engineering modeled sea level rise in accordance with USACE Circular No. 1165-2-211 (USACE 2009). Circular No. 1165-2-211 specifies the use of three sea level rise rates for all civil works program — “low”, “intermediate,” and “high.” Best determined from tide gauges, low rates reflect the historic rate of sea-level change. The nearest NOS tide stations to the project area with sufficient historical data to measure sea level rise lie at Mayport and Daytona Beach north and Miami Beach south of the study area. The Mayport station showed an average sea level rise of 2.40 mm/yr with high confidence. The Daytona Beach station showed a rise of 2.32 mm/yr with lower confidence. The Miami Beach station showed a rise of 2.39 mm/yr with high confidence. Therefore, this analysis used data from Mayport and Miami Beach to estimate sea level rise for the St. Lucie County project area.

NOAA (http://www.co-ops.nos.noaa.gov) publishes mean sea level (MSL) trends for the Atlantic coast of Florida. Based on data (1928 – 1999) from Station 8720220 Mayport and data (1931 – 1981) from Station 8723170 Miami Beach, MSL rises 0.238 m and 0.244 m (0.80 and 0.78 ft) *per century*. These rates correspond to 2.38 and 2.44 mm per year. Adjusting the rate for the project location with respect to the location of the two tide gauges provided a project area low (baseline) total local sea level rise of 0.155 m over a 50-year period.

Gross sea level rise includes changes in land elevation, which vary around the globe. At this time, research located no local land elevation change data. In 2007, the Intergovernmental Panel on Climate Change (IPCC) published a global mean sea level rise of 1.7 ± 0.5 mm/yr in the twentieth century. In the absence of definitive local data, this analysis estimated a vertical land movement of -0.7 mm/yr in St. Lucie County (2.4 mm/yr – 1.7 mm/yr).

Estimates of intermediate and high rates employed the modified NRC-I and NRC-II curves (USACE 2009) to predict a sea level rise of 0.5 m and 1.5 m over 114 years (1986 to 2100). These data applied in the following equation (from USACE 2009) yielded the intermediate and high sea level rise rates in the project area:

$$E(t) = 0.0017t + bt^2$$

where $E_{(t)}$ is the amount of eustatic sea-level rise since 1986 in meters, t is the time in years since 1986, and b is a constant. Taylor Engineering formulated this equation to eliminate the constant b given that $E_{(t)}$ is known when t = 114 (in 2100).

$$E(t_2) = (t_2/t_1^2) * [0.0017*t_1*(t_1-t_2) + E(t_1)*t_2]$$

where t_1 always equals 114 years, and $E(t_1)$ equals 0.5 m for scenario NRC-I and 1.5 m for NRC-III. The analysis period begins in 2011 (t_2 = 25 years) and ends in 2061 (t_2 = 75 years).

Table 3.1-1 presents the results of the sea level rise calculation. The low rate represents the historic rate of sea level rise. The 2011 Sea Level and 2061 Sea Level come from the calculations above; the Average Sea Level Rise equals the difference between these two levels divided by 50 years. The Total Local Sea Level Rise incorporates the estimated vertical land movement (0.7 mm/yr).

Table 3.1-1. Estimated Sea Level Rise, Project Area in South St. Lucie County, FL. Rates Calculated According to USACE Circular 1165-2-211.

Rate	Average Sea Level Rise m/yr (ft/yr)	Total Local Sea Level Rise m/yr (ft/yr)	50-yr Total Local Sea Level Rise m (ft)
Low	0.0017 (0.0056)	0.0024 (0.0078)	0.12 (0.39)
Intermediate	0.0041 (0.013)	0.0048 (0.016)	0.24 (0.79)
High	0.012 (0.038)	0.013 (0.041)	0.63 (2.1)

3.1.8. SEDIMENT CHARACTERISTICS

Tables 3.1-2 and **3.1-3** present the available native beach and offshore sediment characteristics as reported by the Minerals Management Service (MMS 1995, 1999, 2002) (recently changed to the Bureau of Ocean Energy Management, Regulation and Enforcement [BOEM]), Coastal Planning and Engineering (CPE 2006), Coastal Tech (2009), and Taylor Engineering (2010).

Table 3.1-2. Native Beach Sediment Characteristics

Source	Location	Mean Grain Size (mm)	% Fines	% Carbonate	Sorting
MMS (1995, 1999, 2002)	R-3, R-25, R-33, R-38, R-47, R-66, R-76, R-93, R-111	0.62	N/A	60	N/A
CP&E (2006)	R-93, R-96	0.42	0.82	N/A	Poorly Sorted
Coastal Tech (2009)	R-77, R-80, R-85, R-90, R-95, R-98, R-100, R-105, R-110, R-115	0.46	0.19	53	Moderately Sorted
Taylor Engineering (2010)	Beach Composite	0.53	0.14	49.31	N/A

Table 3.1-3. Offshore Sediment Characteristics

Source	Location	Mean Grain Size (mm)	% Fines	% Carbonates	Sorting
MMS (2002)	St. Lucie Shoal, Development	0.40	1.98	87.5	0.89
	St. Lucie Shoal, Reconnaissance	0.43	1.652	85.4	0.902
CP&E (2006)	Pierce Shoal	0.43	2.99	N/A	1.26
	BA 1	0.39	3.14	N/A	1.21
	BA 2	0.47	2.43	N/A	1.23
	BA 3	0.42	3.25	N/A	1.33
	BA 4	0.43	2.27	N/A	1.30
	BA 5	0.44	1.97	N/A	1.09
Coastal Tech (1995, 1996)	Capron Shoal	0.42	1.73	N/A	1.03
	Shoal AB	0.53	1.20	N/A	1.22
	Shoal D	0.40	3.20	N/A	1.48
	Shoal E	0.39	1.50	N/A	0.79
	Shoal F	0.39	2.20	N/A	0.84

3.1.9. HARDBOTTOM

Nearshore sediments comprise marine sand. These sands are underlain by limestone of the Anastasia formation, which exhibits significant elevation differences over short spatial scales. Thus, exposure of the formation, termed “hardbottom”, in the nearshore environment occurs variably along the barrier island system in southeast Florida. Hardbottom, common in the project area, sometimes occurs in the surf zone but more frequently lies 300 ft – 1000 ft from the beach. Sand intermittently exposes or buries the hardbottom areas located in the surf zone and within the limits of the depth of

closure (-17 ft NAVD) depending on the elevation of the hardbottom and wave conditions (Coastal Tech 2010a). Digitization of hardbottom signatures identified in the October 21, 2010 aerial photographs provided the basis for the set of hardbottom maps (**Appendix M**) used in this EIS.

3.2. VEGETATION

Vegetation consisting of beach morning glory (*Ipomoea imperati*), railroad vine (*Ipomoea pes-capre*), sea grapes (*Coccoloba uvifera*), sea oats (*Uniola paniculata*), sea purslane (*Sesuvium sp.*), and beach elder (*Iva imbricata*) typically dominate the dune area. Due to the severe impact of Hurricanes Frances and Jeanne in 2004, the applicant implemented a dune restoration/revegetation project in southern St. Lucie County (Coastal Tech 2009: Design Document). The dune system from R-98 to R-101.4 and from R-103.3 to the St. Lucie/Martin County line was revegetated primarily with sea oats with occasional railroad vine, sea grapes, and sea purslane interspersed.

3.3. THREATENED AND ENDANGERED SPECIES

The project area lies within the coastal area of St. Lucie County, Florida. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have identified the threatened and endangered species listed **Table 3.3-1** as potentially occurring in St. Lucie County. Of the species listed in **Table 3.3-1**, the species most likely to occur within the project vicinity are the following: the five species of sea turtles, manatees, humpback and right whales, smalltooth sawfish, piping plover, and beach jacquemontia.

The Biological Assessment (BA) (**Appendix L**) discusses threatened and endangered species in detail, identifies potential project impacts on the species, and provides protection and conservation recommendations. The BA fulfills USACE requirements for initiation of consultation under Section 7(c) of the Endangered Species Act of 1973 (ESA).

Table 3.3-1. Federally Listed Threatened and Endangered Species that May Occur in St. Lucie County, Florida

Common Name	Scientific Name	Listing Status	
		USFWS	NMFS
PLANTS			
Fragrant prickly-apple	*Cereus eriophorus var. fragrans*	Endangered	-
Lakela's mint	*Dicerandra immaculata*	Endangered	-
Tiny polygala	*Polygala smallii*	Endangered	-
Beach jacquemontia	*Jacquemontia reclinata*	Endangered	
BIRDS			
Audubon's crested caracara	*Polyborus plancus audubonii*	Threatened	-
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	Endangered	-
Florida scrub-jay	*Aphelocoma coerulescens*	Threatened	-
Kirtland's Warbler	*Dendroica kirtlandii*	Endangered	-
Piping plover	*Charadrius melodus*	Threatened	-
Red-cockaded woodpecker	*Picoides borealis*	Endangered	-
Wood stork	*Mycteria americana*	Endangered	-
MAMMALS			
Florida panther	*Puma concolor coryi*	Endangered	
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	Threatened	
West Indian manatee	*Trichechus manatus*	Endangered	
Blue whale	*Balaenoptera musculus*	-	Endangered
Finback whale	*Balaenoptera physalus*	-	Endangered
Humpback whale	*Megaptera novaeangliae*	-	Endangered
Sei whale	*Balaenoptera borealis*	-	Endangered
Sperm whale	*Physeter macrocephalus*	-	Endangered
North Atlantic right whale	*Eubalaena glacialis*	-	Endangered
REPTILES			
American alligator	*Alligator mississippiensis*	Threatened/SA[1]	-
American crocodile	*Crocodylus acutus*	Threatened	-
Eastern indigo snake	*Drymarchon corais couperi*	Threatened	-
Green sea turtle	*Chelonia mydas*	Endangered	Endangered
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened	Threatened
FISH			
Smalltooth sawfish	*Pristis pectinata*	-	Endangered

[1] SA = Similarity of Appearance to a listed taxon
Sources: (USFWS website: http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=12111 accessed December 2010 and NOAA/NMFS website: http://sero.nmfs.noaa.gov/pr/endangered%20species/specieslist/PDF2010/Florida%20Atlantic.pdf accessed December 2010)

3.3.1. SEA TURTLES

St. Lucie County is within the normal nesting areas of three species of sea turtles: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), and leatherback sea turtle (*Dermochelys coriacea*). The loggerhead is listed as a threatened species, while all other sea turtles are listed as endangered under the U.S. Endangered Species Act of 1973. In St. Lucie County, the Florida Fish and Wildlife Conservation Commission defines March 1 through October 31 as the official nesting season for all species of sea turtles.

3.3.1.1. Nesting Habitat

Turtle nesting occurs in south St. Lucie County within the project area. Loggerhead, green, and leatherback turtles currently account for all nests in the project area (EAI 2007, 2008, 2009a).

Between 2000 and 2009, approximately 91.2% of the total sea turtle nests in the project area were loggerheads, followed by 7% green sea turtle nests, and 1.8 % leatherback sea turtle nests. During the six previous nesting seasons (2004 through 2009), project area nests totaled 1366, 1447, 1433, 1535, 1794, and 1626 (personal communication, Jonathan Gorham, Inwater Research Group; May 2010; personal communication, Beth Brost, FWC, July 2010).

The project area lies within two Statewide Nesting Beach Survey (SNBS) zones: North Hutchison Island (24.5 km) in St Lucie County and South Hutchison Island (12 km) in Martin County. FWRI (2008) reported the following nesting activity on North Hutchinson Island between 1993 and 2007:

- 68,602 loggerhead turtles (an average of 4,573 per nesting season)
- 2,478 green sea turtles (an average of 165 per nesting season)
- 964 leatherback turtles (an average of 64 per nesting season)

FWRI (2008) also reported the following nesting activity on the beaches of south Hutchinson Island, Martin County between 1993 and 2007:

- 26,152 loggerhead turtles (an average of 1,743 per nesting season)
- 812 green sea turtles (an average of 54 per nesting season)
- 898 leatherback turtles (an average of 60 per nesting season)

The Index Nesting Beach Survey (INBS) coordinates a detailed monitoring program in conjunction with SNBS. The State of Florida established this program to measure seasonal productivity, allowing comparisons between beaches and between years. Within the project area, this program divides the Atlantic beaches of Florida into 1 km zones with a separate letter designation for each zone. The project renourishment area includes INBS zones Q through Y. INBS zones P and Z comprise beach adjacent to nearshore mixing zone waters south of the project area. **Table 3.3-2** summarizes the

loggerhead sea turtle nests documented by INBS zone / FDEP reference monuments between 2000 and 2009.

Table 3.3-2. Loggerhead Sea Turtle Nests by INBS Zone in the Project Area (2000 – 2009)

LOGGERHEAD (Caretta caretta)

INBS Zone	R - Monument	Nests									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P	R-84 - R-87.5	267	232	184	155	138	178	116	185	154	122
Q	R-87.5 - R-91	371	270	216	200	218	337	213	212	240	193
R	R-91 - R-94.5	288	190	212	196	205	259	123	150	171	157
S	R-94.5 - R-98	470	390	351	289	241	408	168	162	320	255
T	R-98 - R-101	342	356	287	248	214	270	245	261	356	360
U	R-101 - R-104	344	346	371	292	249	184	155	162	243	215
V	R-104 - R-108	344	376	301	273	193	197	230	146	236	267
W	R-108 - R-111	274	217	246	212	197	68	213	195	259	185
X	R-111 - R-114.5	274	196	169	188	136	65	172	149	140	143
Y	R-114.5 - R-3.5	253	213	217	177	95	162	116	112	139	132
Z	R-3.5 - R-7	184	89	136	111	79	107	93	78	129	80
	Totals	**3411**	**2875**	**2690**	**2341**	**1965**	**2235**	**1844**	**1812**	**2387**	**2109**

Data Sources: INSB Zones P – S: personal communication, Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. INSB Zones T – Z personal communication, Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database July 1, 2010. Note: Zones P – S are year totals, while Zones T – Z include data between May 15 and August 31.

Table 3.3-3 summarizes the Green sea turtle nests documented by INBS zone / FDEP reference monument between 2000 and 2009.

Table 3.3-3. Green Sea Turtle Nests by INBS Zone in the Project Area (2000 – 2009)

GREEN TURTLE (Chelonia mydas)

INBS Zone	R - Monument	Nests									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P	R-84 - R-87.5	20	0	4	8	8	18	3	8	9	1
Q	R-87.5 - R-91	15	0	5	10	1	21	9	12	7	11
R	R-91 - R-94.5	16	1	13	8	5	38	11	26	14	8
S	R-94.5 - R-98	25	0	45	8	6	74	29	44	14	13
T	R-98 - R-101	52	2	42	8	13	40	31	89	74	40
U	R-101 - R-104	62	10	86	13	10	51	18	51	32	16
V	R-104 - R-108	23	1	47	4	15	15	7	24	15	10
W	R-108 - R-111	17	1	31	11	4	11	3	49	14	8
X	R-111 - R-114.5	22	0	18	3	3	3	6	19	4	7
Y	R-114.5 - R-3.5	20	1	10	2	4	11	2	12	6	0
Z	R-3.5 - R-7	11	0	6	0	1	5	2	6	3	3
	Totals	**283**	**16**	**307**	**75**	**70**	**287**	**121**	**340**	**192**	**117**

Data Sources: INSB Zones P – S: personal communication, Jonathan Gorham, Inwater Research Group, May 6, 2010. INSB Zones T – Z: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database July 1, 2010. Note: Data for zones Zones P – S reflect annual totals, while data for Zones T – Z reflect totals between May 15 and August 31.

Table 3.3-4 summarizes the Leatherback sea turtle nests documented by INBS zone / FDEP reference monument between 2000 and 2009.

Table 3.3-4. Leatherback Sea Turtle Nests by INBS Zone in the Project Area (2000 – 2009)

LEATHERBACK (Dermochelys coriacea)

INBS Zone	R - Monument	Nests									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
P	R-84 - R-87.5	2	1	1	1	0	2	0	3	0	0
Q	R-87.5 - R-91	2	0	2	2	1	1	0	4	1	2
R	R-91 - R-94.5	1	5	1	5	3	3	2	3	2	16
S	R-94.5 - R-98	5	13	10	15	10	19	4	16	7	32
T	R-98 - R-101	1	3	2	0	1	2	4	3	3	8
U	R-101 - R-104	0	3	6	3	2	2	1	7	9	3
V	R-104 - R-108	0	5	0	4	4	0	0	0	2	5
W	R-108 - R-111	0	5	3	5	4	1	3	6	6	7
X	R-111 - R-114.5	0	0	2	3	0	0	1	14	4	8
Y	R-114.5 - R-3.5	1	8	3	4	2	6	4	8	4	6
Z	R-3.5 - R-7	1	2	2	2	0	8	3	16	7	13
Totals		**13**	**45**	**32**	**44**	**27**	**44**	**22**	**80**	**45**	**100**

Data Sources: INSB Zones P – S: personal communication, Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. INSB Zones T – Z: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database, July 1, 2010. Note: Data for zones Zones P – S reflect annual totals, while data for Zones T – Z reflect totals between May 15 and August 31.

The data show that in the project area

- Loggerhead turtle nests varied between 1,812 in 2007 and 3,411 nests in 2000, with a 10-year average of 2367 nests;
- Green turtle nests varied between 16 in 2001 and 340 nests in 2007, with a 10-year average of 181 nests; and
- Leatherback turtle nests varied between 13 in 2000 and 100 nests in 2009, with a 10-year average of 45 nests.

3.3.1.2. Inner Shelf Habitat

Five sea turtle species occur on the eastern Florida inner shelf (shoreline to the 20-meter isobath). In order of abundance, based on results of sea turtle monitoring conducted in the project area, these species are the loggerhead, green, leatherback, hawksbill, and Kemp's ridley turtles (**Table 3.3-5**). The table orders the several species from highest to lowest abundance.

Table 3.3-5. Sea Turtle Species Potentially occurring on the Eastern Florida Inner Shelf (Adapted from: NMFS and USFWS, 1991a,b; 1992a,b; 1993; EAI, 2007, 2008, 2009a)

Common and Scientific Names	Status[1]	Life Stages Present	Abundance Within the Project Area	Seasonal Presence	Nesting Season
Loggerhead turtle (*Caretta caretta*)	T	Adults, subadults, juveniles, and hatchlings	Abundant	Year-round (most abundant during spring and fall migrations)	April to September
Green turtle (*Chelonia mydas*)	T/E[2]	Adults, subadults, juveniles, and hatchlings	Common	Year-round	July to August
Leatherback turtle (*Dermochelys coriacea*)	E	Adults, subadults, juveniles, and hatchlings	Rare	March to October	March to July
Hawksbill turtle (*Eretmochelys imbricata*)	E	Adults, subadults, juveniles, and hatchlings	Rare	Year-round	June to September
Kemp's ridley turtle (*Lepidochelys kempi*)	E	Juveniles and subadults	Rare	Year-round (most abundant during spring and fall migrations)	(no nesting in area)

[1] Status: E = endangered, T = threatened under the Endangered Species Act of 1973.
[2] USFWS lists green turtles as threatened except in Florida where breeding populations are listed as endangered. Due to inability to distinguish between the two populations away from the nesting beach, all green turtles occurring in U.S. waters are considered endangered (NMFS and USFWS, 1991a,b)..

The ESA protects all sea turtles in U.S. territorial waters. Currently, the USFWS lists leatherbacks as endangered and loggerheads as threatened. Except for the Florida breeding population, listed as endangered, USFWS also lists green turtles as threatened.

3.3.1.2(a) Loggerhead Turtle

Loggerhead turtles (*Caretta caretta*) are present year-round in Florida waters, with peak abundance occurring during spring and fall migrations. Data suggest that nesting adult females are short-term residents that migrate into east Florida waters at 2 to 3-year intervals and reside elsewhere during non-nesting years (Henwood 1987; Schroeder and Thompson 1987). Adult males do not seem to migrate with adult females but may reside in the vicinity of nesting beaches throughout the year. Following nesting activities, many adult loggerheads disperse to the seas around islands in the Caribbean Sea, waters off southern Florida, and the Gulf of Mexico (Meylan and Bjorndal 1983; Nelson 1988). Subadult loggerheads forage opportunistically along the Atlantic seaboard, although evidence suggests that a resident population of subadults overwinter in the Canaveral area each year (Henwood 1987). In Brevard, Indian River, and St. Lucie Counties, juvenile and subadult loggerheads occur throughout the year in estuarine habitats (Ehrhart 1983, 1992; Henwood 1987; Ehrhart and Redfoot 1996; Bresette et al. 2000; Ehrhart et al. 2001; Holloway-Adkins 2005; Provancha et al. 2005).

Juvenile loggerheads, which researchers believe overwinter along the eastern Florida inner shelf, depart in the spring (March – April) when adult males that migrate into the area to mate (Ryder et al. 1994) replace them. The adult loggerhead population (males and females) in Florida waters increases during the nesting season (Magnuson et al. 1990). In general, the eastern coast of Florida appears to provide an important year-round habitat for loggerhead sea turtles along both the inner shelf (0 to 20 meters) and middle shelf (20 to 40 meters) depths. The nearshore rock resources in these areas appear to represent a travel corridor (to nesting sites) rather than a main foraging or developmental habitat (Ryder et al. 1994). Juvenile loggerhead turtles generally feed on insects and invertebrates from within *Sargassum* mats (not present in the project area), while subadult and adult loggerheads primarily feed on bottom dwelling invertebrates (crabs, mollusks, shrimp) and macroalgae (Ryder et al. 1994).

On project beaches, hatchling turtles normally emerge between July and September during the night and swim offshore to begin a pelagic existence within *Sargassum* rafts, drifting in current gyres and convergence zones for several years (Carr 1987; Marine Turtle Expert Working Group 1996a; Witherington 2002). Post-hatchlings from the Florida coast eventually enter currents of the North Atlantic Gyre. At a carapace length of approximately 40 to 60 centimeters, they leave the pelagic environment and move into nearshore habitats (Carr 1987; Bowen et al. 1993).

3.3.1.2(b) Green Turtle

The USFWS considers the green turtle (*Chelonia mydas*) as common within the inner shelf waters off the project area. All life stages of green turtles occur during different times of the year in and around the project area. Ecological Associates, Inc. [EAI], (2009a, b,c,d,e,f,g) consistently observed all life stages adjacent to the southern portion of the project area during all seasons, with the most observations in June. Juvenile green turtles (approximately 2 to 5 years of age) also may move into shallow coastal and estuarine waters along the entire east coast of Florida (CSA International 2009b; Schmid 1995; Hirth 1997).

Florida comprises the major feeding grounds for green turtles in U.S. waters, where the turtles forage mainly on algae and the seagrass *Thalassia testudinum* (Burke et al. 1992). The nearshore waters of the project area include no seagrass (**Appendix J**).

Subadult green turtle habitats on the east coast of Florida include shallow estuarine environments such as the Indian River Lagoon (Ehrhart et al. 1996; Provancha et al. 1998; Bresette et al. 2000), deeper coral and limestone reefs in South Florida (Wershoven and Wershoven 1992; Makowski et al. 2002; Makowski 2004), and shallow nearshore habitats in Brevard, Indian River, and St. Lucie counties (Bresette et al. 1998; Ehrhart et al. 2001; Holloway-Adkins et al. 2002). Subadults also inhabit manmade environments such as shipping channels and turning basins (Henwood 1987; Redfoot 1997).

Several researchers have found juvenile green turtles over nearshore hardbottom habitats in the project area foraging on species of red algae (Ehrhart et al. 1996; Holloway-Adkins 2001; Holloway-Adkins 2005). The most frequently-consumed species were *Gelidium* spp., *Bryothamnion seaforthii*, *Hypnea* spp., *Gracilaria* spp., *Laurencia* spp., and *Bryocladia cuspidata*. The same reports also described juvenile green turtle consumption of a variety of small invertebrates and occasional portions of jellyfish. However, the overall results indicate juvenile green turtles in nearshore hardbottom habitats feed as herbivores (Holloway-Adkins 2001; Gilbert 2005, Holloway-Adkins and Provancha 2005). Sand, pieces of rock, and shell debris found in foraging samples indicate green turtles forage close to the substrate and, either incidentally or selectively, ingest these non-nutritional items for unknown reasons. Stranding events and foraging studies indicate that sea turtles at all life stages are susceptible to ingesting anthropogenic debris (Balazs 1985; Carr 1987; Witherington 2002).

3.3.1(c) Leatherback Turtle

Adult leatherback (*Dermochelys coriacea*) turtles reportedly occur in east Florida waters primarily during summer; aerial surveys also have sighted leatherback turtles off northeast Florida from October through April (Schroeder and Thompson 1987, Knowlton and Weigle 1989, CSA 2002). During these surveys, leatherbacks occurred on the mid-shelf and inner shelf but not usually near shore (CSA 2002). However, historical data suggest that leatherbacks also may use inner shelf waters during periods of local thermal fronts that concentrate food resources (Thompson and Huang, 1993). The cryptic behavior of hatchling and/or juvenile leatherback turtles has resulted in little knowledge of their pelagic distribution. Leatherback turtles occur very rarely in the nearshore waters of the project area.

3.3.1.2(d)Hawksbill Turtle

Hawksbill turtles (*Eretmochelys imbricata)* occur in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans. In the western Atlantic, hawksbill turtles generally inhabit clear tropical waters near coral reefs, including the southeast Florida coast, Florida Keys, the Bahamas, Caribbean Sea, and southwestern Gulf of Mexico (NMFS and USFWS 1993).

Pelagic hatchling hawksbills drift with *Sargassum* rafts. Available data suggest they are herbivorous during this period but become more omnivorous as they age (Ernst et al. 1994). Juveniles shift to a benthic foraging existence in shallow waters, progressively moving to deep waters as they grow and become capable of deeper dives for sponges (Meylan 1988, Ernst et al. 1994). Adult hawksbills typically associate with coral reefs and similar hardbottom areas where they forage on invertebrates, primarily sponges. No nesting or boat survey performed during 2006, 2007, and 2008 observed any hawksbill nests or animals in the project area (EAI 2007, 2008, 2009a,b,c,d,e,f,g).

3.3.1.2(e) Kemp's ridley Turtle

The Kemp's ridley (*Lepidochelys kempi*) is the smallest and most endangered of the sea turtles. Its distribution includes the Gulf of Mexico and southeast U.S. coast, although some individuals have ventured as far north along the eastern seaboard as Nova Scotia and Newfoundland (Marine Turtle Expert Working Group, 1996b). Adult Kemp's ridley turtles occur almost exclusively in the Gulf of Mexico, primarily on the inner shelf (Byles 1988). Kemp's ridley hatchlings inhabit offshore *Sargassum* mats and drift lines associated with convergences, eddies, and rings. Gulf and Atlantic surface currents widely disperse the hatchlings. After reaching a size of about 20 to 60 centimeters carapace length, juveniles enter shallow coastal waters (Marine Turtle Expert Working Group 2000).

Post-pelagic (juvenile, subadult, and adult) Kemp's ridley turtles feed primarily on portunid crabs, but also occasionally eat mollusks, shrimp, dead fishes, and vegetation (Mortimer 1982, Lutcavage and Musick 1985, Shaver 1991, NMFS and USFWS 1992a, Burke et al. 1993, Werner and Landry 1994). The Kemp's ridley is considered very rare in nearshore waters of the project area. No nesting or boat survey performed during 2006, 2007, and 2008 observed any Kemp's ridley nests or animals in the project area (EAI 2007, 2008, 2009a,b,c,d,e,f,g).

3.3.2. MARINE MAMMALS

Three federally-listed species of marine mammals occur on the inner shelf (shoreline to the 20-meter isobath) of the project area (**Table 3.3-6**). The table orders the several species by relative abundance (highest to lowest).

Table 3.3-6. Endangered Marine Mammal Species Potentially Occurring on the Eastern Florida Inner Shelf (Wiley et al. 1995, USFWS 2001, http://www.neaq.org)

Common and Scientific Names	Status[1]	Life Stages Present	Abundance within the Project Area	Seasonal Presence
Florida manatee (*Trichechus manatus latirostris*)	E	Adults, subadults, and juveniles	Common	Year-round (most abundant during winter)
Humpback whale (*Megaptera novaeangliae*)	E	Adults, subadults, and juveniles	Rare	December to March
North Atlantic right whale (*Eubalaena glacialis*)	E	Adults, subadults, and juveniles	Rare	December to March

[1] Status: E = endangered.

3.3.2.1. Florida Manatee

The West Indian manatee is one of the most endangered marine mammals in coastal waters of the U.S. In the southeastern U.S., manatees are limited primarily to Florida

and Georgia. This group constitutes a separate subspecies called the Florida manatee (*Trichechus manatus latirostris*) that comprises four recognized populations or management stocks (Atlantic Coast, Southwest, Upper St. John's River, and Northwest), based on regional manatee wintering sites (http://www. nefsc.noaa.gov/nefsc/publications/tm/tm213/F2009App6.pdf; USFWS, 2001). Adult Florida manatees average about 3.0 m (9.8 ft) in length and 1,000 kg (2,200 lbs.) in weight. Their maximum lifespan is approximately 59 years. Age of first pregnancy is 3 to 4 years, and their gestation period for a single calf is 11 to 14 months, with an average interbirth interval of 2.5 years (USFWS 2001).

Manatees are seen mostly as solitary individuals or in groups of up to six individuals. Some larger aggregations may occur, such as feeding groups that may number up to approximately 20 individuals and winter aggregations near sources of warm water (such as power plant outfalls) that may contain hundreds of individuals (Jefferson et al. 2008).

Most manatees in the southeastern U.S. migrate between a summer range and a winter range, determined by water temperature changes. During winter months, the Florida manatee population confines itself to coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeastern Georgia (USFWS 2001). As water temperatures rise in spring, individuals disperse from these winter aggregation areas, some migrating as far north as coastal Virginia (USFWS 2001). Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range. They are usually found in canals, rivers, estuarine habitats, and saltwater bays, but on occasion have swum as far as 3.7 miles off the Florida coast (USFWS 2001). Within St. Lucie County, manatees are most frequently observed in the Indian River Lagoon and other inland waters. Individual and small groups of manatees are regularly sighted within shallow nearshore waters off St. Lucie County, including the Ft. Pierce Inlet (personal communication, Applicant's consultant, August 2010) and may graze on the algae present on the intermittent nearshore exposed hardbottom present in the project area.

In 1976, the USFWS designated critical habitat for this species. All of the critical habitat areas are located in peninsular Florida, predominantly along the inland waters of the southwest and southeast coasts (USFWS 2001). However, the project area is not designated as critical habitat.

3.3.2.2. Humpback Whale

The humpback whale (*Megaptera novaeangliae*), federally listed as endangered, is a large baleen whale with a maximum length of about 52 feet (16 meters). Humpback whales range from the Arctic to the West Indies. During summer, at least five geographically distinct feeding aggregations occur in the northern Atlantic (Blaylock et al., 1995). During fall, humpbacks migrate south to the Caribbean where calving and breeding occurs from January to March (Blaylock et al. 1995). Aerial surveys during the Cetacean and Turtle Assessment Program (CETAP) detected only a few humpback whale sightings from New Jersey southward during any season (Winn 1982). However, subsequently there have been numerous sightings and strandings off the mid-Atlantic and southeastern U.S. coast, particularly during winter and spring (Swingle et al. 1993,

Wiley et al. 1995). Most of the stranded animals were juveniles, suggesting that the area may provide an important developmental habitat (Wiley et al., 1995). Humpbacks feed largely on euphausiids and small fishes such as herring, capelin, and sand lance, and Blaylock et al. (1995) correlated their distribution largely to prey species distribution and abundance. Calving and breeding occurs in the Caribbean from January to March (Tove 2000).

The humpback whale is rarely sighted within the vicinity of St. Lucie County during its spring/fall migration.

3.3.2.3. North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) is one of the most endangered whales in the world. The New England Aquarium's Atlantic right whale research and conservation initiative estimates a total world population of about only 400 (New England Aquarium 2010). North Atlantic right whales range from Iceland to eastern Florida, primarily in coastal waters. This species uses the waters around Cape Cod and Great South Channel to feed, nurse, and mate during summer (Kraus et al. 1988, Schaeff et al. 1993). From June to September, most animals feed north of Cape Cod. Southward migration occurs offshore from mid-October to early January (Kraus et al. 1993). Coastal waters of the southeastern U.S. (off Georgia and northeastern Florida) are important wintering and calving grounds for North Atlantic right whales. Migration northward along the North Carolina coast may begin as early as January but primarily occurs during March and April (Firestone et al 2008, Minerals Management Service [MMS] 1990).

Designated critical habitat for the North Atlantic right whale includes portions of Cape Cod Bay and Stellwagen Bank and the Great South Channel (off Massachusetts) and a strip of near coastal waters extending from southern Georgia to Sebastian Inlet, Florida; therefore, the project area lies south of the critical right whale habitat . The southern critical habitat area widens near the Georgia-Florida boundary where the highest concentrations of individual whales gather during their winter calving season (typically December through March, with peak calving in December and January). During this time, the population consists primarily of mothers and newborn calves, some juveniles, and occasionally some adult males and noncalving adult females (http://www.neaq.org). Sightings of North Atlantic right whales within waters off Florida are limited to late fall to early spring months. Sightings are concentrated near northeastern Florida and southeastern Georgia; however, sightings of individual whales have been reported as far south as Palm Beach County, Florida.

3.3.3. SMALLTOOTH SAWFISH

The smalltooth sawfish (*Pristis pectinata*), currently listed as endangered by NMFS, rarely occurs within the project area. This species has become rare along the southeastern Atlantic and northern Gulf of Mexico coasts of the U.S. during the past 30 years, with its known primary range now reduced to the coastal waters of Everglades National Park in extreme southern Florida. Fishing and habitat degradation have extirpated the smalltooth sawfish from much of this former range.

