ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
DRAFT INTEGRATED FEASIBILITY STUDY
AND ENVIRON MENTAL ASSESSMENT

April 2016

US Army Corps
of Engineers ®
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Using this Document

Report Reference Materials: To ease navigation through the report, prompts are provided throughout the document, alerting the reader to reference additional sections or graphics, or to explain the purpose of an ensuing discussion. In this report, these prompts can be identified by this blue box format.

Additionally, informational foldouts REF-1, REF-2 and REF-3 are provided at the end of the report to be used while reading the document to serve as reference maps with key points and landmarks. In addition, detailed tables of contents are provided by chapter in the main report, as well as an index at the end of the report.

Organization of this report follows Exhibit G-7 (Feasibility Report Content) provided in Appendix G of ER 1105-2-100 (30 June 2004), documenting the iterative **U.S. Army Corps of Engineers (USACE) Plan Formulation Process.** The planning process consists of six major steps:

(1) Specification of problems and opportunities
(2) Inventory, forecast and analysis of existing conditions within the study area
(3) Formulation of alternative plans
(4) Evaluation of the effects of the alternative plans
(5) Comparison of the alternative plans
(6) Selection of the Tentatively Selected Plan (TSP) based upon the comparison of the alternative plans.

Steps may be repeated as problems become better understood and new information becomes available.

Steps 1 and 2 are discussed in **Chapters 1-2**, and provide the foundation for developing alternative plans and selection of a TSP outlined in **Chapter 3**.

Each chapter, summary graphic, as well as the executive summary describes plan development as it progresses through the four integrated environments that shape a coastal storm risk management (CSRM) project: the **built environment** (upland development, etc.); the **natural environment** (species of concern and their habitat); the **physical environment** (currents, tides, sea level rise, etc.), and the **economic environment** (vulnerability of built environment to damages). Concerns relative to plan formulation and National Environmental Policy Act (NEPA) review are summarized and encapsulated in the discussions of these four main environments.

The recommended format of an **Environmental Assessment (EA)** is provided in 40 CFR 1502.10 and has been integrated into the Feasibility Report. The basic table of contents for the report outlines how the EA format has been integrated into the planning process to develop a TSP that meets the requirements of both USACE Plan Formulation Policy and NEPA.

Note that sections pertinent to the NEPA analysis are denoted with an asterisk.

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DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT St. Lucie County, Florida

Please refer to informational foldouts REF-1 and REF-2.

EXECUTIVE SUMMARY

NOTE: This draft document is not yet complete. The current report describes existing conditions in the study area as well as future conditions if a project is not constructed, problems that a project would address and opportunities available to manage coastal risk. The current report also describes plan formulation, including environmental considerations, to reach a Tentatively Selected Plan (TSP). The document will be revised per comments received during concurrent review, and the TSP could be modified. There will be additional U.S. Army Corps of Engineers (USACE) internal reviews, as well as State and Agency (S&A) reviews prior to the report being made a final report and related information will be assimilated into the report as the TSP progresses to a Recommended Plan.

PURPOSE AND NEED

This report is an interim response to the study authority contained in two resolution dockets by the Committee on Transportation and Infrastructure of the U.S. House of Representatives**: Resolution Docket 2634 St. Lucie County, Florida Shore Protection (11 April 2000)** and **Resolution Docket 2757 St. Lucie County, Florida Shore Protection (23 July 1998).** This single purpose Coastal Storm Risk Management (CSRM) study focuses on the erosion problems and potential storm vulnerability of structures on the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida. The non-federal sponsor is St. Lucie County, Florida.

This study investigates alternatives for a unified plan that addresses coastal storm risk management, as well as incidental opportunities for preservation of environmental resources and recreation for the southern portion Island of Hutchinson. The study area is from Florida Department of Environmental Protection (FDEP) range monument (R) R77 to the Martin County line (approximately R001), and covers the following four reaches, from north to south: North Hutchinson Island reach, Power Plant reach, Narrows of Hutchison Island reach, and South Hutchinson Island reach.

ALTERNATIVE PLANS AND THE TENTATIVELY SELECTED PLAN

Federal Interest Determination and the a Description of the Tentatively Selected Plan

It has been determined there is Federal Interest in a project along the southern portion of Hutchinson Island, based on the Tentatively Selected Plan (TSP) identified using the USACE Planning Process. The Benefit-to-Cost Ratio (BCR) for the TSP is 2.1.