The smalltooth sawfish, distributed in tropical and subtropical waters worldwide, normally inhabits shallow waters (10 m or less), often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters (20 m) of the continental shelf. Shallow water less than 1 m deep appears an important nursery area for young smalltooth sawfish. Maintenance and protection of habitat is an important component of the smalltooth sawfish recovery plan (NMFS, 2006). Recent studies indicate that key habitat features (particularly for immature individuals) nominally consist of shallow water, proximity to mangroves, and estuarine conditions. Smalltooth sawfish grow slowly and mature at about 10 years of age. Females bear live young, and the litters reportedly range from 15 to 20 embryos requiring a year of gestation (NMFS 2006a). Their diet consists of macroinvertebrates and fishes such as herrings and mullets. The smalltooth sawfish reportedly uses its saw to rake surficial sediments in search of crustaceans and benthic fishes or to slash through schools of herrings and mullets (NMFS 2006a).

3.3.4. PIPING PLOVER

The piping plover *(Charadrius melodus)* is a rare to uncommon winter resident that can occur along both the Gulf and Atlantic coasts between September and April. Although found on both coasts, they are more common along the Gulf of Mexico. The piping plover is listed as endangered in Canada and the inland United States, and is threatened along the coast. This small shorebird can occur inland but prefers sandy beaches and tidal mudflats where it forages along the waterline or high up the beach along the wrack line. Piping plovers eat a variety of insects and aquatic invertebrates. Declines have resulted from direct and unintentional harassment by people, dogs, and vehicles; destruction of beach habitat for development; and changes in water level regulation (Haig 1992).

A winter census stated that approximately 20 – 30 piping plovers occur along the Atlantic coast from Duval County south to Brevard, St. Lucie, and Miami-Dade Counties (Florida Natural Areas Inventory [FNAI] 2001). EAI conducted a piping plover survey in the vicinity of the project area (St. Lucie Inlet) from January to May 2009 in support of permitting planned dune restoration project at Bathtub Beach Park on Hutchinson Island. According to Robert Ernest, EAI documented one sighting of a piping plover in or near the project area, but its occurrence there is very rare, given the high amount of human use and associated disturbances. Only one solitary bird has been observed on the Atlantic beaches of Hutchinson Island, located a considerable distant from the inlet (personal communication, Robert Ernest, EAI August 2009). Designated critical habitat for wintering piping plovers occurs south of the project area on Jupiter Island, Martin County, Florida. No critical habitat is designated within the project area.

3.3.5 BEACH JACQUEMONTIA

Beach jacquemontia *(Jacquemontia reclinata),* or beach clustervine*,* is an endangered coastal dune plant endemic to the southeastern coast of Florida. This low-growing, creeping vine typically inhabits the lee side of stable, vegetated dunes, disturbed

openings in maritime hammocks, coastal strand, and coastal scrub. The species produces somewhat fleshy leaves up to 3 cm long and white, star-shaped flowers. Currently, only a few populations remain along the east coast of Florida from Martin County south to Dade County. The primary threats to its continued existence include habitat loss and fragmentation from coastal development and erosion, and displacement from non-native, invasive species such as Brazilian pepper (*Schinus terebinthifolius*).

In its letter dated 14 December 2011, the USFWS indicated that based on observations made in January 2010, the endangered beach jacquemontia may occur within the project area. The potential location(s), quantity, and current vegetative state are unknown for beach jacquemontia specimens that may occur within the project area.

3.4. HARDBOTTOM

Nearshore hardbottom features along the project area comprise marine components of the Anastasia formation, including lithified shell fragments (especially coquina clam), quartz sand, and calcium carbonate (Cooke and Mossom 1929, Cooke 1945). These features parallel the shoreline, extend through the intertidal and subtidal zones, and range from relatively wide expanses of pavement-like platforms with ledges to isolated patches of rocks. The ledges typically have exposed vertical faces and overhangs along the shoreward edges. Nearshore hardbottom in this area is ephemeral in nature due to high wave energy and a dynamic sedimentary environment. The majority of hardbottom observed in the project area includes partially exposed rock with sand veneers of varying depths (**Appendix J**).

The sabellariid tubeworm *Phragmatopoma lapidosa* (also known as *P. caudata*) colonizes nearshore hardbottom in portions of the project area. This colonial species settles in intertidal and subtidal hardbottom areas and uses sand particles in concert with a mucoprotenaceous cement to construct dwelling tubes resulting in construction of reef-like structures (Gore et al. 1978, Nelson and Demetriades 1992; Kirtley 1994; Drake et al. 2007). This “worm rock” is somewhat ephemeral, as storm waves and burial by sediments may destroy the structures (CSA International 2009b) and the species typically constructs the worm rock only from early summer through fall. Although *P. lapidosa* is capable of spawning year-round (Eckelbarger, 1976; McCarthy et al. 2003), spawning peaks in summer and fall (McCarthy et al., 2003). Sabellariid worms have an opportunistic life history typified by fast-growth, short time to sexual maturity, and hardiness regarding physical disturbance (McCarthy et al. 2003). Although *P. lapidosa* is quite resilient to turbidity (Main and Nelson 1988), studies evaluating sediment burial tolerance of *P. lapidosa* colonies within St. Lucie and Brevard counties found increased mortality linked to both depth of sediment cover and duration of burial (Main and Nelson 1988, Sloan and Irlandi 2008).

Off the east coast of Florida, the structure provided by nearshore hardbottom and associated worm rock supports locally moderate to high diversities and abundances of algae, fishes, and invertebrate groups including sponges, hydroids, mollusks, crustaceans, bryozoans, ascidians, and cnidarians (Kirtley 1966, Gore et al. 1978,

Nelson 1989, Lindeman and Snyder 1999, Coastal Planning and Engineering 2006a, **Appendix J**). Considered important nursery habitat for juvenile fishes (Sloan and Irlandi 2008), nearshore hardbottom also provides shelter and/or foraging grounds for sea turtles (Ehrhart et al. 1996, Wershoven and Wershoven 1992, Holloway-Adkins 2001, CSA International 2009b). Corals and/or octocorals occur only rarely in the project area due to seasonal changes (decreases) in water temperature; however, hardbottom areas in deeper water further offshore support octocorals and several genera of scleractinian corals including *Oculina*, *Siderastrea*, and *Phylangia* (**Appendix J**).

Substantial geological evidence suggests that nearshore hardbottom and/or worm rock are also important in the maintenance and persistence of beaches and barrier islands by dissipating wave energy and retaining sediments, and thus increasing the volume of standing sand on beaches adjacent to large worm rock habitat (Gram 1965; Kirtley 1966, 1967; Multer and Milliman 1967; Kirtley and Tanner 1968; Mehta 1973; Kirtley 1974).

As reported in the DEIS, analysis of 2008 aerial photography with transect ground verification showed about 10.4 acres of hardbottom habitat in the nearshore Atlantic Ocean adjacent to the project (from FDEP reference monuments R-87.7 to R-90.3, and from R-98 to R-115+1,000 ft [St. Lucie/Martin County line]). However, the same analysis of 2010 aerial photography estimated 12.97 acres of hardbottom in the same project area. This EIS used the 2010 mapping results for impact analysis. (See **Appendix M** for 2008 maps overlain with applicant's initial plan and 2010 maps overlain with the applicant's preferred alternative). Of the total 2010 hardbottom area, the applicant's preferred alternative would impact 0.57 acre (**Table 2.6.2**).

As discussed in **Section 2.6.1.2**, field survey data were used to identify the hardbottom communities as Community One or Community Two (**Appendix J**). In the northern section of the project area, between reference monuments R-87.7 and R-90.3, hardbottom includes an often discontinuous, low- to medium-relief landward edge with a significant worm rock component (**Appendix J**: Community One). The landward edge of hardbottom is relatively close to shore (within 10 to 20 meters of the mean high water line – MHWL). Hardbottom continues seaward as a series of well-exposed, shore-parallel ledges with vertical relief of 0.5 to 1.0 meters, alternating with partially-exposed, pavement-like platforms. Generally, hardbottom covers the nearshore area in a relatively continuous distribution (**Appendix J**).

Data from the first 50 meters seaward of the shore along each of two monitoring transects surveyed (located at reference monuments R-88.7 and R-90.4) during summer 2009 (**Appendix J**) provided detailed estimates of biological benthos within the footprint of the northern section of the project area. Percent cover of macroalgae ranged from 10% to 70% at individual sampling locations (*in situ* 0.5 square meter quadrats), with an average cover of 35.8%. Red algae dominated the algal community with an average cover of 20.3%, followed by turf algae at 9.5%. Dominant species of red algae included *Laurencia* sp., *Bryothamnion seaforthii*, *Chondria* sp., and *Hypnea musciformes*. Cover of sessile macroinvertebrates ranged from 0% to 15% at individual sampling locations, with an average cover of 1.3%. *P. lapidosa* dominated the

invertebrate community, although other observed invertebrates included hydroids, solitary (*Cinachyra* sp.) and encrusting sponges, encrusting tunicates, holothuroids (*Holothuria grisea*), and various small crabs and other mollusks.

In the southern section of the project area, between reference monuments R-99.5 and R-107, hardbottom occurs as a discontinuous landward edge (**Appendix J**). The landward edge of hardbottom in this region generally occurs as an undercut coquina rock ledge with low relief (of 0.25 to 1.0 meter or 9-39 inches vertical rise) and relatively less biotic cover than Community One (**Appendix J**: Community Two).

Between monuments R-98.5 to just north of R-104, the landward edge of hardbottom is located approximately 40 meters from the MHWL, whereas from just south of monument R-104 to R-107, the landward edge of hardbottom lies approximately 17 to 40 meters from the MHWL. Hardbottom continues seaward as a series of low-relief ledges with a vertical relief of 0.25 to 1.0 meters, alternating with partially-exposed, pavement-like platforms. Worm rock occurs in the intertidal zone near monuments R-101, R-104.5, and R-105.9; hardbottom (including worm rock) in this section showed more evidence of sand-scouring and a dynamic sedimentary environment with minimal to moderate algal cover dominated by turf algae.

Data from the first 50 meters seaward of the shore along each of the six monitoring transects (located at monuments R-100, R-101, R-102, R-103.2, R-104.5, and R-105.9) surveyed during summer 2009 (**Appendix J**) provided more detailed estimates of biological benthos within the footprint of the southern section of the project area. Cover of macroalgae ranged from 0% to 60% at individual sampling locations, with an average cover of 25%. Turf algae dominated the vegetative community with an average cover of 18.5%, followed by green algae at 4.7%. *Caulerpa prolifera* almost completely dominated the green algae component present along the transects. This species commonly occurs on hardbottom outcrops in the intertidal zone in St. Lucie and Indian River counties (CSA International 2009c, **Appendix J**). Sessile macroinvertebrates on transects located between monuments R-100 and R-103.2 provided only a small fraction of total cover (0% to 3% at individual sampling locations) and included no worm rock.

Cover of sessile macroinvertebrates at monuments R-104.5 and R-105.9 ranged from 0% to 100% due to localized abundance of worm rock in the intertidal zone. Other invertebrates observed along these transects included barnacles, hydroids, solitary (*Cinachyra* sp.) and encrusting sponges, encrusting tunicates, holothuroids (*Holothuria grisea*), and various small crabs and other mollusks. **Table 3.4-1** provides a synopsis of dominant hardbottom community components, ordered by relative abundance.

Table 3.4-1. Taxa on Nearshore Hardbottom Habitat in Eastern Central Florida (CSA International 2010a)

Common and Scientific Names	Life Stages Present	Abundance Within the Project Area	Seasonal Presence
Macroalgae	Spores and adults	Common	Year-round (perennial species) and May-October (annual species)
Invertebrates (crustaceans, echinoderms, and mollusks)	Larvae, juveniles, and adults	Common	Year-round
Sponges	Larvae, recruits, and adults	Common	Year-round
Sabellariid worm rock (*Phragmatopoma lapidosa*)	Larvae, recruits, and adults	Common to Occasional	Year-round
Scleractinian Corals (e.g. *Phylangia americana*, *Siderastrea* spp., *Oculina* spp.)	Larvae, recruits, and adults	Rare	Year-round
Octocorals	Larvae, recruits, and adults	Rare	Year-round

Hardbottom Community Three consists of faunal species that were not observed in the more nearshore hardbottom areas including spiny lobster (*Panulirus argus*), octocorals (*Leptogorgia sp.*), holothuroids, and a variety of encrusting sponges. The hardbottom is characterized by large (1 to 3 m diameter), flat rock structures found in deeper (3 to 4 m) water farther from the shoreline than Communities One and Two. Octocorals were observed in Community Three, which is located further offshore and would not be impacted by the implementation of the project; however, they are included in the monitoring transects. Because Community Three is further offshore, it would not be impacted by the build alternatives and will not be addressed in further sections of the EIS.

During the 2010 monitoring event (**Appendix J**), three scleractinian coral polyps were observed in one quadrat on one transect (R-104.5). No scleractinian corals were observed in any quantitative or qualitative video transects. One octocoral was observed during the point count analysis of one transect (R-78.7). Octocorals constituted less than 1% mean coverage along transect R-78.7, which is outside the project area. One stony coral species (*Phyllangia americana americana*, cup coral) also constituted less than 1% mean coverage along transect R-110.5, a transect that starts 188 m from the mean high water line and would not be affected by the project.

3.5. FISH AND WILDLIFE RESOURCES

3.5.1. NEARSHORE SOFT BOTTOM COMMUNITIES

Soft bottom macrobenthic and infaunal communities located within the nearshore portion of the project area experience highly dynamic conditions due to the high energy

wave action in the intertidal surf zone. As discussed in **Section 3.4**, a portion of this environment comprises hardbottom (worm rock and exposed Anastasia rock formations). The remainder of the nearshore environment consists of medium to coarse quartz sand and shell hash coarse carbonate/quartz sand bottom with the assemblages of plants and animals that use these soft bottom habitats.

The project area also includes three large shore-parallel sand gaps that lack nearshore hardbottom structures or feature only very small patches of exposed hard substrate. These areas locate between FDEP reference monuments R-98 to R-99, R-107 to R-109, and R-112 to R-2 and consist of primarily fine, unconsolidated sand substrate (**Appendix J**). In tropical and subtropical areas, the ghost crab genus Ocypode typically dominates the upper beach area. Mole crabs (*Emerita*), haustoriid amphipods, and bivalves (*Donax*) are numerical dominants in the intertidal area, while polychaetes, other amphipod species, and bivalves increase in abundance in the subtidal nearshore areas (Pearse et al. 1942, Dahl 1952, Spring 1981).

Gorzelany and Nelson (1987) studied the effects of beach nourishment on intertidal and subtidal infaunal communities in the Indialantic and Melbourne Beach area. The study listed 99 taxa with *Donax* spp. as the numerically dominant group followed by the polychaete *Happloscoloplos fragilis*, the amphipods *Parahaustorius longimerus* and *Bathyporeia parkeri*, and the polychaete *Paraonis fulgens*. Species richness and density decreased in winter, increased in spring and summer, and decreased in fall. These population shifts did not seem attributable to beach nourishment effects but rather to natural seasonal variations.

3.5.2. OFFSHORE BORROW AREA SOFT BOTTOM COMMUNITIES

Infaunal organisms present in the soft bottoms offshore central east Florida are predominantly common invertebrates including crustaceans, echinoderms, mollusks, polychaetous annelids, and interstitial bryozoans. Infaunal populations exhibit both seasonal and spatial variability in distribution and abundance, due to temperature, sediment topography, bathymetry, and sediment composition, including particle size and organic content (Hammer et al. 2005).

Epifaunal invertebrates commonly occurring on the soft bottoms offshore central east Florida include lady crabs (*Ovalipes* spp.), calico scallop (*Argopecten gibbus*), calico box crab (*Hepatus epheliticus*), iridescent swimming crab (*Portunus gibbesii*), brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), striped sea star (*Luidia clathrata*), and arrowhead sand dollar (*Encope michelini*). The distribution on the epifaunal invertebrates listed above exhibit distributions that are depth-, temperature-, and sediment type-related (Hammer et al. 2005).

Distribution of interstitial bryozoans has recently been studied at shoals located offshore St. Lucie County, including the St. Lucie Shoal. In a study conducted for the U.S. Army Corps of Engineers, Brostoff (2002) identified an average of 19 different species located within the samples from the St. Lucie Shoal, with *Cupuladria doma* the exceedingly dominant species collected. Previous studies of Capron Shoal (north of St. Lucie

Shoal) by Winston and Håkansson (1986) described the bryozoan population as adapting to varying interstitial conditions. Such adaptations include small size, simplified colony structure, and very early reproduction. The distribution of encrusting bryozoans extends along sandy continental shelves, providing a food source for crustaceans, echinoderms, and mollusks (Winston and Håkansson 1986).

3.5.3. NEARSHORE HARDBOTTOM FISH ASSEMBLAGES

An investigation conducted during 2009 documented the fish assemblage associated with the nearshore hardbottom of the project area (**Appendix J**). The extant assemblage comprised primarily reef-associated species generally expected for the region (Gilmore et al. 1981, CSA International 2009b). Although the assemblage consisted of 70 species, numerical dominants included black margate (*Anisotremus surinamensis*), silver porgy (*Diplodus argenteus*), newly settled grunts (*Haemulon* spp.), sailors choice (*H. parra*), hairy blenny (*Labrisomus nuchipinnis*), and porkfish (*A. virginicus*). The grunt family (Haemulidae), represented by nine taxa, dominated taxonomically in the project area.

CSA International identified 24 federally managed species during 2009 surveys of the nearshore hardbottom (**Appendix J**). Represented primarily by the grunt and jack families, many of these managed species also occurred as newly settled or juvenile stage individuals, indicating that the area serves as effective juvenile habitat for most of the managed species recorded. The South Atlantic Fishery Management Council (SAFMC 1998) includes most of the 24 managed species reported in **Appendix J** as members of the snapper-grouper complex. The CSA survey also reported two other managed species, a coastal pelagic species (Spanish mackerel, *Scomberomorus maculatus*) and a coastal shark (nurse shark, *Ginglymostoma cirratum*). Other economically important or notable species observed near or over hardbottom, but not formally recorded during timed swims or in strip transects during the survey include snook (*Centropomus undecimalis*), bonnethead shark (*Sphyrna tiburo*), tarpon (*Megalops atlanticus*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), and Florida pompano (*Trachinotus carolinus*). Although not a federally managed fishery species, the striped croaker (*Bairdiella sanctaeluciae*), a federally designated species of special concern (Gilmore and Snelson 1992) was recorded at five of the survey transects.

3.5.4. COASTAL PELAGIC FISH

The major coastal pelagic families occurring in inshore and coastal waters of the project area include ladyfish, anchovies, herrings, mackerels, jacks, mullets, bluefish, and cobia. Coastal pelagic species migrate over the region's shelf waters throughout the year. Some species form large schools (e.g., Spanish mackerel), while others (e.g., cobia) travel alone or in smaller groups. Many coastal pelagic species inhabit the nearshore environment along beaches and barrier islands of eastern Florida (Gilmore et al., 1981; Peters and Nelson 1987). Commonly occurring species in the project area include anchovies (*Anchoa* spp.), menhaden (*Brevoortia* spp.), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), hardhead catfish (*Ariopsis felis*),

and Florida pompano (*Trachinotus carolinus*). Concentrations of anchovies, herrings, and mullets in nearshore areas may attract larger predatory species (particularly bluefish, blue runner, jack crevalle, sharks, and Spanish mackerel). The presence and density of most coastal pelagic fish species depend on water temperature and quality, which vary spatially and seasonally.

3.5.5. SEABIRDS AND SHOREBIRDS

A number of seabirds and shorebirds may occur along the beach and offshore the project area, including a number of species considered birds of conservation concern by the Migratory Bird Treaty Act of 1918 (MBTA). These species are likely to become candidates for listing under the Endangered Species Act. According to the Florida Natural Areas Inventory (FNAI 2010), all of the migratory species listed in the MBTA, except for the Audubon's shearwater, marbled godwit, and the semipalmated sandpiper, have been observed within St. Lucie County. These species all use sandy beaches for foraging and/or nesting and, therefore, could occur along the project area both onshore and offshore.

3.6. ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act requires identification of habitats needed to create sustainable fisheries and comprehensive fishery management plans with habitat inclusions. The act also requires preparation of an EFH assessment (**Appendix N**) and coordination with NMFS when EFH impacts occur.

EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity" [16 U.S.C. § 1801(10)]. Waters are defined as aquatic areas and their associated physical, chemical, and biological properties that fish use during each stage of their cycle. Substrate includes "sediment, hardbottom, structures underlying the waters, and associated biological communities". Necessary is defined as "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem." Fish includes finfishes, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds, whereas "spawning, breeding, feeding, or growth to maturity" covers the complete life cycle of species of interest.

The SAFMC (South Atlantic Fisheries Management Council) holds responsibility for managing fisheries and habitat in the waters of the project area and has produced several Fisheries Management Plans (FMPs) for single and mixed groups of species. All of these FMPs — including those for penaeid shrimp, spiny lobster, red drum, snapper-grouper (reef fishes) and coastal migratory pelagics — were amended in a single document (SAFMC 1998) to address EFH within the South Atlantic region. In addition to the FMPs prepared by the SAFMC, highly migratory species (e.g., tunas, billfishes, sharks, and swordfish) are managed by the Highly Migratory Species Management Unit, Office of Sustainable Fisheries, NMFS. This Office prepared an FMP for highly migratory species that includes descriptions of EFH for sharks,

swordfish, and tunas (NMFS 1999). The SAFMC recently prepared a Fishery Ecosystem Plan (SAFMC 2009) that expands many of the EFH descriptions provided in the Habitat Plan (SAFMC, 1998). Note that some of the species managed by SAFMC and NMFS also fall under the jurisdiction of the Atlantic States Marine Fisheries Commission (ASMFC) in order to further coordinate the conservation and management of the states' shared fishery resources.

Of the species or species groups managed by the SAFMC and NMFS, the following may occur within the project area for at least a portion of their life history:

- *Sargassum*
- Coral, coral reefs, and live/hardbottom habitats
- Penaeid shrimp
- Spiny lobster
- Coastal pelagic fishes
- Reef fishes (snapper-grouper complex)
- Dolphin and wahoo
- Highly migratory species

The following subsections accounts briefly describe the EFH for these species and their respective life stages.

3.6.1. SARGASSUM

Sargassum, a seaweed that permanently drifts at the surface in warm waters of the Atlantic Ocean (SAFMC 2002), normally occurs in scattered individual clumps ranging from 10 to 50 centimeters (4 to 20 inches) in diameter. Accumulation of *Sargassum* and other flotsam in lines often indicates a convergence zone between water masses. Convergence zones are sites of considerable biological activity; many species (including juvenile sea turtles and pelagic fishes) gather along these zones regardless of whether *Sargassum* or other flotsam is present (Carr 1986).

Floating *Sargassum* provides habitat for as many as 100 fish species at some point in their life cycle, but only two spend their entire lives there: the sargassumfish and the sargassum pipefish (Adams 1960, Dooley 1972, Bortone et al. 1977, SAFMC 2002). Most fishes associated with *Sargassum* are temporary residents (e.g., juveniles of jacks, triggerfishes, flyingfishes, and filefishes). Adults of these species reside in shelf or coastal waters (McKenney et al. 1958, Dooley 1972, Bortone et al. 1977, Moser et al. 1998, Comyns et al. 2002). In addition, several larger species of recreational or commercial importance, including dolphin, yellowfin tuna, blackfin tuna, skipjack tuna, little tunny, and wahoo, feed on the small fishes and invertebrates attracted to *Sargassum* (Morgan et al. 1985).

Sargassum is considered a Habitat of Particular Concern (HAPC) for dolphin and wahoo (SAFMC 2003).

3.6.2. CORAL, CORAL REEFS, AND LIVE/HARDBOTTOM HABITATS

The FMP for coral, coral reefs, and live/hardbottom habitats covers a range of organisms and structural features including reef-building stony corals, black corals, octocorals, sea pens, sea pansies, and live/hardbottom.

The regional distributions and ecological requirements of sea pens and sea pansies are not well known, but their recognized EFH includes muddy, silty bottoms in subtidal to outer shelf depths within a range of salinity and light penetration that includes the offshore borrow site proposed for this project.

The live/hardbottom FMP category also includes nearshore hardbottom. **Section 3.4** provides a description of nearshore hardbottom habitat occurring in the project area. On a broad scale, nearshore hardbottom occurs in patches along the east coast of Florida. Considered EFH for coastal pelagic and reef fish management units (SAFMC 1998, 2009), these patches provide important ecological functions for plants, invertebrates, marine turtles, and fishes of the region (CSA International 2009b). The reef-building polychaete *Phragmatopoma lapidosa* augments the structural complexity of nearshore hardbottom.

The only HAPC for coral, coral reefs, and live/hardbottom within the project area is the *P. lapidosa* worm reefs found on nearshore hardbottom in water depths of 0 to 4 m.

3.6.3. PENAEID SHRIMP

Penaeid shrimp managed by the SAFMC and found in the project area include brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus setiferus*).

EFH for penaeid shrimp encompasses the series of habitats used during their life history, which has two basic phases: the adult/juvenile benthic phase and the planktonic larval/post-larval phase (SAFMC 1998). Benthic adults aggregate to spawn in shelf waters over coarse, calcareous sediments. Eggs attached to the females' abdomen hatch into planktonic larvae. These larvae and subsequent post-larval shrimp feed on zooplankton in the water column and make their way into inshore waters. For the inshore phase of the life history, post-larval shrimp settle to the bottom and resume a benthic existence in estuaries that provide rich food sources as well as shelter from predation. Young penaeid shrimp prefer shallow-water habitats with nearby sources of organic detritus such as estuarine emergent wetlands or mangrove fringe.

3.6.4. SPINY LOBSTER

EFH for spiny lobster (*Panulirus argus*) consists of hardbottom, coral reefs, crevices, cracks, and other structured bottom in shelf waters. Juvenile habitat, located in nearshore waters, ranges from massive sponges, mangrove roots, and seagrass meadows to soft bottom with macroalgal clumps. Spiny lobster has a complex series of planktonic larvae transported by small-scale currents as well as the Gulf Stream

(SAFMC 1998). At least two life stages (adults and planktonic larvae) occur in the project area. Adult spiny lobster frequently occur in holes, crevices, and under ledges provided by regional nearshore and offshore hardbottom habitats. On occasion these adults migrate, walking in groups or single file lines along the open seafloor. Thus, this species would likely occur in the water column of the project area, mostly near the borrow site where the advective effect of offshore currents would prevail).

3.6.5. COASTAL PELAGIC FISHES

The major coastal pelagic families occurring in nearshore waters of the project area are ladyfish (*Elops saurus*), anchovies (*Anchoa* spp.), herrings (Harengula spp, *Opisthonema oglinum*, and *Sardinella aurita*), mackerels (*Scomberomorus* spp.), jacks (*Caranx* spp., *Trachinotus* spp), mullets (*Mugil* spp.), bluefish (*Pomatomus saltatrix*), and cobia (*Rachycentron canadum*). Coastal pelagic species migrate over the region's shelf waters throughout the year. Some species form large schools (e.g., Spanish mackerel *[Scomberomorus maculatus*]), while others travel alone or in smaller groups (e.g., cobia). Many coastal pelagic species inhabit the nearshore environment along beaches and barrier islands of eastern Florida (Gilmore et al. 1981, Peters and Nelson 1987). Commonly occurring species in the project area include anchovies, menhaden (*Brevoortia* spp.), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), hardhead catfish (*Ariopsis felis*), and Florida pompano (*Trachinotus carolinus*). Larger concentrations of anchovies, herrings, and mullets that aggregate in nearshore soft or hardbottom areas may attract larger predatory species particularly bluefish, blue runner (*Caranx crysos*), jack crevalle (*Caranx hippos*), requiem sharks (*Carcharhinus* spp., *Negaprion brevirostris*, and *Galeocerdo cuvier*) and Spanish and king mackerel (*Scomberomorus cavalla*). The distribution of most species depends on water temperature and quality, which vary spatially and seasonally.

Coastal pelagic species managed by the SAFMC include cobia, Spanish mackerel, king mackerel, cero (*Scomberomorus regalis*), and little tunny (*Euthynnus alletteratus*) (SAFMC 1998). Various life stages of all these species may occur in the project area (**Appendix N**).

EFH for coastal pelagic species includes *Phragmatopoma* reefs (worm reefs) off the central coast of Florida; ocean high-salinity surf zone; and nearshore hardbottom located south of Cape Canaveral. This EFH also includes sandy shoals of capes and offshore bars and high-profile rocky bottom and barrier island ocean-side waters from the surf zone to the shelf break zone from the Gulf Stream shoreward (including *Sargassum)*. In addition, EFH for coastal migratory pelagic species includes all coastal inlets and state-designated nursery habitats (SAFMC 1998).

3.6.6. REEF FISHES (SNAPPER-GROUPER COMPLEX)

The Reef Fish Management Unit comprises 73 species from 10 families. Although the fisheries and adult habitat of most of these species exist well offshore of the project area, the young stages of several reef fishes use nearshore hardbottom (e.g., Gilmore et al. 1981, SAFMC 1998, Lindeman and Snyder 1999, Lindeman et al. 2000). SAFMC

(1998) identified the following habitats as EFH for early life stages of reef fishes: attached macroalgae, seagrasses, salt marshes, tidal creeks, mangrove fringe, oyster reefs and shell banks, soft sediments, artificial reefs, coral reefs, and hard/live bottom. The project and surrounding areas include soft bottom and hard/live bottom. Nearshore hardbottom has been identified as an important habitat for many of the 73 members of the Reef Fish Management Unit (SAFMC 1998). **Appendix N** details reef fish species with EFH in the project area.

Generally, reef fishes spawn offshore and then release eggs and larvae into the water column. Reef fishes such as lane snapper (*L. synagris*) and grunts (*Haemulon* spp., *Anisotremus surinamensis*, and *A. virginicus*) have similar life cycles, and their early life stages also occur in the inshore waters of the project area (CSA International 2009b, Lindeman et al. 2000). Nearshore hardbottom provides an important connection to the cross-shelf developmental pathways undertaken by many reef species (Lindeman et al. 2000).

3.6.7. DOLPHIN AND WAHOO

Dolphin (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) are oceanic species associated with the western edge of the Gulf Stream. Dolphin and wahoo travel near this edge as they migrate through the project area near the offshore borrow site. Closely associated with the Gulf Stream, all life stages (eggs, larvae, juveniles, and adults) of these species could occur in the project vicinity near the offshore borrow site (**Appendix N**). Dolphin, tunas, and wahoo feed on small fishes and invertebrates associated with drifting *Sargassum* and other flotsam (Manooch et al. 1983, Manooch and Mason 1984, Morgan et al. 1985). HAPC for dolphin and wahoo is *Sargassum*.

3.6.8. HIGHLY MIGRATORY SPECIES

Worm et al. (2003) identified eastern Florida as an area supporting a high diversity of oceanic predators, such as sharks, billfishes (Istiophoridae), and tunas (*Thunnus* spp. and *Katsuwonus pelamis*), considered under the Highly Migratory Species Management Unit.

Many species, including tunas, swordfish (*Xiphias gladius*), and billfishes, may occur in the project area near the offshore borrow site because of its proximity to the Gulf Stream current. Swordfish and bluefin tuna (*Thunnus thynnus*) migrate through the Florida Straits and into the eastern Gulf of Mexico to spawn (NMFS 1999, 2009). *Sargassum* is important habitat for various life stages of the swordfish, billfishes, and tunas. Sailfish (*Istiophorus platypterus*), blue marlin (*Makaira nigricans*), and white marlin (*Tetrapturus albidus*) regularly occur offshore east Florida.

Coastal sharks are managed under the highly migratory species group. These species commonly occur during various life stages in inland and nearshore shelf waters of east Florida. In the project area, several managed shark species occur, including nurse (*Ginglymostoma cirratum*), hammerheads (*Sphyrna* spp.), and requiem sharks (Gilmore et al. 1981, CSA International 2009b, Gilmore 2009). Some of these species are very

wide-ranging and loosely associated with a variety of habitats (e.g., soft bottom, hardbottom, and the water column). Others, particularly the nurse shark, are associated closely with hardbottom habitats. **Appendix N** presents EFH identified by NMFS (1999, 2009) for coastal shark species.

The reef-building activities of the sabellariid polychaete *P. lapidosa* augment the nearshore hardbottom features in the project area. This species, defined as a foundational or structural species (see **Section 3.4**), forms large colonies commonly referred to as worm rock (Kirtley and Tanner 1968, McCarthy 2001). In addition to fish species, worm rock supports associated assemblages of organisms, such as decapod crustaceans (Gore et al. 1978).

3.7. OFFSHORE BORROW AREA RESOURCES

The sand shoals offshore of the project area are well-developed shore-face connected and isolated linear shoals oriented north-to-south. These features, depositional in nature, exhibit varying degrees of morphological change in response to local hydrodynamic conditions. Sand shoals form as an irregularity on the seafloor and then grow in response to local coastal processes (waves, tides, currents).

Surveys (CPE 2006b) of the proposed borrow area identified clean sand layers from 4 to 20 feet thick. Side-scan and magnetometer investigations conducted during the surveys indicated no hardbottom habitats near the borrow area (CPE 2006b).

Hammer et al. (2005) performed a study to examine the implications of sand removal from potential borrow areas off the east central Florida coastal shelf. The study, focused on federal waters seaward of the current St. Lucie Shoal borrow area, found that waves passing over the shoals turned toward the shoreline sooner than in other areas the same distance offshore. The study concluded that waves refracting over the shoals within the entire investigation area produced area region of increased wave heights landward of each shoal and a corresponding region of decreased wave heights immediately south of the sites. However, the wave refraction over the entire St. Lucie Shoal (federal waters and state waters portion) is potentially more significant than the impact to waves from the other shoals located farther offshore because the St. Lucie shoal area of influence is more focused along the shoreline (Hammer et al. 2005).

Sedimentary habitats such as sand shoals support a variety of invertebrates and demersal fishes, as described in **Section 3.5.2**. Invertebrates using shoals include infaunal and epifaunal species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Demersal feeding fishes prey on most of these species. A number of sand shoal studies conducted along the eastern coast of the U.S. have documented the use of sand shoals as fish habitat (Able and Hagan 1995, Slacum et al. 2006, Walsh et al. 2006, Vassilides and Able 2008, Gimore 2009). CSA International et al. 2009a) generally characterized use of sand shoals by fishes at several spatial scales. At broad scales (1 to 100 square kilometers), fishes may use shoal features as guideposts during migrations, local movements, or spawning. At intermediate scales (tens to hundreds of square meters), different parts of individual

shoals may represent different foraging areas or shelter from predators or waves and currents. At smaller scales (e.g., meters to centimeters), sediment texture (fine sand to shell fragments), variable bedform structures, and biogenic structures may provide important predator refuge or foraging areas. Considering this spatial framework, most fundamental ecological functions of shoals for fishes fall into the categories of spawning, shelter, or foraging.

Gilmore (2009) synthesized unpublished information and data and interviewed local anglers to determine the importance of the east Florida sand shoals, including the St. Lucie Shoal, to fishes. The report inferred from the various data sources that more than 200 species potentially use shoals for orientation, refuge, spawning, and feeding sites. Interviews with anglers confirmed that shoals served as aggregating points for small pelagic fishes such as menhaden, Spanish sardine, thread herring, and false pilchard. These species are important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups.

3.8. COASTAL BARRIER RESOURCES

In 1982, Congress signed the Coastal Barrier Resources Act (CBRA) prohibiting federal expenditures (direct or indirect) for development of designated undeveloped coastal barriers and their associated aquatic habitat, including wetlands, estuaries, and inlets. The three primary goals of the CBRA include

- Minimize loss of human life by discouraging development in high risk areas
- Reduce wasteful expenditure of federal resources
- Protect the natural resources associated with coastal barriers

One Coastal Barrier Resource System (CBRS) map unit, P-11 (Hutchinson Island), lies partially within and adjacent to the project area (**Figure 3.11-1**).

The May 27, 2009 FWS CBRA Consistency Determination letter (**Appendix F**) describes the project area CBRS Unit P-11 as follows: “located east of Port St. Lucie, Florida, supports suitable habitat for species listed under the Endangered Species Act of 1973, as amended (87 Stat. 884; 16 U.S.C. 153 1 et seq.), including the threatened piping plover (*Charadrius melodus*), threatened loggerhead sea turtle (*Caretta caretta*), endangered green sea turtle (*Chelonia mydas*), endangered leatherback sea turtle (*Dermochelys coriacea*), and endangered hawksbill sea turtle (*Eretmochelys imbricata*).” The same letter states, “the beaches of St. Lucie County support the fifth highest nesting density of sea turtles in Florida.”

3.9. WATER QUALITY

The State of Florida classifies the waters offshore of the project area as Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The predominant issue that affects water quality in offshore waters in south Florida is turbidity, considered a good measure of water quality. Turbidity is a measure of the loss in transparency of water

Figure 3.11-1. CBRS Unit P-11 (Hutchinson Island), St. Lucie County South Beach and Dune Restoration Project

due to the presence of suspended particulates — the more total suspended solids in the water, the cloudier it appears and the higher the turbidity. Turbidity is measured in nephelometric turbidity units (NTUs), which is measured by the intensity of light scattered passing through the water sample.

3.10. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The coastline within the project area is located adjacent to predominantly residential, commercial, and recreational areas. No known industrial activities produce hazardous, toxic, and/or radioactive wastes adjacent to the project site; no know industrial activities discharge effluents near the shoreline; and no known records of such past activities exist. Sediments within the littoral zones of the project area, as well as sediments from the borrow areas, comprise particles of a large grain-size. Normally, contaminants do not adhere to materials with such properties. Sediments in the potential borrow sites are sufficiently removed from shipping lanes or other potential contaminant sources. Hence, pollutants are unlikely to have contaminated them.

3.11. AIR QUALITY

St. Lucie County lies within the Southeast Florida Intrastate Air Quality Region, as established by 40 CFR Part 81.49. The U.S. Environmental Protection Agency (EPA) (40 CFR Part 81.310) designates St. Lucie County as being in attainment with National Ambient Air Quality Standards for ozone, nitrogen dioxide, carbon monoxide, total suspended particulates, and sulfur dioxide. Air quality in St. Lucie County exceeds national standards. The EPA has not made a designation for lead in southeastern Florida.

Ambient air quality along coastal St. Lucie County is generally good due to prevalent ocean breezes from the northeast through the southeast. Coastal development and the popularity of the beaches area all contribute to the presence of motorized vehicles and vessels in the project area at any given time. The usually present sea breezes along the Ft. Pierce shore readily disperse airborne pollutants. This project, regardless of the alternative implemented, would not require air quality permits.

3.12. NOISE

Ambient sources of noise within the project area include beach and nearshore recreational activities, breaking surf, boat and vehicular traffic, and noise from adjacent residences. Because St. Lucie County has many seasonal residents and tourists, many more residents are present in the homes and condominiums located along the project area during the winter months. Their presence results in more ambient noise along the beach front as well as more boating traffic during the winter tourist season.

3.13. AESTHETIC RESOURCES

An aesthetic or visual resource is a broad term used to identify the particular scenic qualities that define a place or landscape. The sandy beaches and blue waters of the Atlantic Ocean found along South Hutchinson Island define the aesthetic resources within the project area. Upland development consisting of high and low rise commercial and residential development, vacant lands, and recreational beach access areas backs the coastline. Vacant lands and beach access areas are generally vegetated with low lying shrubby dune plants such as sea oats (*Uniola paniculata*), with occasional interspersed railroad vine (*Ipomoea pescapre*), sea grapes (*Coccoloba uvifera*), and sea purslane (*Sesuvium* sp.). Residents and guests of the numerous condominiums, resorts, and hotels within the project area enjoy the aesthetically pleasing panoramas of the Atlantic Ocean. However, the general project area does not include sites designated under 40 CFR 81.407 as a Class I Federal Area, where visibility is an important value.

Erosional processes currently occurring within the project area distract from the aesthetics and will continue to reduce the width of the beach area and related aesthetic value. According to the Conditions Assessment Report (Coastal Tech 2009: Attachment P), an average 60 feet of dune separated the buildings and the sandy beach. The analysis found project area beaches generally eroded and the shoreline generally in retreat, with the greatest volumetric loss occurring between reference monuments R-90 and R-100. From R-103 to R-109, the slightly accreted beaches advanced slightly seaward.

3.14. RECREATION RESOURCES

Beaches within the project area are somewhat less congested than other nearby beaches due to limited public beach access points and distance from the heavily populated areas of Ft. Pierce, Port St. Lucie, and Stuart. Project area beaches provide an appealing and relaxing South Florida atmosphere. The extent of the project area includes only five public beach access points (**Table 3.14-1**), leaving the remaining areas accessible primarily to residents or guests in condominiums, resorts, and hotels.

Recreational usage along the beaches within the project area includes shore-based water sports such as scuba diving, snorkeling, surfing, surf fishing, and kayaking. Additionally, visitors use area beaches for sunbathing, picnicking, and exercising. Boating is a popular recreational pastime for many residents and tourists to the area. Fishing, lobstering, scuba diving, and snorkeling often start from boats in nearshore hardbottom areas. Offshore angling may occur near the proposed borrow site despite the absence of known, identified fish havens near the borrow area. Numerous boat ramps and marinas in Ft. Pierce, Jensen Beach, and Stuart provide access to the Atlantic Ocean through the Ft. Pierce Inlet located approximately 10 miles north and the St. Lucie Inlet located 7.5 miles south of the project area.

Table 3.14-1. Public Access along the Project Area

Public Access	Area (acres)	Amenities	Parking Spaces	Security
Walton Rocks Beach Park	24	Bathrooms, showers, picnic tables with cover, life guard, dog friendly	100	No
Herman's Bay Beach Access	1	ADA access to boardwalk, picnic tables, pavilion	12	No
Normandy Beach Park	1	ADA access to path, no facilities	20	No
Dolman Beach Park	143.7	ADA access, dune crossover, pavilion, restrooms and shower	100	No
Waveland Beach Park	3.6	ADA access to boardwalk, sitting area, restrooms, showers, lifeguard	100	Yes

In 2007 and 2008, Dr. William Stronge conducted surveys of beach users on South Hutchinson Island (Stronge, 2008: R-77 to St. Lucie/Martin County line). The surveys estimated that almost 250,000 people used the beach during the survey year. **Table 3.14-2** (from Stronge 2008) reports survey results for project area beaches as total counts and as a percentage of the total survey counts. Interviews determined that an average beachgoer would be willing to pay $5.70 ("willingness to pay per beach visit") for the privilege of using the beach.

Table 3.14-2. Project Area Beach Visitor Survey Results (from Stronge 2008, Reported in Coastal Tech 2009: Design Document, **Appendix C**: Benefit Cost Analysis)

Project Area Beaches	Summer 2007		Winter 2007-08		Total	
	Count	% of Total	Count	% of Total	Count	% of Total
Walton Rocks Public	6,067	7.1	12,533	8.0	18,600	7.7
Sand Dollar	2,241	2.6	4,618	3	6,859	2.8
Herman's Bay Public	5,097	6	10,676	6.8	15,773	6.5
Normandy Public	5,437	6.4	8,651	5.5	14,088	5.8
S. of Normandy - to Island Dunes	4,020	4.7	13,489	8.6	17,509	7.2
Dollman Public	5,562	6.5	21,601	13.8	27,163	11.2
Ocean Towers - Nettles Island	9,012	10.6	22,411	14.3	31,423	13
Oceana - North of Waveland	8,340	9.8	10,957	7	19,297	8
Waveland Public	21,685	25.4	25,137	16.1	46,822	19.4
Island Crest South to County Line	17,904	21	26,150	16.7	44,054	18.2
Total	85,365	100%	156,222	100%	241,588	100%

Using the Stronge (2008) data, Coastal Tech (2009: Design Document **Appendix C**, Benefit Cost Analysis) estimated recreational value and benefit of the existing condition, proposed alternative, and the 70 ft berm alternative (**Table 3.14-3**).

Table 3.14-3. Estimated Recreational Value and Benefit of Two Alternatives Compared to the Existing Conditions (From Coastal Tech 2009: Design Document **Appendix C**: Benefit Cost Analysis)

Alternative	Beach Area (sq ft)	Recreation Value	Recreational Benefit
Existing Conditions	637,838	$1,159,730	N/A
Beach Fill to Restore 1972 Dune with 35' Berm	913,515	$1,709,420	$549,690
Beach Fill to Restore 1972 Dune with 70' Berm	1,573,117	$2,916,599	$1,756,869

3.15. NAVIGATION

The majority of the vessel traffic within the project area is associated with recreational boating and fishing. Vessels occurring in nearshore areas are likely used for fishing or diving along the shallow hardbottom areas. The northern extent of the project area is located approximately 10 miles from the Ft. Pierce Inlet and the southern end of the project area is located approximately 7.5 miles from the St. Lucie Inlet. Commercial vessels including shipping vessels, barges, tugs, fishing charter boats, commercial fishing vessels, and sightseeing boats use the Port of Ft. Pierce; however, the shipping lanes and entrance channel do not occur within the project area. The proposed borrow area is not located near any shipping lanes or channels. However, the complex of shoals comprising a portion of the borrow area attract recreational and commercial anglers during certain times of the year when fish are migrating. Hopper dredging vessels are required to follow the requirements for safe navigation established by the USCG.

3.16. HISTORIC PROPERTIES

New South Associates (2008) conducted a Phase I cultural resources survey for the project in October 2007). The survey extended from the Martin/St. Lucie County line to approximately 0.5 miles north of the St. Lucie Nuclear Power Plant.

The Phase I survey consisted of background desktop research, field investigations including surface reconnaissance, systematic shovel testing, metal detection in areas adjacent to recorded locations of historic shipwrecks, artifact identification and analysis, and report preparation. With the exception of two shipwreck sites, all previously recorded historic and prehistoric sites are located well outside of the project area — on

or west of the back dune along or west of U.S. A1A. The field survey uncovered no evidence of the previously recorded sites.

The study recommended that the project avoid areas near previously recorded underwater sites and undisturbed areas of back dune where previously recorded sites are located. The survey found no evidence of any new or previously recorded sites or artifacts over 50 years old in the project fill template. The final report recommended a finding of no project effect on cultural resources listed, eligible for listing, in the National Register of Historic Properties, or otherwise of historical, archaeological, or architectural value; and recommended no further investigation of the area. The Florida Department of State – Division of Historical Resources reviewed the survey report and, in a letter to the U.S. Army Corps of Engineers (USACE) on April 15, 2008, concurred with the report findings and recommendations.

Between September 2007 and June 2008, a remote sensing survey of St. Lucie Shoal located offshore of Martin and St. Lucie Counties was conducted by SEARCH for the U.S. Army Corps of Engineers (USACE), Jacksonville District. For the Applicant in December 2010, SEARCH conducted a remote sensing survey of the portion of the proposed shoal borrow area not previously investigated. SEARCH determined that the proposed activities within the proposed dredge area of St. Lucie Shoal would have no effect on cultural resources, listed, or eligible for listing and recommended no further investigation of the area. The Florida Department of State - Division of Historical Resources reviewed both reports and issued letters dated September 4, 2008 and January 20, 2011 concurring with the report findings and recommendations.

3.17. SOCIOECONOMICS

The Hutchinson Island South CDP (census designated place) subsumes the majority of the project area. The 2000 population census reported 4,846 residents with a population density of 1,074 residents per square mile, 5,889 housing units, and a median household income in 1999 dollars of $43,329. The 2007 and 2008 demographic estimates show these numbers continue to increase. In 2007, the estimated total population for this census place rose to 5,263 people, while the population density rose to 1,167 people per square mile. The 2008 estimated household median income rose to $53,967 (www.factfinder.census.gov).

The existing and proposed uplands uses in the project area are predominately high-density multifamily condominium developments. The project area includes four applicant beachfront parks available for public use — Walton Rocks Beach Park, Dollman Beach Park, Normandy Beach Park, and Waveland Beach Park; no user fees are associated with these facilities. The project area does not contain shoreline armoring structures such as seawalls or groins. Based on zoning maps for the project area, shoreline zoning designations include 86% multifamily, 12% conservation, and 2% commercial.

St. Lucie County employs about 10% of its workforce in the leisure industry and bases much of its economy on tourism. Many businesses, particularly along the coast, rely on revenue generated from tourists.

Fisheries contribute significant (billions of dollars) economic (Kidlow 2008) and aesthetic value to east central Florida. The commercial fishery landings for St. Lucie and Martin Counties alone were worth $3 to $9 million annually between 1990 and 2007 (Gilmore 2009). In addition to commercial fishing, recreational fisheries, tournaments, and artificial reef programs contribute significantly to the local economy.

East central Florida coastal counties possess not only significant inshore fisheries (snook, red drum, spotted sea trout, tarpon, sheepshead, gray snapper, stone/blue crab, shrimp, clam/oyster) but also major lucrative coastal and offshore fisheries (sailfish, swordfish, dolphin, king and Spanish mackerel, pompano, grouper and snapper, shrimp, scallop, spiny lobster) (Gilmore 2008). Local fishing tournaments attract competitors from throughout the United States.

4. ENVIRONMENTAL EFFECTS

4.1. GENERAL ENVIRONMENTAL EFFECTS

The beneficial effects of sand nourishment along the proposed project area include establishing a larger buffer beach to protect upland infrastructure and populations against storms and flooding. Sand nourishment also creates additional dry beach for turtle nesting and recreational activities.

Beach renourishment would likely increase sea turtle nesting habitat if the nourishment sand remains compatible with naturally occurring beach sediments, and if the project includes compaction and escarpment remediation measures.

Dredging operations and the subsequent placement of sediment on the beach have the potential to.affect flora and fauna on a scale ranging from months to decades (Defoe et al. 2009). Dredging equipment may entrain animals; the act of dredging would impact habitats by removal; placement of sand on the beach would bury benthic and beach fauna; physical contact with dredging equipment and vessels (i.e., impact) would harm the animals, as would physical barriers imposed by the presence of dredging equipment (i.e., pipelines); and placement of dredged material in various locations (i.e., covering, compaction, escarpment formation, etc.) could cause avoidance behavior, or reduce available habitat, or otherwise impact those species using the project area (USFWS 2007). Grooming of the beaches to reduce compaction, scarp formation, etc. may also cause temporary impacts.

Potential effects to sea turtles include possible destruction of nests deposited within the boundaries of the proposed project during construction, harassment in the form of construction-related disturbance to or interference with female turtles attempting to nest within the construction area or on immediately adjacent beaches, artificial lighting-induced disorientation of hatchlings as they emerge from the nest and crawl to the water, and behavior modification of nesting females from escarpment formation within the project area during the nesting season. Escarpments could cause false crawls or selection of marginal or unsuitable nesting areas to deposit eggs. At the dredging site, the dredge may entrain swimming turtles.

The quality and/or color and the density of the dredged sand could affect the ability of female turtles to excavate a nest, the nest incubation environment, sex ratios of the hatchlings, and the ability of hatchlings to emerge from the nest.

Several protective measures can minimize some of these potential impacts. Scheduling renourishment projects outside the sea turtle nesting window provides the most important means of avoiding and minimizing impacts. If construction occurs during any part of the nesting season, daily preconstruction (or pre-dawn) surveys to locate nests and the relocation of all found nests to a safe hatchery would reduce impacts within the construction area. During 24 hour/day operations, minimum and shielded construction lighting would reduce turtle avoidance of the beach and false crawl behavior. The use of sand similar to the “natural” or “existing” beach — considering grain size distribution

including a level of “fines” (material passing through a #200 sieve) not exceeding 5% — would likely provide a sand suitable for natural nesting, incubation, and hatching behaviors. After construction, beach tilling can reduce sand density to appropriate levels. Likewise, post-construction removal of scarps before sea turtle nesting season would allow turtles to crawl up the beach to safe nesting elevations. Annual escarpment and compaction monitoring typically occurs just before the sea turtle nesting season for three years after construction.

The proposed project would likely produce more favorable environmental conditions than exist at present, although construction operations would produce some temporary adverse effects as discussed above. In addition, the presence of construction equipment and personnel would temporarily detract from the aesthetics of the beach. Construction would include best management practices to ensure efficient construction and to minimize the time that equipment and personnel remain on project area habitats.

Immediately after renourishment, the dredged sand could appear darker than the sediments on the preconstruction beach, which could detract from the aesthetics of the beach. However, the natural working of the dredged sediments by sunlight, rain, and wind would lighten the color of the sediments in a relatively short time.

After construction, the beach profile typically undergoes a period of reworking by waves and currents. The beach fill reclines to an “equilibrium profile” within about one year of a renourishment. Direct burial of shoreline bottom (benthic) habitat would occur within this equilibrium profile. The first year post-construction would include a potential for greater-than-normal erosion of the dry beach along with possible loss of sea turtle nests. Turbidity could increase in the nearshore waters during renourishment and as the beach profile equilibrates. The use of hopper dredges would eliminate potential impacts associated with hydraulic dredge swing anchors and cables. The applicant has demonstrated that pipeline corridors located in areas without hardbottom habitat would provide the path to transfer material from the dredge to the beach fill areas. Collars fitted on the of (up to) 3-ft diameter pipelines — used for the sand transfer from the hopper dredge to the beach — would minimize contact with the ocean bottom. Anchors or spuds for the hopper dredge would locate entirely in sand bottom. Weekly monitoring of all pipelines to shore would identify any sand movement or leaks that could impact the environment. The dredging contractor would conduct continuous leak monitoring by real-time inspection of pipeline pressure fluctuation.

Construction activities could result in temporary disturbance to sandy benthic habitats in the borrow area and along the nearshore zones in the immediate proximity of construction activities. Since small, short-lived organisms with great reproductive potential populate these sandy beaches and subtidal areas, these communities usually recover relatively quickly from environmental disturbances such as beach restoration projects. A literature review by Newell et al. (1998) concluded that sand and gravel sediments may require 2 – 3 years to reestablish. In another literature review, Brooks et al. (2006) concluded that available literature on offshore benthic assemblages (OBA) residing along the U.S. east and Gulf of Mexico continental shelf suggested that

“general recovery’’ from anthropogenic disturbance to benthic assemblages on the continental shelf occurs between three months and 2.5 years.”

The applicant conducted numerous investigations, including sidescan sonar, aerial photography, and underwater diver-verified reef characterization studies along the project reach. These investigations revealed the presence of hardbottom tracts consisting of limestone outcroppings scattered along the project beach between FDEP reference monuments R-87.7 and R-90.3, and R98 to about R-115+1,000 feet. The landward edge of hardbottom generally occurs between 10 and 50 m (33 – 164 ft) offshore depending on location. CSA International (**Appendix J**) identified three hardbottom types. The first habitat includes relatively persistent low-medium (0.3 m– 1.0 m or 1 – 3 ft) relief limestone outcrops including various algae and the marine bristle worm, *Phragmatopoma lapidosa.* The second habitat includes low-medium relief ephemeral outcropping with biological activity dominated by turf algae. This habitat probably provides a physical refuge area for fauna. A third medium (1 – 2 m or 3 – 6 feet) relief habitat occurs at the seaward edge of hardbottom (nearly 1,000 feet from shore). This persistent habitat (not often covered by sand) contains a much greater plant and animal diversity than the other two habitats.

Interpretation of 2010 aerial photography identified about 12.97 acres of hardbottom in the nearshore of the project beach. The applicant’s preferred alternative would impact about 0.57 acre of this habitat. A USACE UMAM calculation (**Appendix O**) indicated that successful creation of 0.78 acre of artificial reef would offset expected project impacts.

4.2. VEGETATION

4.2.1. BEACH FILL SOUTH SEGMENT ONLY TO RESTORE THE 1972 DUNE WITH A 35-FT BERM (APPLICANT’S PREFERRED ALTERNATIVE)

The applicant’s preferred alternative would result in minor, short-term impacts to herbaceous dune vegetation that inhabits the upper beach and foredune. Fill placement would not occur landward of the dune crest. The proposed beach and dune restoration would help stabilize and protect the dune vegetative communities from storm surge and erosion. Adding sand to the system would promote further dune habitat development.

The plan for this alternative includes re-establishment of the plant community by planting a mix of native dune species that, depending on nursery availability, could include sea oats (*Uniola paniculata*), beach sunflower (*Helianthus debilis*), railroad vine (*Ipomoea pes-caprae*), and dune panic grass (*Panicum amarum*). The planting plan specifies planting units installed on 18-inch centers in staggered rows on the dune crest.

4.2.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

This alternative could result in equivalent impacts to vegetation as the applicant’s preferred alternative.

4.2.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

This alternative would result in equivalent impacts to vegetation as the applicant's preferred alternative, albeit over a greater distance of dune, because this alternative includes beach and dune fill in the north project segment.

4.2.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM

This alternative could result in equivalent impacts to vegetation as the applicant's preferred alternative, albeit over a greater distance of dune, because this alternative includes beach and dune fill in the north project segment.

4.2.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

This alternative could result in equivalent impacts to vegetation as the applicant's preferred alternative albeit over a greater distance of dune, because this alternative includes beach and dune fill in the north project segment.

4.2.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

This alternative could result in equivalent impacts to vegetation as the applicant's preferred alternative, albeit over a greater distance of dune, because this alternative includes beach and dune fill in the north project segment.

4.2.7. NO ACTION (STATUS QUO)

The No Action alternative could affect vegetation within the project area. Continued erosion of the beach would result in continued loss of vegetated beach and dune habitats. Additionally, continued erosion could cause landowners to implement alternative armoring measures such as revetments to protect their property. These measures could result in negative impacts to the dune system by altering profile and displacing vegetation.

4.3. THREATENED AND ENDANGERED SPECIES

4.3.1. BEACH FILL SOUTH SEGMENT ONLY TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED ALTERNATIVE)

4.3.1.1. Sea Turtles

4.3.1.1(a). Nesting Habitat

Of the threatened and endangered species found in coastal St. Lucie County, nourishment activities are more likely to impact sea turtles, simply by their ubiquity during nesting season. Escarpments obstructing beach accessibility, altered beach profiles, different sand color characteristics, and increased sand compaction often

hinder nesting success the first year after nourishment (USFWS, 2005, 2007). Impacts of a nourishment project on sea turtle nesting habitat are typically short-term because natural processes rework a nourished beach in subsequent years. Constant wave and current action reworks the beach, and reduces sand compaction and the frequency of escarpment formation while the sun bleaches darker sand (USFWS 2005).

The applicant initiated an emergency beach fill project in 2005 due to damages to project area beach and dunes during hurricanes Frances and Jeanne in 2004. The upland sand used in the 2005 emergency fill project was incompatible with the native beach (PBS&J 2005). A dune remediation project excavated, removed, and replaced the incompatible sand with more carefully characterized beach-compatible sand (Coastal Tech 2009: Design Document). The area of sand replacement provided an opportunity for an unplanned experiment comparing turtle nesting on natural sand with turtle nesting on replacement beach sand. Below, the term “nourished” applies to the section of beach that required remediation and “natural” to the adjacent sections of beach not impacted and remediated.

Nesting success provides a gauge of beach nesting suitability (EAI 2009a). Less suitable beaches tend to have lower nesting success (a higher false crawl to nest ratio). EAI performed sea turtle nesting surveys for the St. Lucie beach before the storms and after replacement of poor quality sand with suitable quality sand (EAI 2007, 2008, 2009a). **Table 4.3-1** summarizes nesting success between 2003 and 2009 for the three sea turtle species nesting on nourished and natural beach sections of the project area beach (EAI 2009a; personal communication, Beth Brost, FWC; personal communication, Jonathan Gorham Inwater Research Inc., 2010).

During 2005, all three marine turtle species exhibited lower nesting success on the nourished beach than on the natural beach. Loggerhead and green turtles exhibited the greatest differences (**Table 4.3-1**). During the years before the emergency nourishment (2003 – 2004) and the years following 2005 (2006 – 2009), all three species displayed similar or greater nesting success on the nourished beach than on the natural beach. EAI (2009a) attributed the apparent improvement in the suitability of the restored beach for nesting to changes in beach conditions resulting from the dune remediation project.

With the exception of 2005, the nourished area generally showed higher loggerhead and green turtle nest densities (**Table 4.3-2**: nests per kilometer). In 2005, all three species showed lower nest densities on the nourished beach than on the natural beach. Beginning in 2006, however, loggerhead and green turtle have since maintained nest densities on the nourished beach similar to or greater than densities on the natural beach. According to EAI (2009a), the shift back to pre-2005 patterns in the relative distribution of loggerhead and green turtle nest densities in the nourished beach suggests that the remediation project succeeded in mitigating the negative effects of the poor quality sand placed during the 2005 dune restoration project and in providing nesting habitat similar to natural conditions.

Table 4.3-1. Sea Turtle Nesting Success (%) in Project Area: Restored (INBS Zone V-X) vs. a Natural (L-N) Beach

	2003		2004		2005		2006		2007		2008		2009	
Species	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**
Loggerhead	65.7	54.2	59.6	49.6	14.1	33.0	55.9	49.5	52.1	50.6	58.9	56.3	57.3	46.2
Green	75	37.5	46.8	50	11.4	39.6	42.0	30.0	41.3	27.0	65.1	47.4	54.3	45.8
Leatherback	80	87.5	80	74.1	31.0	40.0	78.6	80.0	80.8	83.3	78.4	77.8	76.9	74.3

Source Data 2003, 2004, 2009: INSB Zones L, V-X - personal communication: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database as of July 1, 2010. Zones L, V-X include data between May 15 and August 31. INSB Zones M and N - personal communication: Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. Zones M and N are year totals.
Source Data 2005 to 2008: EAI, 2009a

Table 4.3-2. Sea Turtle Nesting Density (nests/km) in Project Area: Restored (INBS Zone V-X) vs. a Natural (L-N) Beach

	2003		2004		2005		2006		2007		2008		2009	
Species	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**	**Nourished**	**Natural**
Loggerhead	224.3	164.3	175.3	170.3	110	205	205.0	117.3	163.3	123.3	211.7	157.7	198.3	133.3
Green	6	1	7.3	6	9.7	12.3	5.3	9.0	30.7	9.3	11.0	8.0	8.3	7.3
Leatherback	4	9.3	2.7	6.7	0.3	5.3	1.3	3.0	6.7	7.7	4.0	5.0	6.7	8.7

Source Data 2003, 2004, 2009: INSB Zones L, V-X - personal communication: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database as of July 1, 2010. Zones L, V-X include data between May 15 and August 31. INSB Zones M and N - personal communication: Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. Zones M and N are year totals.
Source Data 2005 to 2008: EAI, 2009a

Note regarding data sources: The tables include year totals when available, seasonal totals otherwise. FWC and Inwater Research Group data span May 15 – August 31; EAI data include the entire year. EAI (2009a) provided **Table 4.3-1** data between 2006 and 2008, while the FWC dataset provided data for years 2003, 2004, and 2009. For consistency, nesting density per kilometer of shoreline in **Table 4.3-2** contains only data from Inwater Research and FWC.

Leatherback nest densities did not show the same post-remediation increase in nest densities seen in loggerhead and green turtle nest densities (**Table 4.3-2**, EAI, 2007, 2008). Leatherback nest densities remained lower on the nourished beach throughout the study period. During all seven years (2003 – 2008), fewer leatherback turtles nested on the nourished beach than on the natural beach. These data suggest that the changes in beach conditions between 2003 and 2008 affected leatherback nesting to a lesser extent than loggerhead or green turtle nesting.

The data presented above supports the hypothesis that impacts from beach nourishment to sea turtle nesting and habitat are short term (about one year) assuming the placement of appropriate quality sand. The data also suggest that the beach nourishment could have positive effects on sea turtle nesting through the creation of additional high quality beach habitat. Continuous monitoring of the sea turtle activity in the project area would dictate whether the changes observed between 2003 and 2009 will repeat themselves in the next projects.

In summary, within a year following the project (construction year up to a year post-construction), impacts to sea turtles associated with the project may include

- Disturbance of nesting female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities
- Behavior modification of nesting females from beach escarpment formation during a nesting season. Example: Behavioral changes could result in false crawls or selection of marginal or unsuitable nesting areas to deposit eggs.
- Destruction, damage, or burial of existing nests during nourishment activities
- Effects to eggs and hatchlings from changes in the physical and chemical characteristics of the nourished beach. Example: The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.
- Lighting-induced disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water
- Alteration (burial) of nearshore exposed hard substrate (feeding grounds to sea turtle juveniles) during and subsequent to nourishment activities

USFWS biological opinions for similar projects recognize that placement of sand on a critically eroded beach can enhance sea turtle nesting habitat if the sand placed is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments at the recipient site, and compaction and escarpment remediation measures are properly adopted (USFWS 2005). State and federal permit requirements for beach nourishment projects usually address avoidance and minimization of potential impacts to nesting turtles and nesting habitat. Permit conditions may include consideration of

- Sand quality: a major component of the beach nourishment permitting process is to assure the sand placed on the beach is compatible with the natural beach.
- Timing of construction activities: USFWS has jurisdiction over sea turtles (nesting adults, incubating eggs, and hatching young) on the beach. In St, Lucie County, USFWS requires that nourishment activities avoid the peak nesting season from

May 1 through October 31 to minimize the impact to nesting sea turtles. If projects require nighttime construction activities, state and federal permits would restrict nighttime construction to specific areas, usually no more than 500 feet in length.

- Pre-nesting season compaction monitoring, mechanical tilling, and grading of the beach: these activities can greatly reduce or eliminate the effects of increased sand compaction and scarp formation. Post-construction compaction monitoring or tilling before nesting season is a state and federal permit requirement after nourishment activities, and for three years after project completion. State and federal agencies require tilling the project area beaches if penetrometer testing demonstrates compaction in excess of 500 pounds per square inch at any two adjacent sampling stations or depths. Additionally, leveling of escarpments greater than 18 inches in height or 100 feet in length must occur before nesting season begins.
- Relocation of sea turtle nests: USFWS requires monitoring and relocating sea turtle nests between March 1 and April 30 if nourishment activities occur during that period.
- Hardbottom impacts: avoidance and minimization of hardbottom impacts also comprise major considerations during review of any beach nourishment permit application.

Because the proposed project would use sand with characteristics very similar to the native beach sand, sand quality is unlikely to have negative effects on sea turtle nesting or hatchling emergence. However, the applicant's preferred alternative — Beach Fill South Segment Only to Restore the 1972 Dune with a 35-foot Berm — may still have negative effects on nesting sea turtles resulting from construction-related impacts during and after construction. These impacts could include nesting disturbance, sand compaction, scarp formation, and artificial lighting. Compared to the other alternatives including the north segment, the north segment beach would offer less nesting habitat. Impacts could occur from reduced nesting habitat on the narrower north beach and from greater potential for repeated inundation and washout.

As natural processes rework the nourishment area and the beach equilibrates, the increase in beach area provided by this alternative could have a long-term benefit on sea turtle nesting in the south segment. Also, over time, erosion of the south beach would likely disperse sand to the north and south. Over 10 years, such dispersion could reduce the erosion rate of the north segment and, after 10 years, lead to a north segment beach one-half the width than that resulting from implementation of Beach Fill to Restore the 1972 Dune with a 35-ft Berm alternative (that would nourish both the north and south segments).

4.3.1.1(b). Inner Shelf Habitat

Impact-producing factors (IPFs) associated with all of the build alternatives including offshore dredging that could potentially affect sea turtles include

- Vessel traffic

- Entrainment by hopper dredge drag heads
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity
- Underwater noise and vibration from dredging activities

Vessel Traffic

Dredge, dredge support, and construction vessel traffic raises a chance of these vessels colliding with sea turtles. The risk would vary depending upon location, vessel speed, and visibility. As discussed in **Section 3.3.1.2**, most sea turtles occur within nearshore waters off St. Lucie County and waters of the continental shelf. All life stages (hatchling, juvenile or subadult, and adult) may occur within the project area. During the hatching season, researchers believe that hatchling turtles leave their nesting beaches and swim offshore to areas of water mass convergence. A moving vessel could have difficulty spotting hatchling and juvenile turtles in these areas, especially when the individuals lie within patches of floating *Sargassum*. Adult turtles are generally visible at the surface during periods of daylight and clear visibility.

To reduce the risk of impacts from dredging and vessel strikes, the project would comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NMFS 2006b) and "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. Trained NMFS-approved protected species observers would operate the dredge vessel and dredge support vessel. Operators and crews receive instructions to maintain a vigilant lookout for turtles during offshore transits and maneuvers.

Despite these precautions, turtles could prove very difficult to spot from a moving vessel when resting below the water surface, during nighttime, and during periods of inclement weather. A collision between a sea turtle and a slow moving vessel may occur. Adult, subadult, and perhaps juvenile turtles are often capable of avoiding moving dredge-related vessels when these vessels operate within limited areas at slow to relatively slow speeds.

Entrainment by Hopper Dredge Drag Heads

Entrainment within hopper dredge drag heads could injure or kill sea turtles, particularly within areas of soft sediment in ship channels where turtles are known to bury themselves partially when resting (National Research Council Committee on Sea Turtle Conservation 1990). Sea turtles have also been observed to partially bury themselves in soft sediments that have settled into previous dredge borrow pits (Michals 1997p; Keith Spring and David Snyder, personal communication: observations of sea turtles using borrow pits off Hobe Sound, Florida). Numerous methods have been implemented to reduce the number of turtle takes during hopper dredge operations, including special turtle deflecting hopper dredge drag heads, relocation trawling,

dredging windows, and the implementation of trained protected species observers during dredging operations (http://el.erdc.usace. army.mil/tessp/pdfs/ 1997SADBO.pdf).

The numerous areas of emergent hard substrate in the general project area represent high quality shelter for turtles. The proposed offshore borrow area presents a lower quality refuge, as it is an area of bare sand positioned along the inner continental shelf, proximal to hardbottom habitat.

NMFS-approved protected species observers would operate the hopper dredge, which would come equipped with a sea turtle deflecting drag head deflector within the proposed borrow site (http://el.erdc.usace.army.mil/seaturtles/docs/observercriteria.pdf) during all dredging operations. Even with these measures in place, incidental take(s) of sea turtles during dredging remains a possibility.

Alteration (Burial) of Exposed Nearshore Hardbottom

Impacts to juvenile sea turtle species from the proposed project due to the loss of developmental nearshore habitat (hardbottom) would depend on the extent of buried nearshore hardbottom within the project area and the longevity of that burial (before currents disperse the sand). The project would displace juvenile turtles (i.e., prevent them from using these areas) as long as project sand covers the hardbottom and associated macroalgae. Estimated direct hardbottom impacts from the sand placement total 0.55 acres, about 4% of the total 12.97 acres nearshore hardbottom habitat. Direct impacts were calculated based on the existing hardbottom between the predicted ETOF and the existing MHW line. As discussed in **Sections 2.6.1.2** and **3.4**, the exposed ephemeral nearshore hardbottom and the majority of hardbottom observed in the project area include partially exposed rock with sand veneers of varying depths. The proposed impact should not result in significant adverse effects on juvenile sea turtles due to the ephemeral nature of the hardbottom habitat and the availability of similar foraging habitat within the project vicinity.

Alteration of Exposed Nearshore Hardbottom (Pipeline Placement)

Pipeline placement would directly impact an additional 0.02 acre of hardbottom habitat during construction. The impact would occur outside of turtle nesting season.

Turbidity

Several activities during construction would affect water quality. Dredging and sand placement on the beach face would produce turbidity at the borrow site and along the shoreline. The limited extent and short duration of the reduced water clarity and implementation of proper design and Best Management Practices (BMPs) should reduce the magnitude and extent of temporary impacts of project activities. Turbidity generation would cease at the completion of construction.

Underwater Noise and Vibration from Dredging Activities

Little is known how turtles may respond to noise from offshore activities. In contrast to marine mammals, relatively little is known about sea turtles' hearing ability or their dependency on sound, passive or active, for survival cues. Only two species, loggerhead and green sea turtles, have undergone any auditory investigations. The anatomy of the sea turtle ear does not lend itself to aerial conduction; rather, it lends itself to sound conduction through bone and water (Békésy 1948, Lenhardt 1982, Lenhardt and Harkins 1983). Auditory testing and behavioral studies show that turtles can detect low frequency sounds (Ridgway et al. 1969, Bartol et al. 1999).

Sea turtles could likely hear low frequency underwater noise from construction activities and possibly experience some disturbance. The main noise sources include vessel engines. The most likely impacts would include short-term behavioral changes such as evasive maneuvers, disruption of activities, or short-term departure from the area.

4.3.1.2. Marine Mammals

IPFs associated with the proposed action that could potentially affect listed marine mammals include

- Vessel traffic
- Turbidity
- Underwater noise and vibration from dredging activities

Vessel Traffic

Dredge, dredge support, and construction vessel traffic associated with the proposed action raises the chance these vessels could collide with listed marine mammals. The risk would vary depending upon location, vessel speed, and visibility. As discussed in **Section 3.3.2**, North Atlantic right whales may occur in the project area during the wintering and calving period. Humpback whales may also travel through the middle shelf, offshore of the project area; however, as anticipated, they would not occur within the borrow area or within nearshore waters. Both of these species are large and readily visible at the surface during periods of daylight and clear visibility. Florida manatees may, but are unlikely to occur within the project area. On-board trained and NMFS-approved protected species observers would occupy dredge vessel during all dredging operations, and dredge support vessel operators and crews would receive instructions to maintain a constant lookout for marine mammals during transits and maneuvers.

Despite these precautions, these species could prove very difficult to spot from a moving vessel when they are resting below the water surface, during nighttime, and during periods of inclement weather. However, these animals are capable of avoiding moving dredge-related vessels, especially when these vessels operate within limited areas at slow to relatively slow speeds.

Turbidity

Several activities during construction would affect water quality. Turbidity created by borrow area dredging and sand placement on the beach face represents the primary source of water quality impacts at the borrow site and along the shoreline. Turbidity could cause temporary impacts to about one acre of hardbottom habitat. Proper implementation of the approved design and construction BMPs should prove effective in reducing the magnitude and extent of impacts resulting from project activities. Turbidity generation would cease at the completion of construction. Due to the limited extent and short duration of reduced water clarity, potential project impacts on marine mammals should be negligible.

Underwater Noise and Vibration from Dredging Activities

Potential effects of the elevated background noise levels caused by operator-generated noise to marine mammals include the following:

- Limiting the detection by the mammals of natural sounds
- Disturbing their normal behavior, resulting in possible displacement from areas
- Causing temporary or permanent reductions in hearing sensitivity

The potential effects depend on the type of marine mammal involved because different marine mammals hear at different frequencies. The levels and types of ambient noise also strongly influence the potential area or zone of influence of a operator-generated sound. An animal's sensitivity to different sounds varies with frequency, and its response to a sound likely depends strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Ports Corporation of Queensland 2005). Although underwater noise can affect marine mammals (Richardson et al. 1995), the project does not involve any high energy sound sources that could cause temporary or permanent auditory damage. In general, the sources and levels of underwater noise and vibration generated during the project should cause only minor impacts on marine mammals. The most likely impacts are temporary behavioral responses such as avoidance or altered diving or swimming behavior.

The North Atlantic right whale uses the project area as part of the species' migratory route and as potential calving grounds during the winter months; however, these whales are rare to the project area. The humpback whale is rarely present within the vicinity of St. Lucie County during its spring/fall migration. Manatees have been observed along the coast in the shallow, nearshore waters, though only rarely. Marine mammals would likely avoid areas where a dredge is operating. The project area is an extremely small area when compared to the overall waters used for migration and calving.

4.3.1.3. Smalltooth Sawfish

IPFs associated with the proposed action that may potentially impact smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities
- Entrainment by hopper dredge drag heads

Turbidity

Several activities during construction could affect water quality. The main sources of water quality impacts are borrow area dredging and sand placement on the beach face, which would produce turbidity at the borrow site and along the shore. Turbidity could cause temporary impacts to about one acre of hardbottom habitat. Proper implementation of the approved design and construction BMPs should limit the level and extent of construction-related turbidity. Turbidity generation would cease at the completion of construction. Due to the limited extent and short duration of the reduced water clarity, any potential impacts on smalltooth sawfish should be negligible.

Underwater Noise and Vibration from Dredging Activities

In general, the sources and short-term levels of underwater noise and vibration generated during the project should cause only negligible impacts on smalltooth sawfish. Smalltooth sawfish that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities. These temporary avoidance behaviors should cause negligible impacts on smalltooth sawfish.

Entrainment by Hopper Dredge Drag Heads

The smalltooth sawfish normally inhabits shallow waters (10 m or fewer) often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters of the continental shelf at depths greater than 20 meters (NMFS 2006a). Sawfish encounter a small risk of being entrained in the hopper dredge drag head as it extracts sand from the St. Lucie Shoal. To reduce the risk of impacts from dredging and vessel strikes, the project would comply with the “Sea Turtle and Smalltooth Sawfish Construction Conditions” (NOAA Fisheries 2006). Mitigation measures would minimize entrainment risks. Measures would include the use of sea turtle deflecting drag head deflector, which would also help deflect smalltooth sawfish.

Disturbances from ongoing activities could displace smalltooth sawfish that may visit the project area during the construction period. These disturbances could result in temporary movement or avoidance of the area, but the species would likely return when the temporary disturbance ended.

4.3.1.4. Piping Plover

Wintering grounds for piping plovers include Hutchinson Island. While coastal development has reduced important beach habitat for wintering bird species, beach nourishment can restore beach habitat for many shore birds. However, during the beach renourishment construction phase, some short-term displacement of foraging and

resting birds, including piping plovers, could occur. During construction activities, displaced species may use habitats with similar characteristics north and south of the project area.

Beach nourishment activities are more likely to affect birds that use the beach for nesting and breeding than birds that use the area for feeding and resting during migration (Greene 2002). Dredges, pipelines, and other equipment along the beach could displace piping plovers, or could cause them to avoid foraging along the shore if they are aurally affected (Peterson et al. 2000). If the sand placed on the beach is too coarse or high in shell content, it can inhibit the birds' ability to extract food particles from the sand (Greene 2002). Fine sediment that reduces water clarity can also decrease the feeding efficiency of birds (Peterson et al. 2000).

Minimal direct impacts to piping plovers should occur from project construction because motile birds can avoid construction activities. The disposal of sand on the beach may temporarily interrupt foraging and resting activities of shorebirds that use the project beach area. This limited interruption would occur on the immediate area of disposal and last for the duration of construction. A temporary reduction to the prey base for many shorebirds, which includes the benthic organisms mentioned in **Section 3.5.1**, would also occur in the project area. Recovery from this short-term reduction should occur within about one year after sand placement.

The Endangered Species Act of 1973, the Florida Threatened and Endangered Species Act of 1977, and the Federal Migratory Bird Treaty Act of 1918 protect piping plovers. The threatened species list first included the Atlantic coast population of the piping plover in 1985. To prevent impacts to piping plovers during construction, the project would comply with the USACE-Jacksonville district-wide migratory bird protection policy. Complete migratory bird protection specifications for contracts is available at the website http://www.saj.usace.army.mil/Divisions/Planning/Branches/Environmental/Protection_Environment.htm.

4.3.1.5. Beach Jacquemontia

In its letter dated December 14, 2011, the USFWS indicated that based on observations made in January 2010, the endangered beach jacquemontia may occur within the project area. The potential location(s), quantity, and current vegetative state are unknown for beach jacquemontia specimens that may occur within the project area.

Fill placement would not occur landward of the dune crest. The primary habitat for beach jacquemontia occurs landward of the dune crest on the more stable portions of the dune system.

The implementation of protective measures would avoid and minimize potential impacts to beach jacquemontia. Protective measures would likely include a pre-construction survey to locate and mark beach jacquemontia growing within or adjacent to the project area. For beach jacquemontia identified outside of the project fill footprint, creation of a minimum 25-foot protective buffer around each individual would exclude construction activities within that area. Measures to minimize potential impacts to beach

jacquemontia growing within the project fill footprint may include transplanting individual plants to suitable habitat out of harm's way. If transplanting is necessary, the USFWS staff must review and approve a detailed plan before initiating transplanting activities.

4.3.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

4.3.2.1. Sea Turtles

4.3.2.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality would not likely have negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed in **Section 4.3.1.1(a)**, the Beach Fill with No Impact to Existing Hardbottom alternative could still incur short-term negative effects on sea turtles nesting from nesting disturbance, sand compaction, potential for scarp formation, artificial lighting, etc. during construction and the first year post-construction. This alternative would not offer significant beach area increase; accordingly, this alternative would most likely include little significant beneficial effect on sea turtle nesting through the creation of additional beach habitat.

4.3.2.1(b). Inner Shelf Habitat

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that could potentially affect sea turtles on the inner shelf include

- Turbidity
- Underwater noise and vibration from dredging activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines

For both turbidity and underwater noise IPFs, the Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to sea turtles as the applicant's preferred alternative.

This alternative would not affect hardbottom within the equilibrium toe of fill (ETOF); however, using an offshore sand source could result in 0.1 acre of hardbottom impact within the pipeline corridor.

4.3.2.2. Marine Mammals

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that could potentially affect marine mammals include

- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to marine mammals from turbidity and underwater noise and vibration from dredging and pumping equipment as the applicant's preferred alternative.

4.3.2.3. Smalltooth Sawfish

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that may potentially impact smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to smalltooth sawfish for turbidity and underwater noise and vibration from dredging and pumping equipment as the applicant's preferred alternative.

4.3.2.4. Piping Plover

The Beach Fill with No Impact to Existing Hardbottom alternative would cause the same impacts to piping plovers as the applicant's preferred alternative, albeit over a wider range of beach due to the increased project area compared to the applicant's preferred alternative.

4.3.2.5. Beach Jacquemontia

The Beach Fill with No Impact to Existing Hardbottom would cause the same impact to beach jacquemontia as the applicant's preferred alternative, albeit over a wider range of beach due to the increased project area compared to the applicant's preferred alternative.

4.3.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

4.3.3.1. Sea Turtles

4.3.3.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality would not likely have negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed in **Section 4.3.1.1(a)**, the Beach Fill to Restore the 1972 Beach and Dune alternative could still incur short-term negative effects on sea turtles nesting from nesting disturbance, sand compaction, potential for scarp formation, artificial lighting, etc. during construction and the first year post construction. This alternative does not offer significant beach area increase; accordingly, this alternative would most likely include little significant benefit to sea turtle nesting through the creation of additional beach habitat.

4.3.3.1(b). Inner Shelf Habitat

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune alternative potentially impacting sea turtles on the inner shelf include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill to Restore the 1972 Beach and Dune alternative would cause the same Impacts to sea turtles as the applicant's preferred alternative for turbidity and underwater noise and vibration from dredging and pumping equipment. Estimated direct hardbottom impacts from sand placement total 0.77 acre, about or about 5% of the total 12.97 acres nearshore of the project footprint. This alternative should not result in significant adverse effects on juvenile sea turtles due to the ephemeral nature of the hardbottom habitat and the availability of similar foraging habitat within the project vicinity.

This alternative would also impact 0.1 acre of hardbottom habitat within the pipeline corridor during construction. The applicant's preferred alternative would result in 0.02 acre of pipeline-related impacts.

4.3.3.2. Marine Mammals

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune alternative that could potentially affect listed marine mammals include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune alternative would cause the same impacts to marine mammals as the applicant's preferred alternative.

4.3.3.3. Smalltooth Sawfish

IPFs associated with Beach Fill to Restore the 1972 Beach and Dune alternative that could potentially affect smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune alternative would cause the same impacts to the smalltooth sawfish as the applicant's preferred alternative.

4.3.3.4. Piping Plover

The Beach Fill to Restore the 1972 Beach and Dune alternative would cause the same impacts to piping plovers as the applicant's preferred alternative.

4.3.3.5 Beach Jacquemontia

The Beach Fill with No Impact to Existing Hardbottom would cause the same impact to beach jacquemontia as the applicant's preferred alternative.

4.3.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM

4.3.4.1. Sea Turtles

4.3.4.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. This similarity should avoid negative effects to sea turtles nesting or hatchling emergence success. However, based on the issues discussed in **Section 4.3.1.1(a)**, the North Segment Dune Restoration Only alternative could still have negative effects (i.e., nesting disturbance, sand compaction, potential for scarp formation, artificial lighting) on sea turtles nesting within the first year of the project life on the southern segment. As the beach equilibrates by natural processes in the years following nourishment, the increase in beach area provided by this alternative would have beneficial effects on sea turtle nesting through the creation of additional beach habitat along the south segment, and through the increase in beach width of the north segment due to dispersion of sand from the south segment.

A comparison of the 10-year performance of the Beach Fill to Restore the 1972 Dune with a 35-Foot Berm alternative to the applicant's preferred alternative indicates the 35-Foot Berm alternative could result in a wider north beach segment than the applicant's preferred alternative. However, northward dispersion of sand from the south segment nourishment would result in a slower erosion rate of the north segment beach. After 10 years, the 35-Foot Berm alternative would remain only slightly wider than the applicant's preferred alternative, which does not include nourishment of the north segment. The wider beach along the north segment could increase hatching success of nests successfully laid compared to the applicant's preferred alternative, as nests on wider beaches stand less chance of repeated inundation and washout.

4.3.4.1(b). Inner Shelf Habitat

IPFs associated with this alternative that may potentially affect sea turtles on the inner shelf include

- Alteration (burial) of exposed nearshore hard substrate during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Vessel traffic
- Entrainment by hopper dredge drag heads
- Turbidity
- Underwater noise and vibration from dredging activities

Estimated direct hardbottom impacts for this alternative from the sand placement total 2.63 acres, or about 20% of the total 12.97 acres nearshore of the project footprint. This alternative represents a significant impact to nearshore hardbottom in the project area, but only to a minor fraction of the hardbottom available along Hutchinson Island. Therefore, this alternative should not result in significant adverse effects on juvenile sea turtles due to the ephemeral nature of the hardbottom habitat and the availability of similar foraging habitat within the project vicinity.

This alternative would also impact 0.1 acre of hardbottom habitat within the pipeline corridor.

For all other IPFs, this alternative would cause the same impacts to inner shelf habitat as the applicant's preferred alternative except that the impacts would occur along both the south and north project segments.

4.3.4.2. Marine Mammals

IPFs associated with this alternative that may potentially affect listed marine mammals include

- Vessel traffic
- Turbidity
- Underwater noise and vibration from dredging activities

For these IPFs, this alternative would cause the same impacts to marine mammals as the applicant's preferred alternative except that the impacts would occur along both the south and north project segments.

4.3.4.3. Smalltooth Sawfish

IPFs associated with the alternative that could potentially affect smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities
- Entrainment by hopper dredge drag heads

For these IPFs, the alternative would cause the same impacts to smalltooth sawfish as the applicant's preferred alternative except that the impacts would occur along both the south and north project segments.

4.3.4.4. Piping Plover

This alternative would cause the same impacts to piping plovers as the applicant's preferred alternative for the initial project implementation, except that the impacts would occur along both the south and north project segments.

4.3.4.5 Beach Jacquemontia

This alternative would cause the same impact to beach jacquemontia as the applicant's preferred alternative, except that the impacts could occur on both the south and north segment dunes.

4.3.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

4.3.5.1. Sea Turtles

4.3.5.1(a). Nesting Habitat

The material proposed for placement comprises beach-quality sand of similar grain size and color to the native beach sand. Therefore, sand quality should not reduce sea turtle nesting or hatchling emergence success. However, based on the issues discussed in **Section 4.3.1.1(a)**, the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative could still have negative effects on sea turtles nesting (i.e., nesting disturbance, sand compaction, potential for scarp formation, artificial lighting) within the first year of the project life. As the beach equilibrates by natural processes in the years following nourishment, the increase in beach area provided by this alternative would have the greatest beneficial effects (compared to the other alternatives evaluated) on sea turtle nesting through the creation of additional beach habitat.

4.3.5.1(b). Inner Shelf Habitat

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect sea turtles on the inner shelf include

- Alteration (burial) of exposed nearshore hard substrate during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity
- Underwater noise and vibration from dredging activities

The Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would create the same turbidity and underwater noise and vibration from dredging and pumping equipment impacts as the applicant's preferred alternative but in a greater

area than the applicant's preferred alternative. Estimated direct hardbottom impacts from sand placement totals 3.38 acres, about or about 26% of the total 12.97 acres nearshore of the project footprint. This alternative should not result in significant adverse effects on juvenile sea turtles due to the ephemeral nature of the hardbottom habitat and the availability of similar foraging habitat within the project vicinity.

As with the applicant's preferred alternative, this alternative would also impact 0.1 acre of hardbottom habitat within the pipeline corridor during construction.

4.3.5.2. Marine Mammals

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect listed marine mammals include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same types of impacts to marine mammals but in a larger area of nearshore habitat than would the applicant's preferred alternative.

4.3.5.3. Smalltooth Sawfish

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-Foot Berm alternative that may potentially affect smalltooth sawfish include

- Turbidity
- Underwater noise and vibration from dredging activities

For both of these IPFs, the Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same impacts to smalltooth sawfish as the applicant's preferred alternative except in a larger area of nearshore habitat.

4.3.5.4. Piping Plover

The Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same impacts to piping plovers as the applicant's preferred alternative except in a larger area of shoreline.

4.3.5.5 Beach Jacquemontia

The Beach Fill to Restore the 1972 Beach and Dune with a 70-Foot Berm alternative would cause the same impact to beach jacquemontia as the applicant's preferred alternative except in a larger area of beach foredune.

4.3.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

4.3.6.1. Sea Turtles

4.3.6.1(a). Nesting Habitat

The Beach and Dune Restoration with T-Head Groins alternative would reduce the amount of nesting beach by covering nesting habitat with rock to create the groin above mean high water. When exposed, the T-head groins have the potential to entrap hatchlings or alter their behavior. Potential adverse effects during project construction include disturbance to existing nests, which observers may have missed during daily surveys; disturbance of females attempting to nest; and disorientation of hatchlings. Following construction, groins could interfere with sea turtle behavior. The groins could interfere with ingress and egress of the female turtles; and trap or obstruct hatchlings as they swim seaward. Groins could attract additional predatory fish that would increase hatchling predation risk. The placement of sand in the project area and downdrift impact areas would have additional impacts (i.e., nesting disturbance, sand compaction, potential for scarp formation) within the first year of nourishment activity. Tilling the beach and active monitoring and elimination of scarps would mitigate the impacts from compaction and scarp formation. The beaches in the downdrift areas may erode at a rate equivalent to the sand accretion within the project area. Placement of sand as part of the initial project would help mitigate for downdrift effects, but a groin field could still have negative indirect effects on sea turtles nesting (i.e., nesting disturbance, potential for scarp formation) in the downdrift areas.

The construction of the T-head groins with dune and beach restoration is also anticipated to maintain or increase turtle nesting habitat by increasing the beach width and helping preserve that beach width within the project area. Beaches downdrift of the groin field could require nourishment later to compensate for sand accumulated in the project area. As the beach equilibrates by natural processes in the years following nourishment, the increase in beach area provided by this alternative would have beneficial effects on sea turtle nesting through the creation of additional beach habitat. Overall, the increase in beach area provided by this alternative would have beneficial effects on sea turtle nesting through the creation and maintenance of additional beach habitat. Design of the groins for complete burial by sand would reduce the risks to sea turtles. However, it is likely that the groins would become exposed as the beach erodes, reducing the period of benefit provided by the buried design.

4.3.6.1(b). Inner Shelf Habitat

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect sea turtles on the inner shelf include

- Alteration (burial) of exposed nearshore hard substrate from T-head groin construction activities
- Alteration (burial) of exposed nearshore hard substrate from subsequent nourishment activities

- Ingress and egress to/from beach
- Vessel traffic
- Entrainment by hopper dredge drag heads for subsequent dredging activities
- Turbidity
- Underwater noise and vibration from T-head groin construction activities
- Underwater noise and vibration from subsequent dredging activities

Similar to the applicant's preferred alternative and other alternatives including beach fill, the Beach and Dune Restoration with T-Head Groins alternative would create turbidity and underwater noise and vibration from construction activities and subsequent dredging and pumping equipment impacts. However, additional turbidity and underwater noise would also occur during subsequent nourishment of downdrift areas if required to offset indirect impacts of the groin field. Estimated direct hardbottom impacts from sand placement total 2.93 acres, or about 23% of the total 12.97 acres nearshore of the project footprint. This alternative should not result in significant adverse effects on juvenile sea turtles due to the ephemeral nature of the hardbottom habitat and the availability of similar foraging habitat within the general project vicinity.

This alternative would also impact 0.1 acre of hardbottom habitat within the pipeline corridor compared to 0.02 acre of pipeline-related impacts of the applicant's preferred alternative.

Some speculate that the placement of the T-head groins could impact the ingress and egress of sea turtles to the beach for nesting and the egress of the hatchlings leaving the beach for open water. However, a literature search found no documentation of this potential effect. Because the T-head groins would occur in the nearshore area, they are not expected to affect emergent hatchlings crawling to the water. Swimming hatchlings navigate based on wave direction. The smaller waves and gentler wave-generated currents around the T-head groins would help hatchlings orient to the openings between the structures and ease their way into deeper offshore water.

Hatchlings emerge in mass, crawl down to the sea, and immediately begin a 24- to 36-hour period of swimming, which has been referred to as the "frenzy" phase of the hatchlings migration away from the coast (Carr 1962). Whelan and Wyneken (2007) showed that the mortality rate among hatchlings rose the longer hatchlings remained in nearshore waters, and they speculated that rapid escape from shallow water might comprise a genetic survival mechanism. Large waves and ocean currents often impede hatchlings during their early swimming frenzy to escape shallow water (Whelan and Wyneken 2007). The T-head groins would reduce the large waves reaching the beach and could facilitate turtle hatchling survival rates by reducing wave energy at the shore-sea interface and reducing turbulence in the immediate subtidal. However, the vertical orientation of the groin structures could attract predatory fishes at higher densities than would otherwise occur without the groins. These higher densities could lead to increased predation on the hatchlings. Finally, predatory birds may use emergent groins as perches from which to search for prey, including hatchling turtles passing close by the groins.

For the other IPFs, this alternative would cause greater impacts to the inner shelf habitat than the applicant's preferred alternative. Additional impacts (e.g., turbidity, hopper dredge entrainment, underwater noise, vessel traffic, burial of exposed nearshore hard substrate) would also occur later from the subsequent nourishment of downdrift areas as part of the efforts to mitigate downdrift impact of the groins.

4.3.6.2. Marine Mammals

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect listed marine mammals include:

- Vessel traffic
- Turbidity
- Underwater noise and vibration from T-Head Groin construction activities
- Underwater noise and vibration from subsequent dredging activities

For all of these IPFs, the Beach and Dune Restoration with T-Head Groins alternative would cause impacts to marine mammals potentially larger than those of the applicant's preferred alternative, as the project would require a longer construction period. Additional impacts could also occur from nourishment of downdrift areas to mitigate for the groin field's indirect impacts.

4.3.6.3. Smalltooth Sawfish

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect smalltooth sawfish include:

- Turbidity
- Underwater noise and vibration from T-head groin construction activities
- Underwater noise and vibration from subsequent dredging activities
- Entrainment by hopper dredge drag heads for subsequent dredging activities

For all of these IPFs, the Beach and Dune Restoration with T-Head Groins alternative would cause impacts to smalltooth sawfish similar to those of the applicant's preferred alternative but within a larger area. Additional impacts of the same type could also occur later from the nourishment of downdrift areas to offset indirect impacts of the groins.

4.3.6.4. Piping Plover

The Beach and Dune Restoration with T-Head Groins alternative would cause impacts to piping plovers similar to those of the applicant's preferred alternative but to a greater area of beach. Additional impacts could occur from the subsequent nourishment of downdrift areas to offset indirect groin impacts.

4.3.6.5 Beach Jacquemontia

The Beach and Dune Restoration with T-Head Groins alternative would cause the same impact to beach jacquemontia as the applicant's preferred alternative except along a greater area of beach foredune.

4.3.7. NO ACTION (STATUS QUO)

4.3.7.1. Sea Turtles

4.3.7.1(a). Nesting Habitat

The No Action alternative could affect sea turtles that use the project area beaches for nesting. Beach erosion would likely diminish nesting success because it would reduce the total area of suitable nesting habitat. Also, beach erosion would likely reduce hatching success of nests successfully laid, as nests on narrow, eroded beaches become more vulnerable to repeated inundation and washout.

4.3.7.1(b). Inner Shelf Habitat

No IPFs are associated with the No Action alternative to inner shelf habitat for sea turtles; therefore, no impacts would be expected.

4.3.7.2. Marine Mammals

No IPFs are associated with the No Action alternative to habitat for listed marine mammals; therefore, no impacts would be expected.

4.3.7.3. Smalltooth Sawfish

No IPFs are associated with the No Action alternative to habitat for smalltooth sawfish; therefore, no impacts would be expected.

4.3.7.4. Piping Plover

No IPFs are associated with the No Action alternative to habitat for piping plover; therefore, no impacts would be expected.

4.3.7.5 Beach Jacquemontia

No IPFs are associated with the No Action alternative to beach jacquemontia habitat. Therefore, no impacts would be expected.

4.4 HARDBOTTOM

4.4.1. BEACH FILL SOUTH SEGMENT ONLY TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED ALTERNATIVE)

IPFs associated with the applicant's preferred alternative that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

Impacts to nearshore hardbottom from the applicant's preferred alternative depend on depth of burial, sand characteristics, and duration of coverage. The proposed project would directly impact 0.57 acre of hardbottom habitat within the ETOF. Burial of 0.55 acre nearshore hardbottom and impacts to another 0.02 acre of hardbottom would result in a local reduction of macroalgae and invertebrates that could modify the nearshore food web (greater loss of macroalgal biomass would occur in summer months due to the presence of fast-growing annual species that are absent in winter months). Re-exposure of hardbottom could likely occur due to high-energy dynamics of the area and downdrift and cross-shore erosion of the fill material after equilibration of beach fill. Worm rock, turf, and macroalgae would likely recolonize these re-exposed hard substrates in the same fashion they colonize any previously buried hardbottom. Organisms with high recruitment capabilities dominate the nearshore hardbottom community; coverage and re-exposure of hardbottom substrate is a common occurrence in the project area. Potential impacts by burial are considered minor. The 0.55 acre that the project would permanently bury (as defined for regulatory purposes of evaluating impact and mitigation) but would likely become re-exposed over time represents approximately 4% of the total approximate 12.97 acres of total hardbottom in and immediately adjacent to the project ETOF area. The impacted area represents a much smaller fraction of this habitat along the shoreline of Hutchinson Island.

Alteration of Exposed Nearshore Hardbottom (Pipeline Placement)

Pipeline placement impacts to nearshore hardbottom from the proposed project depend on the placement location, size, and duration of sand delivery pipelines within the project area. The northernmost pipeline corridor (approximately at R-89.5) contains variable presence of hardbottom and partially exposed hardbottom, but no practicable alternative (i.e., other route that could result in lesser impact) appears feasible for the north project segment. Impacts to hardbottom habitat along the northernmost pipeline corridor would total 0.08 acre. The remaining four proposed pipeline corridors (R-100, R-104, R-108, R-114) consist almost completely of sand and shell hash, with some interspersed small expanses of hardbottom or partially exposed hardbottom that totals

0.02 acre. This small expanse provides little biotic cover and may represent an area of ephemeral hardbottom exposure (CSA 2010a). Proposed corridors are approximately 50 feet wide. Permit requirements would include both pre- and post-construction hardbottom surveys to reassess the pipeline corridors for hardbottom impacts. Due to the ephemeral nature of exposed hardbottom in the area, re-exposure of hardbottom in pipeline corridors currently delineated as sand bottom could occur. Assuming the placement of support-collars along the pipeline to raise it above the bottom in hardbottom areas, limited potential impacts to hardbottom would occur due to shading of benthos immediately under the pipeline, crushing of biota beneath the support-collars, and accidental collateral damage to hardbottom impacted by pipeline placement/removal equipment. Shading would have the greatest impact on photosynthetic organisms (e.g., macroalgae). Potential impacts by shading are considered minor as microalgae recolonizes quickly. Accidental collateral damage to hardbottom by pipeline placement and/or removal activities could result in localized crushing of hardbottom and/or associated epibiota. However, implementation of proper design, BMPs (discussed in **Section 2.1.1.1**), and the Draft Pipeline Monitoring Plan (**Appendix P**) should reduce the magnitude and extent of impact resulting from project activities.

Turbidity

Several activities during construction could affect water quality. Sand placement on the beach face, where the main source of water quality impacts to nearshore hardbottom occur, would produce turbidity at the beach sand placement site and adjacent waters. Impacts to nearshore hardbottom from turbidity depend on sediment grain size and duration of pumping activities. Finer sediments would have a longer suspension time compared with coarser sediments. Increased turbidity in nearshore waters could result in temporary shading of photosynthetic organisms (e.g., macroalgae), siltation of sessile organisms, and potentially cause interference to suspension feeders; however, given the anticipated relatively short duration of construction activity, the potential impacts from turbidity are considered minor.

Turbidity associated with the dredge water reentering the ocean from the beach could result in temporary impacts to hardbottom. Temporary turbidity impacts, calculated based on acreage of existing hardbottom between the predicted ETOF and FDEP approved mixing zone limits (65 m from shoreline), are estimated to total up to 10.85 acres of hardbottom. These temporary impacts would occur adjacent to each pipeline location for that fraction of the total construction period associated with each pipeline location (see **Section 2.1.1**).

4.4.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

No impacts to existing nearshore hardbottom would occur from sand placement for the Beach Fill with the No Impact to Existing Hardbottom alternative. However, impacts to hardbottom along the pipeline corridors would be the same as the impacts for the preferred alternative and therefore are considered negligible. In addition, temporary impacts to hardbottom from elevated turbidity associated with this alternative are considered minor.

4.4.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

The Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would cover and thus directly impact 0.67 acre of hardbottom habitat. Pipeline impacts could result in another 0.1 acre of impact to hardbottom habitat. Direct impacts to nearshore hardbottom associated with all other IPFs would be similar to and greater than the direct impacts associated with the applicant's preferred alternative. However, elevated turbidity during construction could temporarily impact up to 9.83 acres of hardbottom within the mixing zone. These temporary impacts within the mixing zone would occur only during sand placement.

4.4.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 35-foot Berm alternative that may potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

The Beach Fill to Restore the 1972 Dune with a 35-foot Berm alternative would cause direct impacts to 2.63 acres of nearshore hardbottom along the southern beach fill segment. In addition, pipeline placement would impact an additional 0.10 acre of hardbottom. Initial project implementation would not impact the often discontinuous, low- to medium-relief nearshore hardbottom including worm rock along the north project segment. This alternative would create the same turbidity from dredging and pumping equipment impacts as the applicant's preferred alternative, except that the impact would occur along the south and north beach segments.

The 2.63 acres that the project would permanently bury (as defined for regulatory purposes of evaluating impact and mitigation), but would likely become re-exposed over time, occurs primarily in the north segment nearshore. In addition, the pipeline corridor impacts would total another 0.1 acre, also primarily in the north segment nearshore. The summed acres (2.73) represent approximately 21% of the approximate 12.97 acres of total hardbottom in and immediately adjacent to the project ETOF area. The impacted area represents a relatively small fraction of this habitat along the shoreline of

Hutchinson Island. Additionally, elevated turbidity would temporarily impact up to 10.85 acres of hardbottom within the mixing zone. The temporary impacts within the mixing zone would occur only during sand placement activities.

4.4.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative that could affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines
- Turbidity

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative would produce greater impacts (3.38 acres of hardbottom burial compared to 2.63 acres for the applicant's preferred alternative) and 0.10 acre along the pipeline corridors. However, relative to the total available habitat in the general project area, direct impacts to nearshore hardbottom associated with all other IPFs would be similar to the direct impacts associated with the applicant's preferred alternative. Temporary impacts associated with elevated turbidity during construction could affect up to 11.03 acres of hardbottom within the mixing zone. These temporary impacts within the mixing zone would occur only during sand placement activities from the settling of sand particles associated with turbidity.

4.4.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that could potentially affect nearshore hardbottom include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos from T-head groin construction activities
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines from subsequent nourishment activities
- Turbidity

Compared to the applicant's preferred alternative, the Beach and Dune Restoration with T-Head Groins alternative would produce significantly greater direct hardbottom impacts within the ETOF (2.83 acres) compared to the applicant's preferred alternative (0.57 acre). The T-Head Groins would rest on some portion of hardbottom that would be lost indefinitely. However, depending on the construction material, the T-Head Groins could colonize and create new but different hardbottom habitat that could be used for foraging and refuge. In addition, 0.10 acre of hardbottom habitat would be impacted along the pipeline corridors.

Similar to the 35-foot berm alternative, elevated turbidity associated with beach placement activities could result in up to 10.85 acres of temporary impacts to nearshore hardbottom within the mixing zone.

Impacts to nearshore hardbottom associated with all other IPFs would be similar to impacts associated with the applicant's preferred alternative.

4.4.7. NO ACTION (STATUS QUO)

There are no IPFs associated with the No Action alternative potentially impacting nearshore hardbottom.

4.5. FISH AND WILDLIFE RESOURCES

4.5.1. BEACH FILL SOUTH SEGMENT ONLY TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED ALTERNATIVE)

IPFs associated with the applicant's preferred alternative and all other build alternatives that could potentially affect fish and wildlife include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities
- Construction noise

<u>Alteration (Burial) of Exposed Nearshore Hardbottom</u>

The loss of this nearshore hardbottom habitat could result in impacts to the young stages of several reef fish species that use the nearshore hardbottom habitat. Nearshore hardbottom is an important component of the cross-shelf developmental pathways used by many reef species (Lindeman et al. 2000). The extent of the impact would depend on the size and longevity of buried nearshore hardbottom within the project area. This alternative is expected to displace juvenile fishes as long as the hardbottom habitat remains covered. Complete burial would preclude reef species from feeding on the flora and fauna that comprise the nearshore hardbottom community. Recolonization of re-exposed hard substrates by worm rock and turf and macroalgae is probable as these organisms have high recruitment capability; coverage and re-exposure of hardbottom substrate is a common occurrence in the project area. The impacted area, 0.57 acre, represents a minor portion (4%) of the total habitat available for use within the project area, and a minor portion of the total hardbottom habitat along the coast of St. Lucie County. In addition, the applicant proposes mitigation to offset the impacts.

Disturbance of Sand Bottom Habitats

Dredging activities within the shoal borrow area and beach fill sites would impact the demersal and pelagic fish species, macrofaunal invertebrates, and infaunal benthic invertebrates. The potential disturbances to the sand bottom habitats include anchoring of the hopper barge during pump out activities, vibrations caused from the pump out activities, and placement of the pump out and conveyance pipes. Injuries to infaunal invertebrates and any motile macrobenthic invertebrate species would most likely occur during entrainment as part of the dredging and sand pumping operations. Some benthic infaunal invertebrates would survive and recolonize parts of the submerged beach fill area, but any exposed on the new beach berm are not anticipated to survive nourishment activity.

Greene (2002) summarized a number of studies of benthic invertebrate recovery rates. These studies show that benthic invertebrate communities' recovery can occur in as few as two weeks but often with an assemblage dissimilar to the preconstruction infaunal community composition. Recovery of the populations typically occurs two to seven months after nourishment, given that organisms living in the high-energy beach environment, especially the intertidal area, are adapted to disturbances (Atlantic States Marine Fisheries Commission 2002). Recovery of organisms in soft-sediments typically occurs through larval transport and post-settlement life-stages (juveniles and adults) and varies with the season, habitat, and the species' life history characteristics. Active dredging operations during project activities would displace motile macrobenthic invertebrates and especially demersal and pelagic fish species that use the soft bottom habitats (shoal areas and beach fill areas) unless these groups avoid the dredging areas. Dredging activities would restrict motile macrobenthic invertebrates and demersal/pelagic fishes from feeding on the infauna and flora living in and on the soft bottom habitat.

Numerous studies have examined the impacts to the infaunal communities of borrow areas including (but not limited to) Turbeville and Marsh (1982), Byrnes et al. (2003), Hammer et al. (2005), Byrnes et al. (2004), and Burlas et al. (2001, 2002). Those studies determined that the community composition, diversity, and abundance recovered to pre-dredge condition within two years.

Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, within those years the sites they considered still developed infaunal biomass that provided a food source for fish and macrocrustaceans. In addition, Turbeville and Marsh (1982) examined an offshore dredging operation off Hillsboro Beach in 1972. They determined that although the faunal similarity analysis indicated a qualitative change in the fauna of the borrow area had occurred, the change was not detrimental. They concluded that the offshore dredging operations conducted caused no observable adverse effects in terms of reduced numbers of species, reduced faunal abundance, or reduced species diversity within the borrow area.

Hammer et al. (2005) found that physical, chemical, and biological factors influence the composition of benthic assemblages. Although excavation of sand borrow areas can expose underlying sediments and change the sediment structure and composition, their research found that the vertical sediment composition in the borrow pits offshore of central Florida tended to be uniform. Therefore, recolonization would likely proceed if, as proposed for the St. Lucie County project, dredging does not cut below the depth of the adjacent grade. In addition, warmer waters (e.g., the Atlantic Ocean waters of central Florida including St. Lucie County) may shorten infaunal recolonization time.

Hammer et al. (2005) also determined that dredging at the sand borrow sites located in central east Florida would not likely adversely affect pelagic fish populations unless dredging disrupts specific spawning, aggregation, or migratory areas. , Impacts from routine dredging operations and accidents would be avoided and minimized with the appropriate management of dredging operations and use of best management practices.

Infaunal sampling performed by CSA (2011) (**Appendix K**) included sampling of the St. Lucie Shoal borrow area, the refuge patch, and an adjacent sand habitat reference site. The analysis of these data indicated that although more total organisms occurred within samples collected at the borrow area sites (11,553) than in the reference site samples (6,268), the same taxa occurred in both locations in similar percentages. The density of organisms per m^2 within the three sampled areas were also similar with 33,483 organisms per m^2 for the reference sites, 49,372 organisms per m^2 for the borrow area sites, and 45,641 organisms per m^2 for the refuge patch sites (**Appendix K:** Summary Table). The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site) (**Appendix K:** Summary Table). Such differences are typical of benthic infauna distribution, characterized by patchiness and wide variability in numbers of individuals. The results of this sampling effort indicated that with the excavation of a portion of the St. Lucie Shoal, although the infaunal community would experience impacts, numerous organisms would remain within the refuge patch and the surrounding area to provide feeding opportunities for demersal/pelagic fishes and for recovery of the organisms within the dredged area.

The temporal duration of construction would be short. Technical literature suggests that soft bottom infaunal invertebrate assemblages typically recover relatively rapidly (two to three years). While recovery of the infaunal invertebrate assemblage takes place, feeding opportunities would be present in the surrounding areas.

<u>Modification of the St. Lucie Shoal Feature</u>

Offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging. Offshore shoal habitats have been identified as important benthic habitats along the eastern U.S. and South Florida. Vasslides and Able (2008) found the richest fish assemblages at study sites off the coast of southern New Jersey associated with sand ridges in the 9 – 14 m depth range.

Recent studies by Gilmore (2009) have determined that as many as 200 species of fish use sand shoal habitats within their life cycle, particularly during their cross-shelf migration, an important phase to the demersal reef fish population. These shoal habitats also function as aggregating points for small pelagic fishes, important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups. Modification of the St. Lucie Shoal feature could impact the demersal/pelagic fish and invertebrate assemblages that use this feature. Depending on the dredging design and execution, this action could alter this shoal structure permanently and could affect the local ecological processes occurring at this location.

The St. Lucie Shoal covers approximately 1.04×10^7 m^2 (about 2,570 acres) including portions of state and federal waters (Hammer et al. 2005, Coastal Technology Corporation 2011 Permit Application SAJ-2009-03448 [IP-GGL] Design Document). The initial excavation would impact an area totaling 2.41×10^5 m^2 (59.55 acres) or only 2.31% of the entire shoal. In addition, the St. Lucie Shoal accounts for only a small fraction of the total sand bottom habitat in the region. The adjacent un-dredged areas would provide the infaunal source to recolonize the excavated area. The excavation would not result in long-term negative impacts to benthic populations or the benthic community.

The dredging design would avoid and preserve the highest areas of the shoal, as recommended by Diaz et al. (2003) and CSA International et al. (2009a) to retain refuge areas for shoal fauna. The implementation of this mitigative approach to dredging should reduce the potential effects to the demersal/pelagic fish assemblages. In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). Slacum et al. (2006, 2010) have indicated that for similar sand shoal habitats in the mid-Atlantic bight off the coasts of Maryland and Delaware, winter dredging may provide the least impactful period for dredging as that period includes the lowest use of the habitat by finfishes and invertebrates. Diaz et al. (2004) characterized seasonal changes in invertebrate fauna, concluding that appropriate project timing and engineering could lessen impacts on fishes by reducing stress on crustaceans that serve as primary prey items. The proposed project (and future projects) would use a dredging window from November through April due to turtle nesting activity on project beaches in other months. Thus, the dredging period could also minimize potential impacts on shoal resources if the site exhibits similar biological cycles to those described in recent literature. Scott (2007), studying benthic communities of sand shoals off Cape May, New Jersey, concluded that continued dredging of the study area had not resulted in impacts to benthic taxa, abundance, or biomass. Based on differences in benthic assemblages in dredged and non-dredged areas, Scott and Burton (2005) concluded that “developing dredging plans for beach replenishment activities to limit the creation of dredge pits over at least 10 feet depth could reduce the chances of causing changes in benthic community, bottom sediment and water quality parameters detected in this study.” They found no significant differences in the finfish communities associated with the study sites and stated, “Since the fish community did not display an impact, the change in water quality and the benthic community observed in this study may have little impact on higher living resources.” As the proposed dredging would extend a maximum of 10 feet below the original surface, the project

would appear to minimize impacts to benthic communities and finfish, at least as far as is currently known.

The wave refraction over the entire St. Lucie Shoal (federal waters and state waters portion) is potentially more significant than the impact to waves from the other shoals located farther offshore because the St. Lucie shoal area of influence is more focused along the shoreline (Hammer et al. 2005). Alteration of wave refraction may cause increased erosional energy along the adjacent shoreline. This could represent a significant and unacceptable impact of dredging St. Lucie Shoal.

The St. Lucie Shoal covers approximately 1.04 x 107 m^2 including portions of state and federal waters (Hammer et al. 2005, Coastal Tech 2009, Design Document). The proposed alternative would impact an area totaling 2.41 x 105 m^2 or only 2.31% of the entire shoal. In addition, the St. Lucie Shoal represents only a portion of the offshore shoals in the central Florida offshore coastal shelf (OCS). Further, Hammer et al. (2005) determined that dredging at the sand borrow sites located in central Florida OCS is not likely to affect adversely pelagic fish populations unless specific spawning, aggregation, or migratory areas are disrupted. With the appropriate management of dredging operations, The impacts from routine dredging operations and accidents would be minimized and avoided with appropriate dredging management and the use of best management practices.

Hammer et al. (2005) evaluated and recommended revising a St. Lucie Shoal dredging design that those authors evaluated for dredging impacts on wave climate. The modeled dredging included removal of 14.6 million cubic meters (cm) (19.1 million cubic yards [cy]) of sand and reduction of the shoal elevation from between -5.4 m and -7.6 m (-17.8 feet and -24.9 feet) to an elevation of -12 m (-39.4 feet — deflation of the shoal to surrounding benthic plain elevations). The modeled dredging caused unacceptable changes in wave climate along the shoreline. However, the Hammer et al. design was substantially different than the applicant's proposed design. The Hammer et al. design removed almost 25 times the amount of sand proposed for removal by the applicant. The proposed project would dredge only a small fraction of the total shoal area and would not reduce the maximum elevation of the shoal in the project area.

Similarly, Kelley et al. (2004) modeled the removal of an estimated 24 million cm (31.4 million cy) with an excavation depth of 4.6 m (15 feet — all of St. Lucie Shoal in federal waters). After determining that this dredging would cause unacceptable effects on the wave climate, they determined that the shoal — if reduced in elevation by fewer than 2.3 m (7.5 feet) — would yield 12 million cm (15.7 million cy) of sand without causing significant impacts on longshore sediment transport. The proposed project would maintain the shoal height and extract about 5% of the volume Kelley et al. identified as safe to extract considering the nearshore wave climate.

The applicant developed an analysis similar to that of Kelley et al. (2004) by assessing possible changes in potential shoreline erosion due to wave climate changes at the shoal translating to the shoreline (**Appendix Q**). This analysis demonstrated that under unrealistically high (average maximum) wave climate changes, the proposed project and the 50-year cumulative effect of project dredging would not cause a significant

change. They showed that the change in wave energy could (assuming the average maximum waves occurred continuously over the 50-year period) remove as much as a foot of shoreline width, or about 0.24 inch / year. The estimated erosion rate falls well within the error of measurement for such changes and as such, does not represent a significant impact.

In a draft report under review by BOEM, Dibajnia and Nairn (2010) summarized field investigations and modeling studies intended to recommend offshore dredging guidelines to protect and maintain the integrity of ridge and shoal found on the OCS. They found that for shoals fewer than 30 meters deep, a shoal reforms itself after dredging with the remaining (smaller) volume. They concluded, "There was no indication that there exists a critical threshold for dredging that once crossed, ridge and shoal features may deflate, losing their morphologic integrity."

Implementation of BMPs in the design of the shoal's dredging profile could help minimize impacts to the shoal (**Section 2.1**). BMPs include maintaining a refuge patch at maximum shoal elevations, orientation of dredging template with the shoal long axis, and excavating below the elevation of the surrounding benthic plain.

Turbidity

Several activities during construction are anticipated to affect water quality. The main source of water quality impacts — borrow area dredging and sand placement on the beach face — would produce turbidity at the borrow site and along the shoreline. Even if it does not kill fish, turbidity has been shown to have negative impacts during extreme natural events (Robins 1957). The nearshore hardbottom fish assemblages would most likely avoid any extreme turbidity conditions. Impacts may occur to fishes in planktonic stages of development and to some juveniles related to turbidity. However, past offshore dredging efforts by USACE, while monitored closely, have not produced visible kills of juvenile fishes. Most fishes able to do so would likely avoid the area until the water quality returns to acceptable levels.

At the borrow site, the vibracore samples logs (Coastal Tech 2009: **Attachment D**: Geotechnical Analyses) indicated that the sand layer exposed within the proposed borrow area after dredging contains less than 4% fines. This is the same percent of fines present in the existing exposed top layer of sediment on the shoal in the area to be excavated. Mobile species would move out of the dredge area during dredging activities due to the short-term disruption to the area from the construction activities. Once dredging ceases, the mobile species are anticipated to return to the area and, based on the geotechnical data, are not expected to experience more turbidity after dredging than prior to dredging. No reports or observations of fish impacts sufficient to harm a species significantly could be identified.

Implementation of proper design and BMPs (**Section 2.1.1.2**) could reduce the magnitude and extent of impact resulting from proposed project activities, which would likely be limited in extent and short in duration.

Underwater Noise and Vibration from Dredging Activities

In general, the expected short-term sources and levels of underwater noise and vibration generated during a dredging project such as proposed should cause only negligible impacts on marine mammals, fish, and other wildlife present in the project area. Wildlife that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities.

Construction Noise

In general, the sources and noise generated during the project construction activities would include temporary sources of noise and could result in short-term, minor, adverse effects to shorebirds and seabirds in the vicinity of both the beach fill and borrow area sites. Shorebirds and seabirds that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities.

4.5.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative that could potentially affect fish and wildlife include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Alteration (Burial) of Exposed Nearshore Hardbottom

The Beach Fill with No Impact to Existing Hardbottom alternative would impact about 0.1 acre of hardbottom habitat as a result of subline placement but would bury no hardbottom.

Disturbance of the Sand Bottom Habitats

The Beach Fill with No Impact to Existing Hardbottom alternative could result in some minor effects on fish and macrobenthic invertebrate assemblages that use soft bottom habitats. However, these effects would be less than those of other beach fill alternatives because this alternative would require less fill material.

Modification of the St. Lucie Shoal Feature

Compared to the applicant’s preferred alternative, the Beach Fill with No Impact to Existing Hardbottom alternative would likely have less impact on fish and macrobenthic

invertebrate assemblages and wave climate because this alternative would require removal of less fill material from the St. Lucie Shoal borrow area compared to other fill alternatives.

Turbidity

Compared to the applicant's preferred alternative, the Beach Fill with No Impact to Existing Hardbottom alternative would have similar but lesser effects on fish, macrobenthic invertebrate assemblages, and other wildlife because this alternative would require less fill material from the St. Lucie Shoal borrow area and equally less beach fill.

Underwater Noise and Vibration from Dredging Activities

The Beach Fill with No Impact to Existing Hardbottom alternative would have the same impacts to fish and other wildlife in the project area from noise and vibration from dredging activities as the applicant's preferred alternative.

4.5.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative that may potentially affect fish and wildlife includes

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Beach and Dune alternative would have slightly greater effects on fish, macroinvertebrate benthic assemblage, and other wildlife for all associated IPFs because this alternative would bury about 0.67 acre of hardbottom and would impact an additional 0.1 acre from the dredge pipeline.

4.5.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 35-foot Berm alternative that may potentially affect fish and wildlife include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature

- Turbidity
- Underwater noise and vibration from dredging activities
- Construction noise

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Dune with a 35-foot Berm alternative would have greater impacts to fish, macroinvertebrate benthic assemblages, and other wildlife for all IPFs as direct impacts would occur on both north and south project segments. This alternative would impact 2.73 acres of hardbottom, a 2.16-acre increase over the applicant's preferred alternative. This increase in hardbottom burial could result in greater impact to the demersal/pelagic fish and macrobenthic invertebrate assemblage due to the increased surface area covered, and a period of elevated turbidity within the north beach fill area. Modeling has shown that in the long term, the sand placed on the south segment would spread into the area north of the south segment and could bury additional nearshore hardbottom areas. Direct impacts to fish and offshore wildlife would occur in the nearshore of the south and north segments.

Impacts within the offshore shoal habitat would also increase compared to the applicant's preferred alternative because of the increased volume of sand required for this alternative compared to the applicant's preferred alternative. The longer offshore construction duration would result in a longer period of construction and underwater noise and vibration.

4.5.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative that may potentially affect fish and wildlife include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative would have greater impact to fish, macroinvertebrate benthic assemblages, and other wildlife for all IPFs. This alternative would impact 3.48 acres of hardbottom, a 2.91-acre increase over the applicant's preferred alternative. This increase in hardbottom burial could result in greater impact to the demersal/pelagic fish and macrobenthic invertebrate assemblage due to the greater surface area covered, and longer period of elevated turbidity within the beach fill area (resulting from the longer construction period). Impacts within the shoal habitat would also increase compared to the applicant's preferred alternative because of the increased volume of sand removed from the borrow area. The extended construction duration would result in longer construction-generated underwater noise and vibration.

4.5.6. BEACH AND DUNE RESTORTATION WITH T-HEAD GROINS

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that may potentially affect fish and wildlife include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos from T-head groin construction activities
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during subsequent nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during subsequent nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from construction and subsequent dredging activities

Compared to the applicant's preferred alternative, the Beach and Dune Restoration with T-Head Groins alternative would increase impacts to macroinvertebrate benthic assemblages and other wildlife for all IPFs. This alternative would impact 2.93 acres of hardbottom, a 2.36-acre increase over the applicant's preferred alternative. This increase could result in greater impacts to the demersal/pelagic fish and macrobenthic invertebrate assemblage and increased turbidity within T-head groin placement area. This alternative could result in similar temporary impacts related to elevated turbidity within the fill placement area, although over a greater shoreline area. However, the T-head groin construction would create additional habitat for demersal/pelagic fish.

The 2.93 acres of impact does not include any potential impacts to hardbottom offshore of the downdrift areas. The downdrift beaches are anticipated to require nourishment at a future time. Additional impacts (e.g., turbidity, underwater noise, burial of exposed nearshore hard substrate, modifications to the shoal feature) from the subsequent nourishment of downdrift areas could occur during that nourishment activity.

4.5.7. NO ACTION (STATUS QUO)

The No Action alternative has no associated IPFs that may potentially impact fish and wildlife; therefore, no impacts would be expected.

4.6. ESSENTIAL FISH HABITAT

4.6.1. BEACH FILL SOUTH SEGMENT ONLY TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM (APPLICANT'S PREFERRED ALTERNATIVE)

IPFs associated with the applicant's preferred alternative and other build alternatives that could potentially affect EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

Impacts to the live/hardbottom EFH from the applicant's preferred alternative would occur through burial or other impacts to 0.57 acre of live/hardbottom habitat. Live/hardbottom habitat provides an important nursery and refuge habitat for the young stages of several fish species within the SAFMC Reef Fishes and Spiny Lobster Management Units. Nearshore hardbottom is an important component of the cross-shelf developmental pathways traversed by many reef species (Lindeman et al. 2000). The extent of the impact would depend on the size and longevity of buried nearshore hardbottom within the project area. It is expected that juvenile fishes would be displaced (i.e., prevented from utilizing these impacted areas) as long as the associated epiflora, epifauna, and seafloor hardbottom structure are covered. Complete burial would preclude reef species from feeding on the flora and fauna that use the nearshore hardbottom reef structure; however, the anticipated impact area of 0.57 acre is a small percentage of the total area available for use. The applicant proposes mitigation to offset hardbottom impacts.

Disturbance of the Sand Bottom Habitats

Members of the penaeid shrimp and red drum EFH management groups use soft bottom habitats contiguous with the surf zone and nearshore hardbottom as forage or shelter habitats. Spiny lobsters use soft bottom habitats contiguous with the nearshore hardbottom as foraging areas. The potential disturbances to the sand bottom habitats include anchoring of the hopper barge during pump out activities, vibrations caused from the pump out activities, and placement of the pump out and conveyance pipes.

Modification of the St. Lucie Shoal Feature

The applicant's preferred alternative, which includes removal of approximately 485,900 cubic yards of sand from the St. Lucie Shoal, would alter the local bathymetric profile in the borrow area. Sand shoals include EFH for coastal pelagic species and some highly migratory species, particularly coastal sharks. In addition, offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging (CSA International et al. 2009). Recent studies (Gilmore 2009) have determined that 200 fish species use the sand shoal habitats along southeast Florida. Gilmore (2009) postulates that the shoal habitats are an intermediate habitat integrated in the cross-shelf migration used by many EFH managed groups. These shoal habitats also function as aggregation areas for small pelagic fishes, important prey for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

Removal of or modification of the St. Lucie Shoal feature could impact the EFH for multiple SAFMC-managed species groups that use this feature. The proposed dredging action could conceivably alter the shoal structure and change the fundamental ecological processes within and near this feature. In a draft report under review by BOEM, Dibajnia and Nairn (2010) summarized field investigations and modeling studies intended to recommend offshore dredging guidelines to protect and maintain the integrity of ridge and shoal found on the OCS. They found that for shoals fewer than 30 meters deep, the shoal they studied reformed itself with the remaining (smaller) volume. They concluded, "There was no indication that there exists a critical threshold for dredging that once crossed, ridge and shoal features may deflate, losing their morphologic integrity."

The St. Lucie Shoal covers approximately 1.04 x 107 m^2 including state and federal waters (Hammer et al. 2005, Coastal Tech 2009, Design Document). The proposed alternative would impact an area totaling 2.41 x 105 m^2 or only 2.31% of the entire shoal. In addition, the St. Lucie Shoal represents only a portion of the offshore shoals in the central Florida OCS. In addition, Hammer et al. 2005 determined that dredging at the sand borrow sites located in the central Florida OCS is not likely to adversely affect pelagic fish populations unless specific spawning, aggregation, or migratory areas are disrupted. With the appropriate management of dredging operations, Impacts of routine dredging operations could be avoided and minimized with appropriate management of dredging operations using best management practices.

The applicant has proposed BMPs (see **Section 2.1.9.2**) including maintaining a refuge patch in the shoal's dredging profile design and not excavating below the surrounding area to help minimize shoal impacts. The dredging design avoids and preserves the highest areas of the shoal, as recommended by Diaz et al. (2003) and CSA International et al. (2009a) to retain refuge areas for shoal fauna. In addition, only a small area of the entire shoal (2.3%) would be dredged. The implementation of this mitigative approach to dredging would reduce the potential effects to the demersal/pelagic fish assemblages. In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations).

In addition, numerous studies have examined the impacts to the infaunal communities of borrow areas including (but not limited to) Turbeville and Marsh (1982), Byrnes et al. (2003), Hammer et al 2005, Byrnes et al. (2004), and Burlas et al. (2001). Those studies determined that the community composition, diversity, and abundance recovered to pre-dredge conditions within two years.

Hammer et al. (2005) found that physical, chemical, and biological factors influence the composition of benthic assemblages. Although excavation of sand borrow areas can expose underlying sediments and change the sediment structure and composition, their research found that the vertical sediment composition in the borrow pits offshore of central Florida tended to be uniform. Therefore, recolonization would likely proceed if the depth of dredging does not cut below the adjacent grade, as is the case for the proposed project. In addition, recovery times of infaunal recolonization may be shorter

in warmer (e.g., central Florida) waters than in colder waters. Hammer et al. (2005) also determined that dredging at the sand borrow sites located in central east Florida would not adversely affect pelagic fish populations unless specific spawning, aggregation, or migratory areas are disrupted. With the appropriate management of dredging operations using best management practices the proposed dredging could avoid and minimize impacts to EFH and management species within the study area.

Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, within those years the sites they considered still developed infaunal biomass that provided a food source for fish and macrocrustaceans. In addition, Turbeville and Marsh (1982) examined an offshore dredging operation off Hillsboro Beach in 1972. They determined that although the faunal similarity analysis indicated that a qualitative change in the fauna of the borrow area had occurred the change was not detrimental. They concluded that the offshore dredging operations conducted caused no observable adverse effects in terms of reduced numbers of species, reduced faunal abundance, or reduced species diversity within the borrow area.

Infaunal sampling performed by CSA included sampling of the St. Lucie Shoal borrow area, the refuge patch, and an adjacent sand habitat reference site (**Appendix K**). The analysis of these data indicated that although more total organisms occurred within samples collected at the borrow area sites (11,553) than in the reference site samples (6,268), the same taxa occurred at both locations in similar percentages. The density of organisms per m^2 within the three sampled areas were also similar with 33,483 organisms per m^2 for the reference sites, 49,372 organisms per m^2 for the borrow area sites, and 45,641 organisms per m^2 for the refuge patch sites (**Appendix K:** Summary Table). The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site) (**Appendix K:** Summary Table). Such differences are typical of benthic infauna distribution, characterized by patchiness and wide variability in numbers of individuals. These results indicate that although the infaunal community would experience impacts with the excavation of a portion of the St. Lucie Shoal, numerous organisms present within the refuge patch and the surrounding area could provide feeding opportunities for demersal/pelagic fishes and for recovery of the organisms within the dredged area.

The portion (2.3%) of the total area of the shoal soft bottom habitat to be dredged and proposed BMPs, including the maintenance of the refuge patch and not dredging below the elevation of the surrounding benthic plain would minimize impacts. Benthic community recovery is anticipated in two to three years.

Dredging activities within the shoal borrow area could also entrain multiple SAFMC-managed species groups, both fish and invertebrates, including the penaeid shrimp, spiny lobster, and red drum species group. Therefore, with the potential to permanently alter the shoal structure and change the fundamental ecological processes of the feature as well as the potential impact from the entrainment of managed species, minor to moderate impact from shoal dredging is expected.

Turbidity

Several activities during construction are anticipated to affect water quality. The main source of water quality impacts is borrow area dredging and sand placement within the beach fill sites. These activities would produce increased turbidity levels in both areas. Turbidity has been shown to negatively impact and sometimes cause fish mortality during extreme natural events of increased turbidity (Robins 1957). The nearshore reef fish assemblages would most likely avoid any extreme turbidity conditions. The limited dredge and fill extent and short duration of the reduced water clarity, along with implementation of BMPs and proper design are expected to minimize adverse effects.

Elevated turbidity during construction is also anticipated to cause temporary impacts to nearshore hardbottom. Temporary impacts, calculated based on acreage of existing hardbottom between the predicted ETOF and FDEP approved mixing zone limits (65 m from shoreline), are estimated to total up to 1.0 acre of hardbottom. These temporary impacts would occur only during sand placement activities from the settling of sand particles.

4.6.2. BEACH FILL WITH NO IMPACT TO EXISTING HARDBOTTOM

IPFs associated with the Beach Fill with No Impact to Existing Hardbottom alternative potentially impacting EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Alteration (Burial or Other Impacts) of Exposed Nearshore Hardbottom

No hardbottom impacts to EFH related to beach fill are anticipated due to the Beach Fill with No Impact to Existing Hardbottom alternative. However, placement of the subline is expected to impact approximately 0.1 acre of hardbottom.

Disturbance of the Sand Bottom Habitats

Because the Beach Fill with No Impact to Existing Hardbottom alternative would require less fill than the applicant's preferred alternative, fewer impacts from disturbance of the sand bottom habitat to the penaeid shrimp, spiny lobster, and red drum species EFH for the Beach Fill would occur.

Modification of the St. Lucie Shoal Feature

Compared to the applicant's preferred alternative, the Beach Fill with No Impact to Existing Hardbottom alternative could result in fewer potential impacts from modification of the shoal topography to EFH of coastal pelagic fishes, dolphin and wahoo, and highly migratory species groups, because this alternative requires less fill material removal from the St. Lucie Shoal borrow area.

Turbidity

Compared to the applicant's preferred alternative, the Beach Fill with No Impact to Existing Hardbottom alternative would produce fewer impacts related to EFH because this alternative would remove less fill material for beach fill operations and thus create less turbidity within the project area including no temporary impacts to live/hardbottom in the mixing zone.

4.6.3. BEACH FILL TO RESTORE THE 1972 BEACH AND DUNE

IPFs associated with the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative potentially impacting EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Beach and Dune (1972 Design) alternative would produce greater impacts to the EFH for all of the SAFMC-managed species for all IPFs. It is anticipated that this alternative would bury 0.67 acre of hardbottom but would require less fill material. For this alternative, dredging would disturb less shoal habitat and would generate less turbidity at the borrow site and beach fill area than would the applicant's preferred plan. This alternative would create 9.83 acres of temporary impacts to hardbottom areas from sedimentation associated with turbidity within the mixing zone. The applicant proposes mitigation to offset direct hardbottom impacts.

4.6.4. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 35-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 35-foot Berm alternative that could potentially impact EFH include

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities

- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Dune with a 35-foot Berm alternative would increase direct impacts to EFH for the SAFMC-managed species for all IPFs. As anticipated, this alternative would bury or otherwise impact 2.73 acres of hardbottom, a 2.18-acre increase over the applicant's preferred alternative. This increase in hardbottom burial could result in greater impact to species from the Reef Fish Management Unit through the loss of hardbottom habitat. However, modeling has shown that in the long term, the sand placed on the south segment would spread north of the south segment and potentially bury additional nearshore hardbottom areas. An increase in the construction period would occur, along with a longer period of elevated turbidity within the borrow area and beach fill area. Impacts within the shoal habitat would also increase due to the increased sand volumes removed from the St. Lucie Shoal borrow area. The increased sand dredging activity volume within the St. Lucie Shoal borrow area could result in increased impacts to EFH for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

4.6.5. BEACH FILL TO RESTORE THE 1972 DUNE WITH A 70-FOOT BERM

IPFs associated with the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative that could potentially impact EFH include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the applicant's preferred alternative, the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative would increase impacts to EFH for the SAFMC-managed species for all IPFs. As anticipated, the Beach Fill to Restore the 1972 Dune with a 70-foot Berm alternative would bury or otherwise impact 3.48 acres of hardbottom, a 2.18-acre increase over the applicant's preferred alternative. This increase in hardbottom burial could result in greater impact to species from the Reef Fish Management Unit through the loss of hardbottom habitat. An increase in the temporal period for construction would occur, along with elevated turbidity within the borrow area and beach fill area. Impacts within the shoal habitat would also increase given the increased sand volumes removed from the St. Lucie Shoal borrow area. The increased sand dredging activity volume within the St. Lucie Shoal borrow area could result in increased impacts to EFH for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

This alternative could cause 11.03 acres of temporary, turbidity-related impacts to hardbottom areas within the mixing zone.

4.6.6. BEACH AND DUNE RESTORATION WITH T-HEAD GROINS

IPFs associated with the Beach and Dune Restoration with T-Head Groins alternative that could potentially impact EFH include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos from T-head groin construction activities
- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during subsequent nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during subsequent nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Compared to the applicant's preferred alternative, the Beach and Dune Restoration with T-Head Groins alternative could result in the same impacts to EFH for the SAFMC-managed species for all IPFs. As with the applicant's preferred alternative, the Beach and Dune Restoration with T-Head Groins alternative would bury 2.63 acres of hardbottom, and result in the same direct impacts and the same temporary impact to hardbottom from turbidity within the mixing zone. However, additional habitat for demersal/pelagic fish would also be created by the construction of the T-head groins. The 2.63 acres of hardbottom impact does not include any potential impacts to hardbottom offshore of the downdrift areas that are anticipated to require nourishment later.

Additional impacts similar to those of the applicant's preferred alternative (e.g., burial of exposed nearshore hard substrate) would occur on downdrift beaches if indirect impacts of the groin fields required mitigation through subsequent nourishment of downdrift areas.

If sand for nourishment of downdrift areas impacted by the groin field were obtained from the St. Lucie Shoal, the borrow area proposed for the project, additional direct impacts to that area would also occur. The additional sand dredging activity within the St. Lucie Shoal borrow area could result in EFH impacts similar to those of the applicant's preferred alternative for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

4.6.7. NO ACTION (STATUS QUO)

No IPFs are associated with the No Action alternative potentially impacting the EFH for the SAFMC-managed species; therefore, no impacts would be expected.

4.7. OFFSHORE BORROW AREA RESOURCES

IPFs associated with the applicant's preferred alternative and all other build alternatives potentially impacting offshore borrow area resources include

- Disturbance of the shoal borrow area sand bottom habitat and associated macroinfauna during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Potential impacts of the applicant's preferred alternative and other build alternatives on offshore borrow resources vary from one another to the extent that any given build alternative requires more or less sand. However, the impacts of different alternatives do not describe a linear relationship because the primary impact results from the construction of a large depression within the shoal. As a group, those alternatives with significantly smaller sand requirements would dig significantly smaller (or shallower) borrow pits and would have lesser potential impacts than the projects with large advance fill volumes. The impacts of the two construction alternatives with relatively small sand requirements (No Hardbottom Impact, and Beach Fill to Restore the 1972 Beach and Dune) are associated with fill volumes about 33% and 43% less than the preferred alternative volume. The smaller requirement would associate with less dredging. This suggest that these alternatives would result in fewer negative effects in the borrow areas than would projects with greater sand requirements. The projects with greater sand requirements than the applicant's preferred alternative require 125% to 185% more than the applicant's preferred alternative. The Beach Fill to Restore the 1972 Beach and Dune with a 70-foot Berm requires almost twice that required for the applicant's preferred alternative. This alternative would likely require a much larger borrow area or a much deeper borrow area than the Beach Fill to Restore the 1972 Dune with a 35-foot Berm, and Beach and Dune Restoration with T-Head Groins alternatives with sand requirements similar to those of the applicant's preferred alternative.

Disturbance of the Shoal Borrow Area Sand Bottom Habitats

Dredging of the offshore borrow site would result in mechanical disturbance of the seabed. The proposed activity includes removal, suspension, and displacement of dredged material, which would alter the benthic environment and its associated infauna and epibiota, two important components of the food web for commercially and recreationally important fishes and invertebrates. However, a literature synopsis by the U.S. Geological Survey (USGS) in 2004 examined community composition, diversity, and abundance to determine the recovery and/or recolonization time of benthic communities. Studies such as Burlas and Clarke (2002), Byrnes et al. (2003, 2004), Hammer et al. (2005), and Turbeville and Marsh (1982) found that recovery durations could range from three months to 2.5 years. Hammer et al. (2005) found evidence to suggest that recovery times of infaunal recolonization are shorter in warmer waters (such as the central Florida shelf) than in colder waters.

In addition, infaunal sampling performed by CSA (CSA International 2011) (**Appendix K**) included sampling of the borrow area, the refuge patch, and an adjacent sand habitat reference site. The analysis of these data indicated that although more total organisms

occurred within samples collected at the borrow area sites (11,553) than in the reference site samples (6,268), the same taxa occurred in both locations in similar percentages. The density of organisms per m^2 within the three sampled areas were similar with 33,483 organisms per m^2 for the reference sites, 49,372 organisms per m^2 for the borrow area sites, and 45,641 organisms per m^2 for the refuge patch sites (**Appendix K:** Summary Table). The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site) (**Appendix K:** Summary Table). Such differences are typical of benthic infauna distribution, characterized by patchiness and wide variability in numbers of individuals. These results indicate that with the excavation of a portion of the St. Lucie Shoal although the infaunal community would experience impacts, numerous organisms present within the refuge patch and the surrounding area could provide feeding opportunities for demersal/pelagic fishes and for recovery of the organisms within the dredged area.

Excavation of sediments from borrow sites would modify the existing topography of the shoal feature, exposing underlying sediments that could change the sediment structure and composition of the borrow site. These changes could lead to changes in benthic community composition. However, at the borrow site, the vibracore samples logs (Coastal Tech 2009, Design Document: **Attachment D** Geotechnical Analyses) indicate that the sand layer exposed within the proposed borrow area after dredging contains less than 4% fines. A similar percent of fines occurs in the existing exposed top layer of sediment on the shoal area to be excavated. Byrnes et al. (2004) determined that infaunal community recovery depends primarily on the depth of excavation; that shallow, large areas of excavation are better than smaller deep excavations; and that the impacts from dredging would not adversely affect EFH on a broad scale. Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, the borrow sites develop infaunal biomass that provides a food source for fish and macrocrustaceans within that period.

Modification of the St. Lucie Shoal Feature

Benthic species' ability to perform life functions (e.g., burrowing, feeding, or settling as larvae) varies with sediment quality, and members of the current benthic community may or may not have the same success in the physical characteristics of the underlying sediment as in the existing sediment. A literature synopsis by the U.S. Geological Survey (USGS) in 2004 examined community composition, diversity, and abundance to determine the recovery and/or recolonization time of benthic communities. Studies such as Burlas and Clarke (2001), Byrnes et al. (2004, 2005), Hammer et al. (2005), and Turbeville and Marsh (1982) found that recovery durations could range from three months to 2.5 years. Hammer et al. (2005) found evidence to suggest that recovery times of infaunal recolonization are shorter in warmer waters (such as the east central Florida shelf) than in colder waters. Recovery of the original community composition has been suggested to potentially take a substantial amount of time, especially in sand mining areas used repeatedly. However, Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, within

those years, sites still continue to develop infaunal biomass providing a food source for commercially and recreationally important fishes and invertebrates.

The literature review of infaunal density and species richness studies examining benthic composition of dredged shoals found no consistent pattern of faunal response to dredging (USGS, 2004). For example, Byrnes et al. (2004) determined that infaunal community recovery was dependent primarily on the depth of excavation where shallow excavation areas were impacted less than areas of deep excavation. Similarly, Hammer et al. (2005) found that recolonization was dependent on physical, chemical, and biological factors within the vertical sediment structure of the borrow pit. Hammer et al. (2005) studied borrow areas on the east central Florida shelf and demonstrated that initial recolonization would begin within days and later successional stages would proceed, even if dredged shoals were not completely reestablished, as long as the depth of dredging did not cut below the adjacent grade (as with the proposed project) and impact the vertical sediment composition in the borrow pit. Finally, Turberville and March (1982) examined an offshore dredging operation off Hillsboro, Florida and concluded that while dredging operations resulted in a qualitative change in fauna of the borrow area, dredging caused no observable adverse effects in terms of reduced numbers of species, reduced faunal abundance, or reduced species diversity. Given the short temporal duration of proposed dredging activities and relatively rapid recovery of the soft bottom infaunal invertebrate assemblage, short duration impacts to soft bottom assemblages within the borrow site are expected.

Excavation alters the seabed topography, creating pits that may refill rapidly or cause detrimental impacts to the benthic community for extended periods. In contrast, dredging can also create habitats different from the surrounding area, which could result in increased habitat complexity and biodiversity of the area. Studies have shown that some borrow areas located within highly depositional areas have a relatively short filling time, whereas other areas may take up to 12 years to return to pre-dredge topography (Wright 1977). In general, shallow dredging over large areas causes less change than smaller deep pits. Borrow pits excavated in small deep pits reduce current velocities at the bottom, which can cause the deposition of fine particulate matter and potentially create a biological assemblage much different in composition from the original (Hammer et al. 2005). This action could alter this shoal structure permanently and locally affect the seabed topography within the borrow site. However, these potential changes in the shoal structure may not cause long-term changes in the benthic community species abundance and richness but could alter the community composition. The applicant sampled infauna at the south end of the St. Lucie Shoal borrow area within the proposed “refuge patch” within the borrow area and within an adjacent sand habitat reference site. Analysis of those samples (**Appendix K**) indicated that although more total organisms occurred within the borrow area site than within the reference site, the same taxa occurred in both locations in similar percentages. The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site) and is typical of benthic infauna distribution, which is characterized by patchiness and wide variability in numbers of individuals (**Appendix K**). Dredging-

related changes could shift the percent composition of a set of species common to the general area.

The following BMPs proposed in the design of the dredging profile of the shoal could help minimize the impacts to the shoal.

- A dredge profile design that would avoid dredging across the shoal.
- Dredging to leave the crest of borrow area shoal undisturbed to serve as a "refuge patch" to minimize impacts to benthic infauna.
- No excavation of the shoal area would occur below the existing surrounding benthic plain
- A dredge design that would delineate "Initial Cut Area" to keep dredging "localized" on southernmost point of the shoal where the shoal tapers down to a similar elevation as the surrounding benthic plain.

In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). The St. Lucie Shoal accounts for only a small fraction of the total sand bottom habitats in the region, and the proposed action would initially impact an area totaling 2.41 X105 m^2 or only 2.31% of the entire shoal. The adjacent unimpacted areas would provide a source for recolonization of the excavated area and reduce the potential for long-term negative impacts to the benthic community.

The applicant's preferred alternative comprises a one-time, complete project, does not include systematic dredging of the shoal, and would not result in the loss of shoal features. The build alternatives propose extraction of a small fraction (between 485,900 and 899,600 cubic yards) of the more than 24 million cubic yards of sand that make up St. Lucie Shoal. The proposed dredging design takes into account numerous BMPs including maintaining a refuge patch in the highest elevation area, dredging above the surrounding substrate elevation, avoidance of dredging across the shoal, and monitoring turbidity to avoid and minimize impacts to the structure and functions of St. Lucie Shoal. In addition, with the implementation of the applicant's preferred alternative, the amount of sand required for future renourishment events within the project area would be small enough that nourishment using upland sand sources could occur in a single period outside turtle nesting season.

Turbidity

Increased turbidity levels could result from dredging sediments at the borrow area and from suspending fine grained fractions of the borrow material in the water column. Suspended sediments could create a visible, turbid plume in the water column. In addition, excess seawater, decanted and discharged overboard by the hopper dredge, could temporarily increase turbidity during construction. These turbid plumes could cause physical or behavior impacts to invertebrates, particularly sessile organisms on the nearshore hardbottom areas. If the borrow material contains only a small portion of fine grained materials, turbidity should diminish rapidly and have little impact on organisms in the area; however, if the fine grained portion is high, turbidity can remain for longer periods or, in some cases, persist over the long term. Preliminary

geotechnical data indicate that the sands in Area A of the St. Lucie shoal contain less than 1.6% fines (Coastal Tech 2009: **Attachment D**: Geotechnical Analyses) and therefore, would likely generate relatively little turbidity.

Underwater Noise and Vibration from Dredging Activities

Potential effects of the elevated background noise levels caused by dredge operator noise to marine mammals include

- Limiting the detection by mammals of natural sounds
- Disturbing their normal behavior, resulting in possible displacement from areas
- Causing temporary or permanent reductions in hearing sensitivity

The potential effects depend on the type of marine mammal involved because different marine mammals have different hearing frequencies. The levels and types of ambient noise also strongly influence the potential area or zone of influence of a dredge-made sound. Clarke et al. (2002) characterized underwater sounds generated by bucket, hydraulic cutterhead, and hopper dredging operations, but have not reported the relationships between such noises and faunal behavioral changes associated with those noises. An animal's sensitivity to different sounds varies with frequency, and its response to a sound likely depends strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Ports Corporation of Queensland 2005). Underwater noise can affect marine mammals (Richardson et al. 1995). However, the project does not involve any high-energy sound sources that could cause temporary or permanent auditory damage. In general, the sources and levels of underwater noise and vibration generated during the project are expected to cause only minor impacts on marine mammals. The most likely impacts are temporary behavioral responses such as avoidance or altered diving or swimming behavior.

The proposed dredging activity would occur in part of the species' migratory route and potential calving grounds during the winter months; however, these whales are rare to the project area. The humpback whale is rarely present within the vicinity of St. Lucie County during its spring/fall migration. As manatees use the open ocean relatively infrequently, manatees would not likely occur in the offshore shoal area. Marine mammals would likely avoid areas where the dredge is operating. The project area is an extremely small area when compared to the overall waters used by the North Atlantic right whale for migration and calving.

Thomsen et al. (2009) studied the possible noise sensitivity of marine life off the coast of England. They found that dredging noises occurred at frequencies between high-level noise (e.g., sonar and pile driving) and lower-level noise (e.g., normal vessel traffic). They identified specific vertebrate and invertebrate species in their study area potentially impacted by dredging noises. However, they gave no indication that such noise had the potential for permanent adverse effects. They concluded that the main issues with dredging noise included the lack of information about the noise generated by dredging operations and the lack of any experimental study of potential impacts.

The applicant's preferred alternative and all other alternatives using offshore sand would have similar effects on the offshore borrow area resources for all IPFs to a greater or lesser degree based on the quantity of sediment dredged.

No IPFs are associated with the No Action alternative to offshore borrow area resources.

4.8. COASTAL BARRIER RESOURCES

The project area includes portions of CBRS (Coastal Barrier Resource System) Unit P-11 (Hutchinson Island), which precludes federal expenditure of funds for a beach restoration project within those areas. In a May 27, 2009 letter from the USFWS (**Appendix F**) relative to a USACE request for a "consistency determination" under the Coastal Barrier Resources Act (CBRA), the USFWS determined that the project areas within CBRS Unit P-11 did not meet the exception criteria that allows "expenditure of Federal revenues" to renourish these areas. In the same letter, the FWS determined that because the majority of the land outside the excluded parcels of CBRS Unit P-11 is privately owned and not under any perpetual conservation designations, the renourishment of these beaches would encourage development on those parcels. Accordingly, with one exception, the applicant excluded the sections of beach within the CBRS Unit P-11. In spite of the federal funding conditions, the applicant decided to include this one exception — Dollman Park (R-101 – R-103) — of the CBRS shoreline as part of the project because the applicant recognized the need for fill in that location. Due to the exclusion of the majority of the beach section within CBRS Unit P-11, no significant negative impacts to the CBRS units are expected from this project.

Any of the beach nourishment alternatives could benefit adjacent coastal barrier resources by dispersing sand into those areas as the project beach subsequently erodes. Placement of approximately 485,900 cubic yards of sand within the project area is anticipated to contribute to the sand-sharing system and provide feeder benefits to adjacent shorelines.

4.9. WATER QUALITY

Implementing any of the build alternatives would likely cause temporary increases in turbidity levels due to the dredging of sediments at the borrow area and placement of sediments on the beach. Turbidity results from the suspension in the water column of fine grained fractions of the borrow material. Suspended sediments create a visible, turbid plume in the water column. This turbid plume can cause physical or behavior impacts to invertebrates, particularly sessile organisms on the nearshore hardbottom areas. If the borrow material contains only a small portion of fine grained materials, turbidity should diminish rapidly and have little impact on organisms in the area; however, if the fine grained portion is high, turbidity can linger for longer periods or, in some cases, persist long term. Preliminary geotechnical data indicates that the sands in Area A of the St. Lucie Shoal contain less than 1.6% fines (Coastal Tech 2009: Design Document, **Attachment D**: Geotechnical Analyses); therefore, turbidity is anticipated to diminish rapidly. In addition, if the composition of the borrow material is sufficiently high in carbonates such as shell and coral fragments, turbidity can increase

as the water can take on a “milky” appearance as the carbonate materials grind in the high energy surf zone into small clay-like particles. A composite sediment sample from Area A of the St. Lucie Shoal indicates a 78.4% carbonate content (Coastal Tech 2009: Design Document, **Attachment D**: Geotechnical Analyses), with less than 1% gravel (shell). This finding would indicate that only a very small portion (less than 1%) of the material would have the potential to grind up within the high-energy surf zone creating a “milky” appearance to the water.

During project construction, turbidity monitoring would provide information to demonstrate compliance with state water quality standards at the mixing zone boundary. Monitoring would occur at both the borrow area and at material placement locations. Background monitoring at the borrow material placement site would occur approximately 65 m from shore and 150 m up-current from the fill discharge or placement location. Compliance monitoring would occur no more than 65 m from shore within the densest portion of any visible turbidity plume, 150 m down current of the discharge point.

No IPFs are associated with the No Action alternative to water quality within the beach fill or borrow area.

4.10. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

None of the build alternatives are anticipated to affect hazardous, toxic, or radioactive waste sites or producers in the project area, including the FPL Hutchinson Island Nuclear Power Plant. No impacts associated with the disturbances of such sites are anticipated. The proposed project would not involve placement, use, or storage of hazardous and toxic materials in or near the project area. A potential for hydrocarbon spills exists with dredging and construction equipment in the area, but accident and spill prevention plans delineated in the contract specifications should prevent most spills. The construction contract would include requirements to properly manage, store, and dispose of all materials generated by the project.

4.11. AIR QUALITY

The short-term impacts from emissions by dredges and other construction equipment associated with the project are not anticipated to affect onshore or offshore air quality significantly. Exhaust emissions from vehicles, vessels, and construction equipment associated with the project would have a temporary and localized effect on air quality. Offshore sea breezes are anticipated to disperse pollutants. This project requires no air quality permits. The analysis below estimates emissions from the applicant’s preferred plan, but the emissions levels of the other build alternatives are sufficiently similar to reach the same conclusion concerning air quality impacts as provided below.

Taylor Engineering used project-specific parameters to prepare an air quality analysis to estimate emissions for the applicant’s preferred alternative. The analysis included calculation of total project emissions of nitrogen oxides (NO_x), sulfur dioxide (SO_2),

carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM) less than 10 microns and greater than 2.5 microns.

Power requirements, duration of operations, and emission factors for the various equipment types used in project construction provided the basis for estimates of air pollutant emissions resulting from construction of the applicant's preferred alternative.

The product of horsepower (hp) rating, activity rating factor (percent of total power), and operating time provided the estimate of project energy use. The energy use value multiplied by an engine-specific emission factor yielded emission estimates.

Operational data reported in the Martin County FEIS (USACE 2010) for a beach nourishment project of similar size immediately south of the proposed project area provided power requirements and duration for each phase of the proposed hopper dredging activity.

The hp rating of the dredge plant considered propulsion (3,500 hp), dredging (2,565 hp), pumping (2000 hp), and auxiliary (600 hp). Different rating or loading factors were used for dredging, propulsion, and pumping. The air quality analysis contains the following assumptions:

- Project would dredge 485,900 cubic yards.
- Dredging cycle time (dredging, travel to transfer point, pump-out, and return to dredge site, and idle time) would last five hours.
- Each dredging cycle would move on the order of 2,000 cubic yards of material, requiring approximately 243 loads to excavate enough material to place 485,900 cubic yards of sand on the beach.
- Dredging could last 65 to 181 days.
- Distance from dredge site to transfer point would span three miles.
- Placement and relocation of nearshore mooring buoys used during pump out may involve up to two tender tugboats, a derrick barge, two work barges, and pipeline hauler/crane.
- Construction would include moving the buoy (and the subline) five times during the project; each move would require approximately 12 hours of machine operation.
- Crew/supply vessel operation would approach four hours per day.

The analysis assumed that all dredging, hopper transport, and crew/supply vessel activities would occurred over state waters and at the placement site. The beach-fill-related estimates assumed the use of up to four bulldozers/pipeline movers and two trucks, each operating 80% of the time for the duration of the project.

Emission factors for the diesel engines on the hopper dredge, barge, and tugboats came from EPA's *Compilation of Air Pollutant Emissions Factors, AP-42, Volume 1*

(2002). Derived emission factors for tiered equipment used in beach construction came from NONROAD model (5a) estimates.

Any of the action alternatives may result in small, localized, and temporary increases in concentrations of NO_x, SO_2, CO, VOCs, and PM (**Table 4.11-1**). Because the project is located in an air quality attainment area, the EPA requires no preliminary air quality conformity assessment.

Emissions associated with the dredge plant would provide the largest contribution to the inventory. However, the total project emissions represent a minor percentage of the existing point and nonpoint and mobile source emissions in St. Lucie County (**Table 4.11-1**). Prevailing winds would quickly disperse any pollutant released into the atmosphere from the project area.

Emission quantities vary with the number of trips and total operating time required to dredge the necessary quantity of sand. The calculated emissions of the applicant's preferred alternative would fall between those with lower sand volume and related construction activity requirements and those with greater sand requirements. The No Action alternative would have no impact on air quality.

Table 4.11-1. Estimated Emissions of the Applicant's Preferred Alternative
(tons per year)

Activity	Emissions (tons)					
	NO_x	**SO_2**	**CO**	**VOC**	**$PM_{2.5}$**	**PM_{10}**
Dredge Plant (Hopper)						
Dredging/Operation	11.1	0.2	2.5	0.3	0.2	0.2
Turning/Sail	23.3	0.4	5.3	0.6	0.4	0.4
Pump-out	6.2	0.1	1.4	0.2	0.1	0.1
Idle/Connect-Disconnect	2.2	0.0	0.5	0.1	0.0	0.0
Supporting Offshore Activities	6.8	0.1	1.6	0.2	0.1	0.1
Beach Fill	4.6	0.8	2.2	0.3	0.4	0.4
Total Project Emissions	**54.2**	**1.7**	**13.5**	**1.6**	**1.2**	**1.2**
2002 Countywide Emissions Nonpoint + Mobile	9,509	1,661	70,230	12,636	1,480	6,646
2002 Countywide Emissions Point and Nonpoint + Mobile	10,037	1,681	70,777	14,162	1,551	6,743

St. Lucie County 2002 emissions from EPA National Emission Inventory http://www.epa.gov/air/data/

4.12. NOISE

Project construction activities could result in short-term minor adverse effects to the noise environment in the vicinity of both the beach fill and borrow area sites. Construction would include temporary sources of noise. This noise has the potential to disturb biological resources such as fishes, sea turtles, marine mammals, and seabirds as discussed above in **Section 4.3** and **Section 4.5.** Sound would likely dissipate significantly over the three-mile distance between the dredging area and shoreline, but may be detectable on shore.

Proper maintenance of construction, dredging, and pumping equipment would minimize the noise impacts, and construction activities would likely occur for a short period. Construction noise may have a short-term, minor effect on sound levels in the vicinity of the construction activities.

The No Action alternative would not result in noise impacts.

4.13. AESTHETIC RESOURCES

IPFs associated with the applicant's preferred alternative and all other build alternatives potentially impacting aesthetic resources include

- Presence of construction equipment
- Noise
- Turbidity

The pipeline coming out of the water and along the beach, earthmoving equipment spreading sand along the beach, and associated construction activities would temporarily affect the aesthetics in the project area. Earth moving equipment used to distribute the sand would temporarily create visual disturbance as well as noise and exhaust fumes, which would decrease the overall aesthetic value in the immediate vicinity of the project activities. Earth moving equipment would operate from along the beach front to distribute the sand effectively after initial placement on the beach from the discharge pipes. Sand placement would cause short-term turbidity increases in the nearshore waters, resulting in a change in water color and clarity, and resulting in temporary minor impacts.

Analysis of grain size, color, and hue of the proposed borrow area sand area indicates that the dredged sand would be similar to the existing sand. With restoration of the currently eroded beaches, the overall aesthetic value within the project beach area is anticipated to increase.

The view within the proposed borrow area during project implementation may be affected by the presence and operation of equipment performing dredging and beach fill operations.

Any of the build alternatives could result in diminished aesthetic values in the north segment as the beach continues to erode and narrow. Dispersion of sand from the south segment could partially offset this erosion.

With the No-Action alternative, the aesthetic value of the beach is anticipated to diminish as the beachfront erodes and narrows. In addition, the potential for the construction of numerous emergency shoreline armoring structures and other stopgap measures could increase and, if implemented, would diminish the aesthetic value of the area and result in long-term, permanent impacts to the aesthetics of the area.

4.14. RECREATION RESOURCES

IPFs associated with all the build alternatives potentially impacting recreational resources include

- Limited and/or restricted access
- Turbidity

Recreational use of the beaches and coastal waters would temporarily decrease in the immediate vicinity of active nourishment and borrow dredging efforts. Temporary public safety restrictions would keep beachgoers and recreational users from the areas of active construction on the beach and at the borrow site. The active construction areas would shift along the project area beach; recreational users could access areas already nourished. Increased turbidity and resulting decrease in visibility would reduce or eliminate scuba diving and snorkeling in the project construction zone and in the mixing zone down current of the project area beach, where temporary increased turbidity could occur. The project would not likely affect nearshore coastal boating and fishing, which could continue as usual during nourishment activities. Project implementation could result in overall short-term impacts to recreational opportunities.

The Recreational Benefits Assessment conducted from 2007 to 2008 (Stronge 2008) surveyed beach users on south Hutchison Island in St. Lucie County from R-77 to the Martin/St. Lucie County line to determine the amount beach users would willingly pay during each visit to use the beach. Based on the amount that beach users would willingly pay, Stronge concluded that nourishment would add a recreational use benefit of $549,690 compared to the existing beach, resulting in a positive impact to recreation from project implementation.

With the No Action alternative, recreational opportunities would diminish over time on the beach area, as the beach would continue to erode and narrow. Offshore recreational opportunities (e.g., fishing, snorkeling, or scuba diving) would not incur impacts.

4.15. NAVIGATION

Recreational and fishing boats comprise the majority of vessel traffic in the project vicinity. Although most of the traffic is concentrated within the Indian River Lagoon, Ft.

Pierce Inlet, and St. Lucie Inlet, private and chartered fishing and excursion boats frequently visit nearshore and offshore reefs and shoals. Commercial vessel traffic is generally limited to those traveling to and from the Port of Ft. Pierce through Ft. Pierce Inlet. The proposed borrow area is located away from commercial shipping routes. Project construction would have short-term effects on vessels in the project vicinity due to the presence of the dredging vessel and associated pipelines.

4.16. HISTORIC PROPERTIES

IPFs associated with the build alternatives potentially impacting historic properties include

- Damage to historic or cultural resources

The final archaeological / cultural resources investigation report for the project area recommended a finding of no project effect on cultural resources listed, eligible for listing, in the National Register of Historic Properties, or otherwise of historical, archaeological, or architectural value; and recommended no further investigation of the area. The Florida Department of State – Division of Historical Resources reviewed the survey report and, in a letter to the USACE on April 15, 2008 (**Appendix F**), concurred with the report findings and recommendations.

Between September 2007 and June 2008, a remote sensing survey of borrow area 5 located offshore of Martin and St. Lucie Counties was conducted by SEARCH for the U.S. Army Corps of Engineers (USACE), Jacksonville District. For the applicant in December 2010, SEARCH conducted a remote sensing survey of the portion of borrow area 5 not previously investigated. SEARCH determined that the proposed activities within borrow area 5 would have no effect on cultural resources, listed, or eligible for listing and recommended no further investigation of the area. The Florida Department of State - Division of Historical Resources reviewed both reports and issued letters dated September 4, 2008 and January 20, 2011 concurring with the report findings and recommendations.

No IPFs are associated with the No Action alternative for historic properties within the project area; therefore, no impacts would be expected.

4.17. SOCIOECONOMICS

Sand dredging activities would limit or restrict access to the St. Lucie Shoal borrow area habitat for recreational and commercial fishing. This reduction in access may temporarily impact local businesses that provide fuel, food, fishing equipment, and bait to private and commercial vessels that fish within the project shoal borrow area. However, the restricted access area represents a very small portion of the total area available for fishing in southern St. Lucie County. The short duration of construction associated with any of the build alternatives could result in the return of some fish species relatively rapidly after completion of dredging (CSA International 2009b). Increased recreational uses of the nourished beach after project completion would likely

offset the short-term economic impacts from lost recreational and commercial fishing opportunities.

Storm damage reduction benefits include the dollar amounts of potential storm damage that project alternatives would prevent. **Table 4.17-1** summarizes the annual economic benefits associated with each alternative. The applicant provided an economic analysis (Coastal Tech 2009: Design Document, **Attachment C**: Cost Benefit Analysis) of all alternatives evaluated in this EIS except for the applicant's preferred alternative, developed after completion of the 2009 report. The applicant provided a supplemental analysis of economic benefits for the applicant's preferred alternative using the same methods described in the above-referenced document (personal communication, applicant's consultant, January 2012). That analysis, included in **Table 4.17-1**, found that the applicant's preferred alternative yields the greatest net primary benefit.

Table 4.17-1. Alternatives Benefits Summary

Alternative	Annual Benefits			Total	B/C Ratio	Net Primary Benefits
	Storm Damage Reduction Benefits	Land Loss Benefits	Recreational Benefits			
No Action	--	--	--	--	--	--
No Impact to Hardbottom	$269,799	$451,895	--	$721,694	0.27	($1,991,926)
1972 Template	$348,115	$451,895	--	$800,010	0.21	($3,065,146)
35' Berm - South Segment Only*	$1,579,912	$183,888	$486,042	$2,249,842	2.05	$1,152,868
35' Berm	$1,964,066	$446,245	$549,690	$2,960,002	2.04	$960,934
70' Berm	$2,557,388	$446,245	$1,756,869	$4,760,502	2.30	$937,424

*Applicant's preferred alternative

Potential effects to socioeconomic resources in the project area due to continued erosion of existing beach (No Action alternative) include increased potential of storm damages. These damages, all resulting from diminishing beach and nearshore areas, may include losses to buildings and land along the Atlantic coastline, losses in tourism and tax revenue to St. Lucie County, losses of recreational opportunities, and losses in jobs related to these activities.

4.18. PUBLIC SAFETY

As a public safety measure, beach and water-related recreation in the immediate vicinity of the discharge pipe would be prohibited during project construction. Likewise, water-related activities near the dredge site would also be prohibited during project construction. Recreational access to these areas would return to pre-construction

conditions following completion of the project. Long-term effects are not anticipated. The No Action alternative would assume continued erosion, allowing the surf zone to advance landward, with the potential of adverse impacts to public safety due to storm damage.

4.19. ENERGY REQUIREMENTS AND CONSERVATION

Energy requirements for the proposed alternative would be limited to the fuel for the dredging and pumping equipment, labor transportation, and construction equipment associated with beach placement. The use of sand from the proposed borrow areas would require less energy expenditure than obtaining sand from any other distant source. The No Action alternative would allow erosion to continue, and could require greater energy expenditure of on-site preventative measures and post-storm clean-up in the event of a storm (USACE 1996).

4.20. NATURAL OR DEPLETABLE RESOURCES

No natural energy resources occur within the proposed project area. The sand shoal proposed as a source for beach fill is considered a depletable resource. Project dredging would reduce the quantity of shoal sand. The St. Lucie Shoal, currently proposed as the offshore borrow site, contains approximately 1.3 million cubic yards of beach compatible material (CPE 2006b). The sand shoals offshore of the project area include well-developed, shore-face connected and isolated linear shoals with north-to-south orientation. These features, depositional in nature, exhibit varying degrees of morphological change in response to local hydrodynamic conditions. Sand shoals form as an irregularity on the seafloor and then grow in response to local coastal processes (waves, tides, currents). Ongoing formation results in a growing shoal. Shoals may also represent relic structures of past coastal processes no longer in action at a particular site.

Excavation of sediments from borrow sites exposes underlying sediments and can change the sediment structure and composition of the borrow site. This can lead to changed benthic community composition. Benthic species' ability to perform life functions (e.g. burrowing, feeding, or settling as larvae) varies with sediment quality and members of the current benthic community may or may not have the same success in the physical characteristics of the new sediment as in the existing sediment. In addition, excavation alters the seabed topography, creating pits that that may refill rapidly or remain for extended periods. Studies have shown that some borrow areas located within highly depositional areas have a relatively short filling time, whereas other areas may take up to 12 years returning to pre-dredge topography. In general, shallow dredging over large areas causes less change than smaller deep pits. If borrow pits are excavated in small deep pits, current velocity is reduced at the bottom, which can cause the deposition of fine particulate matter and potentially create a biological assemblage much different in composition than the original (Hammer et al. 2005). These assemblages may not provide the same trophic support as the original benthic community. However, the project dredging design provides a maximum dredging depth of only 10 feet below the existing surface (a relatively shallow dredging template) and

the dredge footprint comprises a very small portion of the total benthic habitat area. Predators on the benthic community would still have ample forage area after dredging ends.

Structurally, however, dredging could alter this shoal structure permanently and locally affect the seabed topography within the borrow site. BMPs (**Section 2.1.1.1**) applied to the design of the dredging profile of the shoal including avoidance of dredging across the shoal and maintaining a refuge patch at the highest shoal elevations would help minimize the impacts to the shoal habitat. In addition, based on physical geological models of shoal formations, there does not appear to be a mechanism that supports the idea that structural integrity of a shoal feature would "deflate" or "unravel" when subject to repeated dredging events (CSA International et al. 2009a), which has been suggested by Michel et al. (2001). Dibajnia and Nairn (2010) summarizing field and modeling studies of shoal behavior with dredging indicated that dependent upon dredging location, shoals will reform and retain existing original height after completion of dredging.

However, not all impacts from dredge pits are detrimental. Borrow pits are known to attract numerous fishes and have been known to provide resting places for sea turtles (K. Spring and D. Snyder, personal observations off Hobe Sound, Florida).

4.21. REUSE AND CONSERVATION POTENTIAL

There is no potential for reuse associated with the proposed project activities; therefore, this is nonapplicable to the proposed renourishment project. Energy requirements for the proposed alternatives would be confined to fuel for the dredge, labor transportation, and other construction equipment.

4.22. URBAN QUALITY

No direct permanent impacts related to urban quality are expected as a result of the proposed project. Implementation of the proposed project would indirectly and positively impact urban quality by restoring an eroded beach, by increasing the recreational beach activity, and by increasing the tax revenue and tourism commerce.

The commercial businesses and residential properties along the project beach could benefit from the storm protection afforded by the project and incur less risk of property damage. The presence of construction equipment could temporarily detract from the aesthetics of the environment, possibly temporarily affecting the localized visual aesthetics associated with south Hutchinson Island.

The No Action alternative would assume continued shoreline erosion, reduction of storm protection, and continued loss of recreational beach area with repercussions to tax revenues and tourism commerce.

4.23. SOLID WASTE

No impacts related to solid waste are expected due to this project. Precautionary measures anticipated in the contract specifications would identify and require proper disposal of solid wastes. Precautionary measures include proper containment and avoidance of overflow conditions by emptying containers on a regular schedule. Disposal of any solid waste material into Atlantic waters would not be permitted.

4.24. SCIENTIFIC RESOURCES

Scientific resources associated with all the build alternatives and the No Action alternative were not evaluated and are unknown. No comments related to scientific resources were received during scoping or DEIS comment periods.

4.25. NATIVE AMERICANS

The NOI, NOA, and the DEIS were published in the Federal Register. The documents were available for stakeholder comments, including federally recognized Native American Tribes. No comments related to the presence of any cultural resources have been received. The FEIS will be sent to all interested parties for additional comment.

4.26. DRINKING WATER

Implementation of either the applicant's preferred alternative or other build alternative and the associated effects were not evaluated and no comments were received.

4.27. CUMULATIVE IMPACTS

Cumulative impacts are those that result 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 result from spatial (geographic) and temporal (time) crowding of environmental perturbations. The impacts may result from the accumulation of similar effects or the synergistic interaction of different effects (Council on Environmental Quality 1997).

Table 4.27-1 summarizes cumulative impacts by identifying the past, present, and reasonably foreseeable future condition of the various resources with and without the project. Cumulative Effects Assessment **(Appendix R)** contains more detailed information about the cumulative impact analysis, conducted as recommended by guidance contained in Council on Environmental Quality (1997).

4.27.1. CUMULATIVE ACTIVITIES SCENARIO

The geographic scope of this analysis includes the shoreline of St. Lucie County and Martin County between Ft. Pierce Inlet and St. Lucie Inlet (about 22 miles of shoreline) and Atlantic Ocean sand shoals between about three and six miles offshore of the

Central Florida coastline. The project impact area extends from R-96.5 in St. Lucie County to R-1.5 in Martin County due to the proposed mixing zone (150 meters from the point of sand discharge) and potential downdrift (southerly) transport of sand in the nearshore area. Other similar projects to the north and south and all the other reasonably foreseeable actions along the shoreline of Hutchinson Island could, together with the proposed project, result in cumulative impacts. In addition to the coastline, the area includes the offshore borrow area located in a sand ridge (St. Lucie Shoal) three miles offshore of R-88 to R-115 in water depths of approximately 36 to 43 feet. Cumulatively, the project and other similar projects could impact sand shoals three to five miles offshore.

4.27.1.1. Past Conditions and Activities

A Conditions Assessment Report (Coastal Tech 2009: **Attachment P**) summarizes historical shoreline changes from R-77 through R-115. Except for the segment from R-103 to R-109, the shoreline within the study area predominantly retreated from 1972 to 2006. A volumetric study conducted by the USACE indicates that from 1997 to June 2004, the beaches of the study area cumulatively experienced slight erosion. From June 1997 to November 2004, following landfall of hurricane Frances and Jeanne (September 2004), a much stronger trend of erosion occurred.

Following hurricanes Frances and Jeanne, emergency dune restoration was conducted by the applicant — including placement of about 162,000 cubic yards of sand along the dune from R-98.4 to R-101.5, and from R-103.3 to the Martin County line (PBS&J, 2005) — over about 15,500 feet of dune and corresponding to a fill density of about 10 cubic yards/foot. Individual property owners have also undertaken dune restoration projects; placed quantities are unknown, but the applicant believes these amounts are relatively minor.

North of the project area, the federal Ft. Pierce Shore Protection Project area (about 1.3 miles in length) has received nourishment sand since 1971, before the federal project was defined. The federal project began in 1980. Since that time, 14 nourishments have placed sand on various portions of the project beach. Abutting the proposed project to the south, the federal Martin County Shore Protection Project, initiated in 1995, has renourished a four-mile project three times. Most recently, Martin County nourished Bathtub Beach, about 1,000 feet of shoreline, in spring 2010. Sail Fish Point Beach, just south and about 1,500 feet in length, received sand in 2005 and 2009.

Table 4.27-1. Summary of Cumulative Impacts

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with Project
Threatened and Endangered Species: Sea Turtles	Five sea turtle species occur in the area (loggerhead, green, hawksbill, Kemp's ridley, and leatherback). Loggerhead, green, and leatherback turtles nest on area beaches. Juvenile green turtles use nearshore hardbottom areas for feeding (macroalgae), resting, and shelter from predators. Past and current threats to sea turtle populations include artificial lighting, beach armoring, anthropogenic disturbance, trawling, dredging, vessel strikes, fishing gear entanglement, and ingestion of discarded anthropogenic marine debris.	Sea turtle nesting and nearshore habitat use would continue in the area. Project-specific impacts would be avoided, but ongoing threats to sea turtle populations would continue. In the absence of the project, property owners may armor their shoreline to protect their property, which may result in loss of nesting habitat and possible impacts on nearshore hardbottom habitat.	In addition to ongoing threats, the project would result in loss of a small defined area of juvenile developmental habitat (nearshore hardbottom). Sea turtles may be disturbed by turbidity and noise during construction. There is a small risk of sea turtles being struck by a construction vessel or entrained in the hopper dredge draghead; these risks would be minimized through vessel-strike avoidance and dredge-related impact mitigation measures. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts are anticipated.
Threatened and Endangered Species: Marine Mammals	Three endangered marine mammal species may occur in the area: Florida manatee, humpback whale, and North Atlantic right whale. Only the manatee is common. Past and current threats to marine mammal populations include vessel strikes, fishing gear entanglement, ingestion of marine debris, pollution, and underwater noise.	Marine mammals would continue to occur in the area. Project-specific impacts would be avoided, but ongoing threats to marine mammal populations would continue.	In addition to ongoing threats, marine mammals may be disturbed by turbidity and noise during construction. There is a small risk of marine mammals being struck by a construction vessel or entrainment within a hopper dredge draghead. Mortality of a manatee or North Atlantic right whale would represent a significant cumulative impact due to the small population of these species. The risk would be minimized through vessel-strike avoidance and dredge impact – related mitigation measures.
Threatened and Endangered Species: Smalltooth Sawfish	The smalltooth sawfish is an endangered species inhabiting shallow, nearshore waters. Historically, its population and range have declined, mainly due to fisheries bycatch. Other past and current threats are habitat loss and degradation, entanglement in marine debris, pollution, and anthropogenic disturbance.	Smalltooth sawfish would continue to inhabit the area. Project-specific impacts would be avoided, but ongoing threats to sawfish populations would continue and may result in further decreases in population size and range.	In addition to ongoing threats, sawfish may be disturbed by turbidity and noise during construction. There is a small risk of sawfish being entrained in the hopper dredge draghead, which would be minimized through mitigation measures. Due to the small spatial extent and short duration of project impacts, the smalltooth sawfish would not likely incur other than minor impacts.

Table 4.27-1. Summary of Cumulative Impacts

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with Project
Nearshore Hardbottom	Two nearshore hardbottom communities occur in the area. One consists of low- to medium-relief habitat with wormrock and supports hydroids, encrusting sponges, macroalgae, and turf algae. The other consists of low-relief coquina ledges with little or no epibiotic cover. These communities have historically been subjected to the dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure.	Nearshore hardbottom areas would continue to exist in the area, subject to the natural dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure. In the absence of the project, property owners may construct shoreline armoring to protect their property, which may result in impacts to nearshore hardbottom.	The project could result in burial of 0.55 acres of nearshore hardbottom habitat and other impacts to 0.02 acre. However, the impact represents a small percentage of the similar habitat in the area and impacts couldl be mitigated through the construction of artificial reef habitat. Cumulatively significant impacts could occur if the 10-year renourishment interval is shortened due to sea-level rise.
Fish and Wildlife Resources	Nearshore soft bottom habitats including sand shoals support a variety of invertebrates and demersal fishes. Invertebrates using shoals include infaunal and epifauna species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Most of these species are used as food by demersal fishes.	Project-specific impacts would be avoided, but soft bottom communities would continue to be affected by natural sand movement. In the absence of the project, property owners may armor their shoreline to protect their property, which may result in impacts to nearshore soft bottom communities. Regionally, other sand shoal areas are likely to be used in support of future beach nourishment projects.	In addition to ongoing processes affecting soft bottom fish and wildlife resources, there would be localized effects of dredge and fill activities along the beach and in the offshore borrow area that may persist for a few months to a few years. Major long-term effects are not anticipated because resident fish and wildlife species are wide-foraging or migratory and spend only a portion of their life cycle at the borrow area and beach fill sites.
Essential Fish Habitat	Managed species and species groups in the project area include *Sargassum*; coral, coral reefs, and live/hardbottom habitats; penaeid shrimp; spiny lobster; red drum; coastal pelagic fishes; reef fishes; dolphin and wahoo; and highly migratory pelagic species. Habitats of Particular Concern (HAPCs) for coral, coral reefs, and live/hardbottom habitats of the eastern Florida area include the *Phragmatopoma* worm reefs found in nearshore waters; nearshore hardbottom found in water depths of 0 to 4 m; and hardbottom found in water depths of 5 to 30 m.	Project-specific impacts would be avoided, but the acreage of nearshore hardbottom Essential Fish Habitat (EFH) would fluctuate with natural sand movement. Increased exposure of hardbottom may provide increased habitat for surf zone fishes, increased foraging habitat for green sea turtles, and increased refuge for juvenile fishes. In the absence of the project, property owners may construct armoring to protect their property, which may result in impacts to nearshore EFH.	In addition to ongoing processes affecting nearshore EFH, the project would result in impacts to 0.57 acre of nearshore hardbottom habitat that would result in an incremental loss of EFH for corals and other hardbottom groups, as well as reef fishes. However, the impact represents a small percentage of the similar habitat in the area. Unavoidable impacts would be mitigated through the construction of artificial reef habitat consisting of low to medium-relief to mimic the structure of the affected areas. Dredging would affect EFH by temporarily altering the sand shoal habitat (e.g., reducing shoal height, creating pits). However, the impact is reversible and represents a small percentage of the similar habitat in the area.

Table 4.27-1. Summary of Cumulative Impacts

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with Project
Water Quality	The project area consists of Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The predominant issue that affects water quality in the area is turbidity, which varies significantly under natural conditions (e.g., during storms), sometimes exceeding 29 NTU. Historically, coastal water quality has been affected by unrelated anthropogenic sources such as stormwater and effluent runoff resulting in increased nutrients and freshwater inputs. Urbanization and population growth in the region contributes to coastal water quality degradation.	Project-specific impacts would be avoided, but turbidity would continue to occur intermittently due to storm activity, rainfall, currents, and other natural phenomena. Water quality may deteriorate due to unrelated anthropogenic sources such as stormwater and effluent runoff.	In addition to the ongoing natural and anthropogenic fluctuations in water quality, local, short-term turbidity would occur adjacent to the beach fill sites and offshore borrow area. BMPs would be implemented during construction to reduce the magnitude and extent of turbidity, and adverse effects on water quality are expected to be minor. Turbidity would be monitored during construction to ensure that State water quality standards are met at the mixing zone boundary. Due to the small spatial extent and short duration of project impacts, no long-term effects are expected.

4.27.1.2. Present/Ongoing Activities

There are no ongoing beach restoration activities in the project area. The St. Lucie shoal is not currently being used for any other beach restoration projects. Recreational usage along the beaches within the project area includes shore based water sports such as scuba diving, snorkeling, surfing, surf fishing, and kayaking. Additionally, the area beaches are used for sunbathing, picnicking, and exercising. Boating is a popular recreational pastime for many residents and tourists to the area. Fishing, scuba diving, and snorkeling are often done from boats in nearshore hardbottom areas close to the shore. These shallow nearshore hardbottom areas are attractive areas for scuba diving and lobster fishing as well as angling from small vessels. Angling may occur near the proposed borrow site, although there are no known fish havens near the borrow area.

4.27.1.3. Reasonably Foreseeable Future Activities

USACE has a feasibility study underway to investigate a federal project but does not anticipate completing the project feasibility study and implementation process before 2012. The applicant has initiated this project to address the deteriorated shoreline and emergency conditions as soon as possible with parallel development of a future federal Shore Protection Project to provide for the future renourishment of south St. Lucie County beaches.

To provide for future renourishment of the project, a conceptual 50-year borrow area dredge plan has been proposed based upon the report titled “St. Lucie County Sand Search – Geotechnical Investigations – Reconnaissance Level Investigations” (Coastal Tech 2010c). The renourishment interval and volume are 10 years and 177,000 cubic yards, respectively. The proposed borrow area for project renourishment is located offshore St. Lucie County in reasonable proximity to the project fill area. The borrow can also likely yield the 50-year total estimated volume of beach compatible sand.

The proposed Martin County Beach Erosion Control Project (USACE 2008) would authorize construction of a protective and recreational beach along four miles of shorefront southward from the St. Lucie County line to near the limit of Stuart Public Beach Park (R-1 to R-25). The authorized project was initially constructed in 1996 with a planned periodic renourishment interval of 11 years. Federal participation (cost-sharing) is authorized for 50 years from date of initial construction and expires in 2046. The previously approved borrow area, used for initial construction, has been depleted. Therefore, Martin County has investigated three sand shoals including portions of the St. Lucie Shoal complex located approximately three to seven miles offshore Martin and St. Lucie Counties. Martin County has proposed a potential borrow area south of the St. Lucie Shoal as a source of beach-compatible sand. The total sand needed for the remainder of the 50-year life of the project is estimated to total between 2.4 and 4.0 million cubic yards. The next renourishment phase, scheduled for 2011, would involve the placement of approximately 589,600 cubic yards of material along the four-mile project area.

Regionally, beach nourishment is expected to continue in the coming years, compounding opportunities for recurring impacts. In southeast Florida alone, approximately 100 nourishment events are projected to occur between 1969 and 2050 dredging at least 100,000,000 cubic yards of sediment from an area 4 miles wide by 120 miles long (from Dade County to Martin County) (USACE 1996).

Future renourishment projects at the proposed site would require less sand (177,000 cubic yards) than the initial nourishment on a 10-year renourishment cycle. This sums to a requirement of about 885,000 cy over the 50-year project planning horizon. This amount comprises less than 4% of the sand resources in the St. Lucie Shoal. Additionally, based on recent beach nourishment projects, construction of a 177,000 cubic yard project using upland sand sources can reasonably occur within a single annual period outside turtle nesting season. With one-third the sand requirement of the proposed initial project, use of an upland sand source for renourishment projects is a reasonable alternative. A project of this scale would create less disruption to the local human population and less damage to infrastructure than would occur in the larger initial nourishment. A future renourishment project proposal should carefully evaluate the use of upland sand for construction.

The applicant provides local sponsorship to the State of Florida for implementing the state Ft. Pierce Inlet Management Plan. Part of that sponsorship has included investigations to meet and maintain sand bypassing requirements across Ft. Pierce Inlet identified in the sand management plan. In 2004, Taylor Engineering completed a study for the applicant to identify an annual bypassing operation that could either meet the state adopted bypassing requirements or, at a minimum, supplement the USACE shore protection project just south of Ft. Pierce Inlet (Taylor Engineering 2004). The bypassing operation could buffer high erosion rates seen immediately south of the Ft. Pierce Inlet south jetty and maintain the federal beach restoration project's design template over its renourishment interval. The study identified two alternatives — north jetty sand tightening with mobile sand bypassing plant and north jetty sand tightening with nearshore dredging — as reasonably attractive alternatives to bypass sand across the inlet. The applicant has recently completed a feasibility study of a third alternative — construction of a sediment basin in the inlet (Taylor Engineering 2010). An effective deposition basin in the inlet would capture incoming sediments and provide a sand source for bypassing operations. A deposition basin (sand trap) would create an area of deep water, effectively decreasing flow velocities within the basin and causing sediment to deposit there, rather than further in the navigation channel and inlet interior. Past experience at several east coast Florida inlets has proven the effectiveness of channel deposition basins as replenishing sand sources for bypassing projects. At Ft. Pierce Inlet, a deposition basin within the inlet with periodic dredging could potentially fulfill or supplement sand bypassing volume requirements. The applicant's Board of County Commissioners has recently directed applicant staff to move ahead with design and permitting of a sand trap in the northwest corner of the inlet, adjacent to Ft. Pierce Inlet State Park. Bypass sand quality would likely equal or exceed that available from other sources (offshore or upland) and might in the long-term serve to improve the general quality of the sand and the nearshore environment along Hutchinson Island. The sand trapped in the impoundment comes from beaches updrift (north) of the inlet rather than from offshore or upland sources, and so provides very similar quality sand to the

Hutchinson Island nearshore system that it received prior to construction of the inlet. This sand would ultimately make its way to the south St. Lucie County beaches, the focus of this EIS.

4.27.1.4. Sea-Level Change

Potential relative sea-level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. Future sea-level change is likely to result in both direct and indirect impacts on nearshore marine resources in the project area. Direct impacts could include changes in the areal extent of exposed hardbottom habitat due to sand movement. Indirect impacts could result from increased beach erosion, which may prompt more frequent (and possibly more extensive) beach nourishment projects in the area. The largest uncertainty is predicting the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level.

Using USACE Circular No. 1165-2-211, **Section 3.1.7** provides estimates of sea level rise ranging from 0.39 ft (0.12 m) to 2.1 ft (0.63 m) over the next 50 years.

The U.S. Climate Change Science Program (CCSP 2009) Synthesis and Assessment Product 4.1 (SAP 4.1) *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region* details both how sea-level change affects coastal environments and what planners should address to protect the environment and sustain economic growth. SAP 4.1 represents the most current knowledge on implications of rising sea levels and possible adaptive responses. Many options are available for protecting land from inundation, erosion, and flooding ("shore protection"), or for minimizing hazards and environmental impacts by removing development from the most vulnerable areas ("retreat"). However, policymakers have not decided whether the practice of protecting development should continue as sea level rises, or be modified to avoid adverse environmental consequences and increased costs of shore protection. Most shore protection structures are designed for the current sea level, and retreat policies that rely on setting development back from the coast are designed for the current rate of sea-level rise. Those structures and policies would not necessarily accommodate a significant acceleration in the rate of sea-level rise.

4.27.2. CUMULATIVE IMPACTS BY RESOURCE

In accordance with the approach recommended by the Council on Environmental Quality (1997), this analysis focuses on the potential impacts that are most important or meaningful. The marine resources of most interest for the cumulative analysis are threatened and endangered species, hardbottom, fish and wildlife resources, EFH, and water quality.

4.27.2.1. Threatened and Endangered Species

4.27.2.1(a). Sea Turtles

As discussed in **Section 3.3.1**, five endangered or threatened sea turtle species occur in the area (loggerhead, green, hawksbill, Kemp's ridley, and leatherback). Loggerhead, green, and leatherback turtles nest on area beaches. Juvenile green turtles use nearshore hardbottom ledges for feeding (macroalgae), resting, and shelter from predators.

Species recovery plans indicate that past and current threats to sea turtle populations include artificial lighting, beach armoring, anthropogenic disturbance, trawling, dredging, vessel strikes, fishing gear entanglement, and ingestion of marine debris (NMFS and USFWS 1991a; 1992a, b; 1993; 2008). These impacts are widespread, diffuse, and ongoing. They are anticipated to continue in the future regardless of whether this project occurs.

The project could result in burial of a small area of nearshore hardbottom and other impacts to an additional 0.02 acre, which would represent an incremental loss of developmental habitat for juvenile sea turtles. The animals would be prevented from using the buried hardbottom habitat as long as macroalgae and seafloor structures are covered. However, the area impacted (0.57 acre) is a small percentage of the total habitat area available in the region, representing approximately 4% of the total approximate 12.97 acres of hardbottom in the project area. Therefore, the impact to sea turtle developmental habitat is considered minor. Cumulatively, other beach nourishment projects in the area have provided successful mitigations for permanent impacts.

In addition to habitat loss, sea turtles may be disturbed by turbidity and noise during construction, and there is a small risk of a sea turtle being struck by a construction vessel or entrained in the hopper dredge draghead. To reduce the risk of impacts from dredging and vessel strikes, the project would comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NOAA Fisheries, 2006) and "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. The applicant proposes the use of trained and NMFS-approved protected species observers on board the dredge vessel during all dredging operations. Dredge support vessel operators and crews would be instructed to maintain a constant lookout for sea turtles during transits and maneuvers. With mitigation measures in place, the potential for sea turtle "takes" due to dredging and vessel strikes is expected to be significantly reduced.

Although there is a risk of a small number of sea turtle "takes" due to dredging and vessel strikes, the impacts would not likely be detectable cumulatively, based on the other known sources of impact to sea turtles. The National Academy of Sciences (1990) estimated that between 5,000 and 50,000 loggerheads were killed annually by the shrimping fleet in the southeast U.S. Atlantic and Gulf of Mexico. Mortality associated with shrimp trawls was estimated to be 10 times greater than that of all other

human-related factors combined. Most of these turtles were neritic juveniles, the life stages most critical to the stability and recovery of sea turtle populations (NMFS and USFWS 2008).

The FPL nuclear power plant just north of the project area regularly entrains marine turtles in its cooling water intake system, and FPL holds an incidental take permit for this impact. The plant has an ongoing program that captures almost all turtles before they enter the plant, where they would die. Some turtles are killed each year. Hatchlings and juveniles may pass through the net and die without the notice of plant personnel. Mortality at the plant represents the most significant ongoing impact to marine turtles along the Hutchinson Island shoreline.

Increased shoreline development due to the project could result in additional indirect impacts on sea turtle nesting due to increased artificial lighting, increased beach traffic, etc. However, the project area upland offers little opportunity for future development growth. More importantly, the potential for indirect development affects has been minimized in the design of the applicant's preferred alternative. In consultation with the FDEP, the applicant has delineated the project area to (a) include that portion of the study area that is designated by FDEP as "critically eroded" — thus qualified for state cost-sharing and where beach nourishment appears feasible for obtainment of a FDEP permit, but (b) excluded shoreline segments where minimal or no beach-front development exists and where beach nourishment would contribute little to storm damage prevention benefits.

Due to the small spatial extent and short duration of activities, no significant impacts on sea turtles are expected during a single nourishment event. Over the next 50 years, assuming a 10-year nourishment interval, the potential for significant cumulative impacts from repeated activities in the same area is low. However, if the interval is reduced due to future sea-level change, the potential for significant cumulative impacts would increase. Also, depending on the timing of beach nourishment project(s) in northern Martin County, there is the possibility of concurrent, project-related impacts on local sea turtles. If future projects in southern St. Lucie and northern Martin County are conducted concurrently, cumulative minor local habitat loss due to burial of hardbottom areas in multiple areas may elevate the level of the impacts. Also, the range of influence from noise, vessel traffic, and turbidity could overlap. However, the projects to the north and south have both provided mitigation for their permanent impacts and have avoided additional impacts in previous renourishments. Future performance of these projects would likely continue to avoid additional impacts.

4.27.2.1(b). Marine Mammals

As discussed in **Section 3.3.2**, three endangered marine mammal species may occur in the area: the Florida manatee, humpback whale, and North Atlantic right whale. Of these, only the manatee is common regionally. The two endangered whales are rare and may be present seasonally (December to March). Manatees are usually found in quiescent inshore waters and would likely be only very occasional visitors along the beach; they would likely only very rarely occur in the borrow area three miles offshore.

Historically, the most significant threat presently faced by Florida manatees is death or serious injury from boat strikes (USFWS 2001). Other known causes of manatee deaths include entrapment or crushing in water control structures and navigational locks, poaching and vandalism, entanglement in shrimp nets, monofilament line (and other fishing gear), entrapment in culverts and pipes, and ingestion of debris. Natural causes of death include disease, parasitism, reproductive complications, and other non-human-related injuries, as well as occasional exposure to cold and red tide. Vessel strikes would continue to be a significant threat to the Florida manatee population regardless of whether this project occurs.

For humpback whales and right whales, ship collisions and fishing gear entanglements are the most common anthropogenic causes of mortality (NMFS 1991, 2005). Other potential threats are habitat degradation, noise, contaminants, underwater explosive activities, climate and ecosystem change, and commercial exploitation. These widespread, diffuse, and ongoing impacts would continue regardless of whether this project occurs.

Vessel strikes comprise the most important potential impact on marine mammals. Because the existing manatee and the North Atlantic right whale populations are so small, any vessel striking a manatee or North Atlantic right whale during the project would represent a significant cumulative impact. To reduce the risk of vessel strikes, the project would comply with the "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. Trained and NMFS-approved protected species observers would be used on board the dredge vessel during all dredging operations, and dredge support vessel operators and crews would be instructed to maintain a constant lookout for marine mammals during transits and maneuvers. With these mitigation measures in place, the potential for marine mammal "takes" due to vessel strikes is expected to be significantly reduced.

A single nourishment event includes a small spatial extent of habitat for a short time and most marine species would avoid the area during construction. However, the project may result in temporary disturbance of marine mammals due to turbidity and noise during construction. These are minor impacts not likely to cause cumulative changes to marine mammal populations. The proposed 10-year nourishment interval over the next 50 years would help keep the potential for significant cumulative impacts from repeated individual nourishment projects low. However, if future sea-level rise results in a shorter interval between nourishments, the potential for significant cumulative impacts would increase. The timing of beach nourishment project(s) in northern Martin County may increase concurrent, project-related impacts on local marine mammals. If future projects in southern St. Lucie and northern Martin County are conducted concurrently, the range of influence from turbidity, noise, and vessel traffic would extend spatially, if not temporally.

4.27.2.1(c). Smalltooth Sawfish

As discussed in **Section 3.3.3**, the smalltooth sawfish is an endangered demersal fish species inhabiting shallow, nearshore waters. Historically, its population has declined and its range has contracted, mainly due to fisheries bycatch (NMFS 2009). Other past

and current threats are habitat loss and degradation, entanglement in marine debris, pollution, and anthropogenic disturbance (NMFS 2009). These widespread ongoing impacts are expected to continue in the future regardless of whether this project is conducted.

Construction-related turbidity and noise may disturb the smalltooth sawfish. There is also a small risk of sawfish being entrained in the hopper dredge draghead. To reduce the risk of impacts, the project would comply with the "Sea Turtle and Smalltooth Sawfish Construction Conditions" (NOAA Fisheries 2006). With these mitigation measures in place, the potential for "takes" of smalltooth sawfish during dredging is expected to be significantly reduced.

The small spatial extent and short duration of construction activities suggest that any single nourishment event is not very likely to impact smalltooth sawfish. Project construction may result in temporary disturbance or dislocation of these animals from dredging, turbidity, and noise. These are minor impacts that should not result in negative population effects. Over the next 50 years, assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects in the same area is low. However, if the interval is reduced due to future sea-level change, the potential for significant cumulative impacts would increase. The timing of beach nourishment project(s) in northern Martin County may result in concurrent, overlapping impacts on smalltooth sawfish from the construction of two projects at the same time. If future projects in southern St. Lucie and northern Martin County are conducted concurrently, the range of influence from noise, vessel traffic, and turbidity could overlap. Also, if the projects use the same sand shoal(s), dredging-related impacts could overlap.

4.27.2.2. Hardbottom

As discussed in **Section 3.4**, two types of nearshore hardbottom communities occur in the area. Hardbottom Community One consists of low- to medium-relief habitat with a significant wormrock component and supports fauna such as hydroids, encrusting sponges, macroalgae, and turf algae. Hardbottom Community Two includes low-relief consolidated coquina rock ledges with little or no epibiotic cover. These hardbottom communities have are constantly subjected to the dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure. These natural impacts would continue regardless of whether the project occurs.

Available natural resources information documents no past or ongoing anthropogenic impacts to nearshore hardbottom communities in the project area. If the project is not implemented, property owners may harden their shoreline to protect their property, which may result in impacts to nearshore hardbottom due to additional sand movement and scour.

The main unavoidable adverse impact from the applicant's preferred alternative is the burial of an estimated 0.55 acre of nearshore hardbottom habitat and an additional 0.02 acre impact from pipeline placement. The impact areas represent approximately 4% of the approximately 12.97 acres of hardbottom in the nearshore of the project beach.

Additional, extensive nearshore habitat occurs north of the project area. The applicant proposed mitigation for unavoidable impacts through construction and monitoring of artificial reef habitat. The artificial reef consists of low to medium-relief intended to mimic the structure of the affected areas. .

Over the next 50 years, assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects in the same area is low. However, if the interval is reduced due to future sea-level rise, the potential for significant cumulative impacts on nearshore hardbottom would increase. More frequently conducted nourishment projects would allow less recovery time for hardbottom communities temporarily buried by each project. Under any of the estimated sea-level changes (low, intermediate, or high), the nearshore hardbottom habitat likely would continue to exist. However, the areal extent and location of exposed hardbottom may change. For example, if the shoreline retreats, additional outcrops may become exposed in shallow water. Hardbottom areas farther offshore would be in slightly deeper water and could be less likely to be affected by beach fill projects. Over the next 50 years, sea-level change and beach nourishment projects are likely to be significant influences on the distribution and characteristics of nearshore hardbottom communities in the area.

A federal shoreline restoration project in northern Martin County begins at the southern terminus of the proposed project area (the St. Lucie County – Martin County line). A permit application for renourishment of this project area (first nourished in 1995) is now under regulatory review. The simultaneous construction of the projects could have result in positive and negative impacts. The nourishment of eight miles of beach would slow the overall erosion rate of either project constructed alone, but could impact a greater area of hardbottom habitat both north and south of the combined project area as the projects erode and disperse a greater volume of sand than would only one of the projects.

4.27.2.3. Fish and Wildlife Resources

As discussed in **Section 3.5** and **Section 3.7**, nearshore soft bottom habitats including sand shoals support a variety of invertebrates and demersal fishes. Invertebrates using shoals include infaunal and epifauna species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Demersal fishes prey on most of these taxa.

The project could result in localized effects of dredge and fill activities along the beach and in the offshore borrow area that may persist for a few months to a few years. However, resident fish and wildlife species are wide foraging or migratory and spend only a portion of their life cycle at the borrow area and beach fill site.

Over the next 50 years, assuming a 10-year renourishment interval, the potential for significant cumulative impacts on fish and wildlife resources from repeated individual nourishment projects in the same area is low. However, if the interval is reduced due to future sea-level rise, the potential for significant cumulative impacts would increase. In addition, beach restoration projects in Martin County may occur close to the same

timeframe as the applicant's project, use similar or nearby shoals for beach sand and thus create the potential for concurrent and overlapping impacts on benthic communities in the borrow area. The potential for significant cumulative impacts can be reduced by leaving portions of the existing shoals undisturbed. These "refuge patches" would help reduce the potential for significant cumulative impacts by providing a nearby source of plant and animal re-colonization propagules for the disturbed borrow area. Further, joint project planning by the counties can include overall impact minimization when selecting times and locations for dredging and nourishments

4.27.2.4. Essential Fish Habitat

As discussed in **Section 3.6**, managed species and species groups with EFH in the project area include *Sargassum*; coral, coral reefs, and live/hardbottom habitats; penaeid shrimp; spiny lobster; coastal pelagic fishes; reef fishes; dolphin and wahoo; and highly migratory pelagic species. HAPCs for coral, coral reefs, and live/hardbottom habitats of the eastern Florida area include the *Phragmatopoma* worm reefs found in nearshore waters; nearshore hardbottom found in water depths of 0 to 4 m; and hardbottom found in water depths of 5 to 30 m.

The applicant's preferred plan could result in the burial of 0.55 acre of nearshore hardbottom habitat, which could result in an incremental loss of EFH for hardbottom and coral species as well as reef fishes. Additionally, 0.02 acre of hardbottom is anticipated to be temporarily impacted resulting from pipeline placement. However, the total hardbottom impact (0.57 acre) is a small fraction of the total habitat area available in the region, representing about 4% of the approximate 12.97 acres of hardbottom in the project area. Dredging would affect EFH by temporarily altering the sand shoal habitat (e.g., temporarily reducing shoal height and creating pits). However, the impact is reversible and the applicant proposes to mitigate for the impact with 0.78 acre of mitigation reef. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts on EFH are expected. Assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects in the same area is low. However, as noted above under Hardbottom, if the renourishment interval decreases due to sea-level rise, the potential for significant cumulative impacts on EFH would increase. Over the next 50 years, sea-level change and beach nourishment projects would likely exert significant influences on the distribution and characteristics of nearshore EFH. For the 50-year life span of the project, any subsequent beach nourishment project would require an individual EFH assessment and evaluation of the anticipated effects.

4.27.2.5. Water Quality

As discussed in **Section 3.9**, the project area consists of Class III marine waters, designated as suitable for recreation and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Turbidity varies significantly under natural conditions (e.g., during storms), sometimes exceeding 29 NTU and presents the most dynamic component of water quality along the shoreline. Historically, anthropogenic sources such as stormwater and effluent runoff have affected coastal water quality, resulting in increased nutrients and freshwater inputs. Urbanization and population

growth in the region contributes to coastal water quality degradation. These types of impacts are expected to continue in the future regardless of whether the project is implemented.

The project would cause temporary, localized water column turbidity in the offshore borrow area and along the project shoreline. Construction BMPs should reduce the magnitude and extent of turbidity, resulting in only minor adverse effects on water quality. Turbidity monitoring during construction would ensure maintenance of state water quality standards at the mixing zone boundary.

The small spatial extent and short duration of the dredge and fill activities and the BMPs to be implemented during construction are expected to minimize water quality effects. Assuming a 10-year renourishment interval, the potential for significant cumulative impacts from repeated individual nourishment projects is low. If sea-level rise results in more frequent nourishment, the potential for significant cumulative impacts on water quality would increase. Also, depending on the timing of beach nourishment project(s) in northern Martin County, there is the possibility of concurrent, overlapping water quality impacts.

4.27.3. CONCLUSIONS

Ongoing beach restoration activities in the area include USACE shore protection projects at Ft. Pierce and the Martin County Shore Protection Project immediately south of the proposed project area. Long-term monitoring of those projects has not revealed cumulative impacts, and USACE and FDEP have found the mitigation projects have reached the anticipated ecological success. The St. Lucie shoal is not currently in use for any other beach restoration project. However, in addition to the proposed project with a 10-year renourishment interval, reasonably foreseeable future activities include federal beach restoration projects in St. Lucie County and Martin County. Regionally, dredging projects for beach nourishment are expected to continue, compounding opportunities for recurring impacts. Ongoing recreational usage of the nearshore environment includes fishing, boating, diving, snorkeling, and beach recreation activities.

Future sea-level change may result in significant direct and indirect impacts to nearshore marine resources in the project area. Direct impacts could include changes in the areal extent of exposed hardbottom habitat due to sand movement. Indirect impacts could result from increased beach erosion, which may prompt more frequent (and possibly more extensive) beach nourishment projects in the area. Predicting sea level rise and the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level comprise the largest uncertainties in estimating cumulative impacts.

Over the next 50 years without the project, important factors affecting the nearshore environment are likely to include sea-level change and ongoing, low-impact human uses such as fishing, diving and snorkeling, and boating. If the project is not implemented, property owners may construct revetments or other armoring to protect their property,

which may result in indirect impacts to nearshore hardbottom by exacerbating erosion, sand movement and scour.

If the applicant's preferred project occurs, 0.57 acre of nearshore hardbottom would be impacted — burial of an estimated 0.55 acre and pipeline intrusion on 0.02 acre. This hardbottom habitat serves as developmental and foraging habitat for juvenile sea turtles and EFH for coral/hardbottom biota and reef fishes. However, the area impacted (0.57 acre) represents approximately 4% of the approximate 12.97 acres of hardbottom in the project area and a very small fraction of hardbottom resources along the Hutchinson Island shoreline. In addition, construction of artificial reef habitat in the same nearshore area would mitigate the impacts. While the proposed mitigation would occur closer to shore than the Ft. Pierce and Martin County projects, results of other mitigations suggest that if the mitigation is located appropriately (does not become permanently buried), it should develop similar habitat to that impacted by the project.

All other alternatives except No Action and No Hardbottom Impacts have greater hardbottom impacts than the applicant's preferred alternative.

Endangered or threatened marine species that may occur in the project area include five species of sea turtles, the Florida manatee, the North Atlantic right whale, the humpback whale, and the smalltooth sawfish. Any vessel striking a manatee or North Atlantic right whale during the project would represent a significant cumulative impact because the existing populations are so small. Vessel strikes (or dredging impacts) on the other species, while obviously of concern, are relatively infrequent and often avoidable. To reduce the risk of vessel strikes, the project would comply with the "Vessel Strike Avoidance Measures and Reporting for Mariners" issued by NOAA Fisheries, Southeast Region. Conscientious application of all appropriate mitigation measures should minimize the potential for impacts to endangered and threatened species. Rare terrestrial dune plants such as the beach jacquemontia could be affected. However, USFWS prescribed measures to avoid the plant would be included for any build alternative.

For nearshore resources, the project creates a relatively low potential for significant cumulative impacts from repeated individual renourishment events. However, if future sea-level rise dictates a more frequent nourishment interval, the potential for significant cumulative impacts would increase. For example, more renourishment projects would provide less recovery time for hardbottom communities temporarily buried with each project. In addition, depending on the timing of future federal beach nourishment project(s) in St. Lucie County and Martin County, there is the possibility of concurrent, overlapping impacts from those two projects. Avoidance of significant impacts to offshore shoals or their depletion is a potential impact that would require ongoing and long-term coordination and management between the local, state, and federal government agencies interested in long-term use of that resource.

4.28. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

4.28.1. IRREVERSIBLE

An irreversible commitment of resources is one in which the ability to use a resource is lost forever. The use of sand from offshore or upland borrow areas would irreversibly commit those sand resources to this project and preclude their use for future nourishment projects. However, the offshore borrow area for this project is estimated to contain 1.3 million cubic yards of beach-compatible sand, which is more than twice the sand required for the project (about 485,900 cubic yards). To provide for future renourishment of the project area, the applicant has developed a conceptual 50-year borrow area dredge plan that identifies nearby and adjacent borrow areas with sufficient beach compatible sand to meet the 50-year project life.

Use of sand from offshore borrow areas would also irreversibly preclude its current use as habitat for benthic organisms. However, portions of the existing shoals are proposed to be left undisturbed as “refuge patches” to minimize impacts to existing benthic resources and to provide for re-colonization of disturbed borrow areas. Sufficient remaining sand reserves within and adjacent to the borrow area would provide for re-colonization of benthic organisms. Due to the dynamic nature of nearshore benthic environments, sand used to nourish the beach would eventually disperse in the nearshore areas and create habitat for shallow water benthic communities.

Impacts of beach restoration on nearshore hardbottom communities are reversible. These nearshore hardbottom areas are cyclically covered and exposed due to seasonal and other temporal changes in beach profiles. In view of the natural, highly dynamic fluctuations in exposure and burial of the nearshore rock resource and the modest scale of the proposed beach fill activity, abandonment of the project at any point can be reasonably anticipated to result in the near or wholly complete recovery of existing conditions.

4.28.2. IRRETRIEVABLE

An irretrievable commitment of resources means that opportunities for other uses are foregone for the period of the Proposed Action. Typically, it refers to the use of renewable resources, including human effort, and to other utilization opportunities foregone in favor of the Proposed Action.

All of the build alternatives would result in the temporary commitment of nearshore hardbottom areas as locations for placement of beach sand, which is a temporary loss of habitat use during the project period. The loss would be mitigated through the implementation of a program to construct nearshore artificial reef (see **Appendix G**). As noted, impacts of beach restoration on nearshore hardbottom communities are reversible and do not represent an irretrievable commitment of these resources for project use.

4.29. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The main unavoidable adverse impact of the build alternatives is the burial and other impacts to nearshore hardbottom habitat in varying amounts (**Table 2.6-2**). Burial of nearshore hardbottom would result in a local reduction of macroalgae and invertebrates that could modify the nearshore food web. Loss of macroalgae would be more severe in summer due to the presence of annual species. Re-exposure of hardbottom is possible due to high-energy dynamics of the area and equilibration of beach fill. Re-colonization of re-exposed hard substrates by worm rock and turf and macroalgae is probable as these organisms have high recruitment capability.

The no build alternative would result in decreased protection of upland structures, loss of turtle nesting habitat, and decreases in available recreational beach.

In addition to the direct impacts on epibiota, burial of nearshore hardbottom areas would result in an incremental loss of EFH for reef-associated fishes as well as developmental habitat for juvenile sea turtles. These animals would be prevented from using the buried hardbottom habitat as long as macroalgae and seafloor structures are covered. However, the area to be buried is a small percentage of the total habitat area available for use.

Due to the configuration of nearshore hardbottom habitat in the area, some level of impact to these areas is unavoidable for a beach nourishment project. The applicant's preferred plan has been designed to avoid and minimize the impact to the rock habitat to the extent practicable, while maintaining the requisite level of shore protection. Construction of artificial reef habitat would mitigate for unavoidable impacts.

To offset lost ecological functions from the burial of nearshore hardbottom resulting from any of the build alternatives, the applicant proposes to construct artificial reef(s) in comparable locations. UMAM calculations (**Appendix O**) indicate a requirement for 0.78 acre of artificial reef creation for the applicant's preferred plan. The applicant proposes to construct the mitigation reef prior to constructing the beach.

Other unavoidable adverse impacts of fill projects to the marine environment include

- Burial of infauna and non-motile epifauna in nearshore sand bottom areas due to placement of beach fill. Recovery would depend on the ability of buried organisms to burrow through the sediment layer and the ability of adjacent populations to recolonize the area. However, the affected area is a small percentage of the total sand bottom habitat in the region.
- Impacts to infaunal communities in the offshore borrow area due to sand removal and habitat alteration. These impacts are reversible, as the affected areas would gradually fill with sand from adjacent areas and be recolonized by infauna. Portions of the existing shoals are proposed to be left undisturbed as "refuge patches" to minimize impacts to existing benthic resources and also provide for recolonization of benthic resources in the disturbed borrow areas.

- Temporary, localized water column turbidity in the offshore borrow area and along the project shoreline. BMPs implemented during construction should reduce the magnitude and extent of turbidity and the project should result in only minor, temporary adverse effects on water quality. Turbidity would be monitored during construction to ensure that turbidity from construction activities conforms to State water quality standards at the mixing zone boundary.
- Temporary, localized air quality and noise impacts due to emissions from offshore and onshore construction equipment
- Temporary aesthetic/visual impacts due to the presence of construction equipment in the offshore borrow area and along the project shoreline
- Temporary loss of recreational use of the beach and adjacent nearshore areas during construction. Minor impacts to recreational opportunities would likely occur. The project area comprises a small percentage of the total area available for similar recreational activities in St. Lucie County.

The No Action alternative would also have effects including reduction of protection to upland structures, reduction in turtle-nesting habitat, and reduction in beach recreational opportunities.

4.30. LOCAL SHORT-TERM USES AND MAINTENACE/ENHANCEMENT OF LONG-TERM PRODUCTIVITY

All of the build alternatives are expected to produce localized, short-term impacts on nearshore benthic communities and water quality, but the build alternatives are not expected to cause significant adverse impacts on long-term productivity. Shoreline protection using periodic beach nourishment is an ongoing activity along much of the Florida shoreline. Beach nourishment projects have a temporary and short-term impact on nearshore biological resources and local offshore biological communities when offshore dredging supplies the nourishment sand. Most motile organisms (fishes, crabs, and some sand dwelling organisms) within the offshore borrow area and nearshore fill zone should be able to escape these areas during construction. Less-motile individuals that are unable to escape from construction would be lost, but lost populations of those individuals typically recolonize rapidly after project completion. Any build alternative would produce temporary increases in turbidity but would not result in significant long-term water quality degradation. Short-term reductions in primary productivity and reproductive and feeding success of invertebrate species and fish are expected. These impacts should not negatively affect the sustainability of these populations given the localized scale of impacts and the proposed creation of artificial reef or reefs to mimic the existing habitat (see **Appendix G)**.

4.31. INDIRECT EFFECTS

Some prior studies have concluded that beach nourishment projects lead to greater development, tourism, investment, and subsequently greater long-term requirements for shoreline protection (National Research Council Committee on Beach Nourishment and Protection 1995, Pilkey and Dixon 1996, Dean 1999). However, other studies

concluded that shoreline development is fostered mainly by economic factors other than public investment in shoreline protection (Cordes and Yezer 1998, Cordes et al. 2001). If allowed to occur, increased shoreline development could result in additional indirect ecological impacts such as adverse effects on sea turtle nesting due to increased artificial lighting, etc.

Few sites in the uplands adjacent to the project area remain open for development, so there is little or no opportunity for future development growth adjacent to the project beach. The existing shoreline includes a mix of residential, commercial (lodging), and public park facilities. More importantly, the potential for indirect development effects has been minimized in the design of the build alternatives. The applicant has delineated the project area to (a) include that portion of the study area that is designated by FDEP as "critically eroded." The project qualified for state cost-sharing where beach nourishment appears feasible for obtainment of a FDEP permit, but (b) excludes shoreline segments where minimal or no beach-front development exists and where little or no storm damage prevention benefits would be realized via beach nourishment.

Selection of the No Action alternative could lead indirectly to losses to property due to storm erosion, or upland constructed armoring or structures. These losses could lead to a tempering or reduction of future development, and/or abandonment or dereliction of existing development (i.e., decreased or lessened investment). Alternatively, they could generate increased demand for shoreline armoring by private interests as developed properties become imperiled by storm erosion.

4.32. COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

Recognizing the importance of the state's beaches, the Florida Legislature in 1986 adopted a posture of protecting and restoring the state beaches through a comprehensive beach management planning program. Under the program, the FDEP's Bureau of Beaches and Coastal Systems evaluates beach erosion problems throughout the state seeking viable solutions. The primary vehicle for implementing the beach management planning recommendations is the Florida Beach Erosion Control Program, a program established to work in concert with local, state, and federal governmental entities to achieve the protection, preservation, and restoration of the coastal sandy beach resources of the state. Eligible activities include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sand transfer, dune restoration and protection activities, and other beach erosion prevention activities consistent with the adopted Strategic Beach Management Plan.

The FDEP has classified most of the south St. Lucie County beaches as "critically eroded areas," a level of erosion that threatens substantial development, recreational, cultural, or environmental interests. One way to restore eroded beaches is through beach nourishment where sand is collected from an offshore location by a dredge and is piped onto the beach. A slurry of sand and water exits the pipe on the beach and once the water drains away, only sand is left behind. Bulldozers move this new sand on the

beach until the beach matches the design profile. Beach nourishment comprises a preferred way to add sand to a system because it provides a significant level of storm protection benefit for upland properties and includes the relatively few impacts to the coastal system. An additional benefit of beach restoration projects is that such projects quickly restore shorebird and marine turtle habitat.

The St. Lucie County coastline is a valuable resource providing storm protection, recreation, economic value, and wildlife habitat. The preservation of this coastline is a long-term, ongoing applicant commitment. The applicant's main objective is to abate ongoing and historical beach erosion; specific applicant criteria for plan formulation include optimizing project performance and cost effectiveness — generally consistent with USACE planning regulations for shore protection projects, and minimizing environmental impacts to the extent feasible.

Along many coastal areas, including the project area, erosion threatens oceanfront properties. Beach and dune restoration is necessary to help prevent the loss of property and/or the construction of numerous emergency shoreline armoring structures and other stopgap measures that would very likely continue to narrow the beach. With beach narrowing, sea turtle nesting habitat diminishes until (ultimately) no nesting habitat remains. While narrow beaches may still support nesting, if high tides reach a dune line on a regular basis, hatching success dramatically decreases from nest inundation and washout. In addition, recreational use of narrowed beaches diminishes. Therefore, the proposed project is consistent with federal, state, and local objectives.

4.33. CONFLICTS AND CONTROVERSY

Conflicts and controversy have been identified, considered, and fully addressed throughout the EIS after coordination with agencies and through the public comments.

4.34. UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

The proposed activity (i.e. beach nourishment) is commonly conducted, and has previously been permitted and conducted in St. Lucie County. To date, the USACE has identified no uncertain, unique, or unknown associated with the build alternatives considered in this EIS.

4.35. PRECEDENT AND PRINCIPLE FOR FUTURE ACTIONS

An emergency beach fill project (2004 – 2005) provided the only precedent beach nourishment action taken in the project area. This EIS considers a one time, single, and complete beach fill project with potential for a renourishment interval of 10 years. Project permits, if issued, would allow only a single nourishment event. Any future proposed nourishment project would require new permit applications with an independent evaluation and assessment of the anticipated project effects on the environment at the time of application for new permits.

4.36. ENVIRONMENTAL COMMITMENTS

The applicant is committed to avoiding, minimizing, or mitigating for adverse effects by implementing protection measures and complying with all environmental permit requirements. In addition to the mitigation and monitoring proposed in **Section 2.6**, the applicant is committed to the following protection measures during project construction.

4.36.1. SEA TURTLES

The following NMFS construction conditions to protect swimming sea turtles should be considered for use during any permitted beach nourishment project.

- The permittee shall instruct all personnel associated with the project of the potential presence of the species and need to avoid collisions with sea turtles. All construction personnel are responsible for observing water-related activities for the presence of sea turtles.

- The contractor shall advise all personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid entrapment. Barriers may not block sea turtle entry or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

- All vessels associated with the construction project shall operate at "no wake/idle" speeds as all times while in the construction area and while in water depths where the draft of the vessels provides less than a four-foot clearance from the bottom. All vessels would preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a sea turtle is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-foot radius of the equipment. Activities may not resume until the protected species has departed the project area on its own volition.

- Any collision with and/or injury to a sea turtle shall be reported immediately to the National Marine Fisheries Service Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

4.36.2. MANATEES

The following conditions intended to protect manatees from direct project effects are typically applied in any area known to potentially include this species.

- All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.

- All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

- Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

- All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shut down if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

- Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-731-3336) for north Florida or Vero Beach (1-772-562-3909) for south Florida.

- Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the permittee upon completion of the project. Awareness signs that have already been approved for this use by the Florida Fish and Wildlife Conservation Commission (FWC) must be used (see MyFWC.com). One sign, which reads *Caution: Boaters* must be posted. A second sign measuring at least 8"/2" by"11" explaining the requirements for "Idle Speed/No Wake" and the shutdown of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

4.36.3. SMALLTOOTH SAWFISH

The following NMFS construction conditions to protect smalltooth sawfish are a common component of permit specific conditions.

- The permittee shall instruct all personnel associated with the project of the potential presence of the species and need to avoid collisions with smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of smalltooth sawfish.

- The contractor shall advise all personnel that there are civil and criminal penalties for harming, harassing, or killing smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid entrapment. Barriers may not block smalltooth sawfish or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

- All vessels associated with the construction project shall operate at "No Wake/Idle" speeds as all times while in the construction area and while in water depths where the draft of the vessels provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a smalltooth sawfish is seen within a 50-foot radius of the equipment. Activities may not resume until the protected species has departed the project area on its own volition.

- Any collision with and/or injury to a smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

4.36.4. TURBIDITY

Implementation of the following measures would help avoid/minimize turbidity-related impacts:

- The Contractor shall monitor water quality (turbidity) at the dredging and beach placement sites, as required by the JCP and the 401 Water Quality Certification.

- If turbidity values at the dredging site exceed permitted values, the Contractor shall suspend all dredging activities. Dredging shall not continue until water quality meets state standards.

4.37. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

4.37.1. NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

The National Environmental Policy Act (NEPA) establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within the federal agencies. The purpose of NEPA is to create a policy that encourages productive and enjoyable harmony between man and his environment; to promote efforts that prevents or eliminates damage to the environment, and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the Nation. The act also establishes the Council on Environmental Quality (CEQ).

The act requires, before initiation of any major federal action significantly affecting the quality of the human environment, development of a detailed assessment of the environmental impact of the applicant's preferred alternative, any adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the applicant's preferred alternative, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved in the applicant's preferred alternative should it be implemented.

Since the St. Lucie County South Beach and Dune Restoration Project requires a permit from a federal agency, the USACE, it is classified as a federal action. This EIS provides the mechanism for the project to comply with NEPA.

4.37.2. ENDANGERED SPECIES ACT OF 1973

Section 7 of the ESA states that any project authorized, funded, or conducted by any Federal agency should not "… jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined … to be critical." The USACE is required to "informally" consult with the USFWS, the National Oceanic and Atmospheric Administration (NOAA), and NMFS to determine whether any federally-listed or proposed endangered or threatened species or their designated critical habitats occur in the project area. The USACE determined that the project "may affect" listed species or habitats. The USACE prepared a Biological Assessment (BA) (**Appendix L**) to identify the nature and extent of impacts and recommend measures that would avoid or reduce

potential impacts on the species. Therefore, the USACE has initiated “formal” consultation under Section 7 of the ESA with NMFS and USFWS. NMFS has provided the 1997 Regional Biological Opinion on Hopper Dredging along the South Atlantic Coast (1997 SADRBO) for hopper dredging related to swimming sea turtles, which stated hopper dredging activities will not jeopardize the continued existence of swimming sea turtles and that no further consultation is required for hopper dredging activities. In addition, the 1997 SADRBO indicated that the effects of hopper dredging on humpback whales and North Atlantic right whales, may affect, but are not likely to adversely affect, these species and no further consultation related to hopper dredging activities is required. If the USFWS concludes that the Project is not likely to jeopardize any listed species or result in the destruction or adverse modification of critical habitat, it may also issue an incidental take statement as an exception to the takings prohibitions in Section 9 of the ESA.

Formal consultation with USFWS for loss of foraging habitat was conducted. In a December 14, 2011 letter from USFWS to the USACE (**Appendix F**), the USFWS concluded formal consultation concerning the proposed project and provided terms for reinitiation of consultation.

4.37.3. FISH AND WILDLIFE COORDINATION ACT OF 1958

The Fish and Wildlife Coordination Act (FWCA) provides the basic authority for the Fish and Wildlife Service's involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. The act requires that fish and wildlife resources receive equal consideration to other project features and also requires federal agencies that construct, license or permit water resource development projects to first consult with the USFWS and the National Marine Fisheries Service as applicable as well as state fish and wildlife agency regarding the impacts on fish and wildlife resources and measures to mitigate these impacts.

4.37.4. NATIONAL HISTORIC PRESERVATION ACT OF 1966

Archival research, field investigations, and consultation with the Florida State Historic Preservation Officer (SHPO) were completed in accordance with the National Historic Preservation Act, as amended; the Archeological and Historic Preservation Act, as amended; and Executive Order 11593. Refer to **Section 4.16** for the results of SHPO consultation. The project is not anticipated to affect historic properties included in or eligible for inclusion in the National Register of Historic Places. The project complies with each of these federal laws.

4.37.5. CLEAN WATER ACT OF 1972

The objective of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters. The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters. The act aimed to attain a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife,

and provides for recreation in and on the water" by 1983 and to eliminate the discharge of pollutants into navigable waters by 1985.

Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry and set water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. In order to comply with the CWA, under Section 404, a USACE permit is required for the discharge of dredged or fill material into waters of the U.S.

Appendix S contains the 404(b) evaluation for this EIS.

4.37.6. CLEAN AIR ACT OF 1972

The proposed project would not require air quality permits. This project would include coordination with the EPA and would comply with Section 309 of this act.

4.37.7. COASTAL ZONE MANAGEMENT ACT OF 1972

The Coastal Zone Management Program federal consistency review process is described in 15 C.F.R. 930: Federal Consistency with Approved Coastal Management Programs Regulation, as amended. Federal consistency is the Coastal Zone Management Act provision requiring that federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. The State of Florida's Coastal Management Program (FCMP), accepted by the National Oceanic and Atmospheric Administration in 1981, is based on a network of multiple state agencies implementing 24 state statutes that protect and enhance the state's natural, cultural, and economic coastal resources (www.dep.state.fl.us/cmp/federal/14 statutes.htm). The goal of the program is to coordinate local, state, and federal agency activities using existing laws to protect Florida's "coast." The Florida Department of Environmental Protection is responsible for directing and coordinating the implementation of the state-wide Coastal Management Program.

Florida's coastal zone stretches beyond its coastal counties to include the entire state's land area and territorial seas minus the lands the federal government owns, leases, holds in trust, or whose use is otherwise by law subject to the sole discretion of the federal government, its officers, or agents, as well as lands held by the Seminole and Miccosukee Indian Tribes. Federal consistency review is required for any project that is within, or is expected to affect the resources, land, or water uses of the Florida coastal zone and requires a federal license or permit, is federally funded, or is a direct activity of a federal agency. As the St. Lucie County South Beach and Dune Restoration Project requires a federal permit, the project meets the criteria for federal consistency review (**Appendix T**).

4.37.8. FARMLAND PROTECTION ACT OF 1981

The proposed project will not impact prime or unique farmland. The act does not apply.

4.37.9. WILD AND SCENIC RIVER ACT OF 1968

The proposed project will not affect any designated Wild and Scenic River reaches. The act does not apply.

4.37.10. MARINE MAMMAL PROTECTION ACT OF 1972

Under the authority of the MMPA (Marine Mammal Protection Act of 1972; 16 U.S.C. §§ 1361 et seq.), the Secretary of Commerce is responsible for the protection of all marine mammals except walruses, polar bears, sea otters, manatees, and dugongs, which are the responsibility of the Secretary of the Interior. These responsibilities have been delegated to NMFS and the USFWS, respectively.

The MMPA prohibits the “take” of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. Under Section 3 of the MMPA, “take” is defined as “harass, hunt, capture, kill, or attempt to harass, hunt, capture, or kill any marine mammal.” In the 1994 amendments to the MMPA, two levels of “harassment” were defined. “Harassment” is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A); or any act that has the potential to disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, migration, breathing, nursing, breeding, feeding, or sheltering (Level B). In cases where U.S. citizens are engaged in activities, other than fishing, that result in “unavoidable” incidental take of marine mammals, the Secretary of Commerce can issue a “small take authorization.” The authorization can be issued after notice and opportunity for public comment if the Secretary of Commerce finds negligible impacts. The MMPA requires consultations with NMFS if impacts on marine mammals are unavoidable. The scoping letters received from NMFS indicates that their opinion is that there will be no impact on marine mammals for project implementation.

4.37.11. ESTUARY PROTECTION ACT OF 1968

The proposed project will not affect any designated estuaries. The act does not apply.

4.37.12. FEDERAL WATER PROJECT RECREATION ACT

Funding for this project includes no federal monies. Therefore, the Federal Water Project Recreation Act does not apply.

4.37.13. FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

The project is being coordinated with NMFS and will be in compliance with the Fishery Conservation and Management Act.

4.37.14. SUBMERGED LANDS ACT OF 1953

The Submerged Lands Act (SLA) granted title to the natural resources located within three miles of the adjacent state's coastline (three marine leagues for Texas and the Gulf coast of Florida). For purposes of the SLA, the term "natural resources" includes oil, gas, and all other minerals, including sand resources. This act provides for the jurisdiction of the borrow area sand resources by the State of Florida.

4.37.15. COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

The build alternatives would protect adjacent coastal barrier resources to greater or lesser degrees by restoring valuable beach and dune habitat. Placement of approximately 485,900 cubic yards of sand within the project area would contribute to the sand-sharing system and provide feeder benefits to adjacent shorelines. This project will comply with this act.

4.37.16. RIVERS AND HARBORS ACT OF 1899

The build alternatives will not obstruct navigable waters of the United States. This proposed project alternatives are reviewed under the authority of Section 10 of the Rivers and Harbors Act. .

4.37.17. ANADROMOUS FISH CONSERVATION ACT

The proposed build alternatives are not anticipated to affect anadromous fish. The EIS includes coordination with NMFS.

4.37.18. MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

The Migratory Bird Treaty Act of 1918 makes it unlawful to pursue, hunt, take, capture, kill, or sell birds listed therein ("migratory birds"). The statute does not discriminate between live or dead birds and also grants full protection to any bird parts including feathers, eggs, and nests. Over 800 species are currently on the list. The U.S. has entered into Treaties with Great Britain, Canada, Japan, Mexico, and Russia to protect migratory birds. The Treaties not only stipulate protections for the birds themselves, but also for habitats and environs necessary for the birds' survival. Impacts to migratory birds will be mitigated by implementation of conservation measures required by the Migratory Bird Treaty Act and the Migratory Bird Conservation Act.

4.37.19. MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The alternatives considered in detail in this EIS do not propose activities regulated under the Marine Protection, Research, and Sanctuaries Act. Therefore, compliance with the act is anticipated.

4.37.20. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801-1882) established regional FMCs and mandated that FMPs be developed to responsibly manage exploited fish and invertebrate species in Federal waters of the U.S. When Congress reauthorized this act in 1996 as the Sustainable Fisheries Act, several reforms and changes were made. One change was to charge the NMFS with designating and conserving EFH for species managed under existing FMPs. Charging the NMFS with this responsibility was intended to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or non-fishing activities and identify other actions that encourage the conservation and enhancement of such habitat. NMFS recommends consolidated EFH consultations with interagency coordination procedures required by other statutes such as NEPA or the ESA (50 CFR 600.920(e)(1)) to reduce duplication and improve efficiency. The mandatory content of an EFH Assessment is detailed in 50 CFR 600.920(e)(3). The EFH Evaluation is presented in **Appendix N**.

4.37.21. E.O. 11990, PROTECTION OF WETLANDS

This project will not affect wetlands as defined by the Order. The project does not apply to the goals addressed in this Executive Order.

4.37.22. E.O. 11988, FLOODPLAIN MANAGEMENT

No activities associated with the proposed project will take place within a riparian, lacustrine, or estuarine floodplain; therefore, it is anticipated that the project, if implemented, would remain in compliance with the goals of Executive Order 11988.

4.37.23. E.O. 12898, ENVIRONMENTAL JUSTICE

Executive Order 12898 provides that to the greatest extent practicable and permitted by law, federal agencies shall ensure that there is not disproportionately high and adverse human health or environmental effects from its programs, policies, and activities on minority populations and low-income populations in the U.S. There are no minority or low income populations within the project area; however, if an upland source for backfill is used there may be the potential for the presence of minority or low income populations nearby. If an upland borrow source is used, it would be obtained from an existing mine, and therefore, no additional impact to minority or low income populations are anticipated.

4.37.24. E.O. 13089, CORAL REEF PROTECTION

The Coral Reef Protection Executive Order (E.O). defines U.S. coral reef ecosystems as “those species, habitats, and other natural resources associated with coral.” Presence of corals and/or octocorals in the project area is extremely rare; however, hardbottom areas in deeper water further offshore support octocorals and several

genera of scleractinian corals including *Oculina*, *Siderastrea*, and *Phylangia* (**Appendix J**). No impacts to the deep-water corals offshore of the project area are anticipated.

4.37.25. E.O. 13112, INVASIVE SPECIES

The proposed project is not expected to introduce invasive species.

5. LIST OF PREPARERS AND REVIEWERS

5.1. PREPARERS

This document was prepared by Taylor Engineering, Inc. and CSA International, Inc. (CSA). **Table 5.1-1** lists the individuals that contributed to the technical content in this document.

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