Plan Formulation

A description of the alternatives, their performance in terms of benefits and costs, and the methods used for screening are provided in the sub-sections that follow.

Management Measures

Management measures are specific structural or nonstructural actions that would take place at geographical locations within the project areas. For the first iteration of evaluating measures, the entire project area was split into two geographical locations:

1) The Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island reaches were grouped together due to their proximity and similarity in physical and built features.
2) The South Hutchinson Island reach was evaluated separately due to its erosive nature and more densely developed coastline.

Structural management measures initially considered included: Seawalls, Revetments, Sand covered soft structures, Beach nourishment, Groins, Submerged artificial reefs, Nearshore berm placement, Emergent breakwaters, and Dunes with vegetation.

Non-structural management measures initially considered included: No-action, Coastal construction control line, Moratorium on construction, Establish a no-growth program, Relocation of structures, Floodproofing of structures, and Acquisition of land and structures.

During the plan formulation process, management measures were screened against the four Federal accounts, planning objectives, and constraints using a qualitative assessment in a matrix. Ultimately, most of these measures were screened out, and the three northern reaches (Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island) were de-scoped from the study area, due mainly to few structures in the area and as a result, few damages. The South Hutchinson Island reach was carried forward (a length of approximately 3.4 miles), with two structural measures carried forward to the modeling stage: 1) Beach Nourishment and 2) Dunes with vegetation. The screening process is described in detail in **Chapter 3** of the main report.

Dunes and Vegetation: This measure would include placement of beach compatible material, from either upland or offshore sources, as an extension of the existing dune feature. Vegetation would be planted after initial placement of the dune material. Preliminary engineering design work concluded that the most feasible plan for dunes and vegetation would be extending the existing dune by either 10 or 20 feet. These alternatives were named “Dune10” and “Dune20” respectively. Periodic nourishment triggers would occur once the extended dunes were fully eroded and construction would be completed using a hydraulic dredge to transport material from an off-shore borrow source.

Beach Nourishment**:** This measure includes initial construction of a beach fill and future renourishment at planned intervals. Renourishment of the beach would be undertaken periodically to maintain the erosion control features within design dimensions. There were several combinations of project dimensions initially considered for beach nourishment. Five different “design berm” templates were considered

which included various alternatives as follows: 1) maintaining a zero-foot berm (ABERM), 2) 20-foot berm (BBERM), 3) 40-foot berm (CBERM), 4) 60-foot berm (DBERM), and 5) 80-foot berm (EBERM). Using these design berm templates, a "sacrificial fill" amount was then considered in 20-foot increments. For example, one project option would be to maintain a 20-foot design berm with an additional 40-feet of sacrificial fill. Much like the dunes and vegetation measure, periodic nourishment triggers would occur once sacrificial berm lengths have been fully eroded. Using truck transportation of fill was considered as a possible option for beach nourishment but was found to be too cost prohibitive. As a result, hydraulic dredging would be used for this measure as well.

For a more detailed explanation of renourishment triggers and related specifications please refer to the **Engineering Appendix** of this report.

Alternative Development

An alternative plan is a set of one or more management measures functioning in tandem to address project objectives.

Though the team only carried forward two management measures there were a total of 42 alternatives for initial modeling. The two dune extension options (10-foot and 20-foot) were modeled individually and also in combination with the beach nourishment berm extensions.

The alternative names were descriptive and followed a convention of design template (A-E) as described above), berm width (20 to 100-foot), and the width of the dune extension (0 to 20-foot). So for example, a project that maintains a 0-foot design template, 40-foot berm extension, and maintains the existing dune would be labeled: ABerm40DuneEx. For a more detailed explanation of renourishment triggers and the various alternative specifications please refer to the **Engineering Appendix** of this report.

After initial modeling it was apparent that the only economically justifiable design template was maintaining a 0-foot berm extension (A), and only sacrificial fill extensions up to 40-feet. The various alternatives provided nearly the same level of total benefits but the costs increased greatly with the size of the project. Dune extensions in combination with beach nourishment berm extensions were also unjustifiable but a stand-alone project of Dune10 was carried forward to the final array. Upon realizing larger projects had no justification, the decision was made to add alternatives and model sacrificial-fill amounts in 10-foot increments. The alternatives carried into the final array for Beach-fx modeling (100 iterations) were as follows: ABerm10DuneEx[1], ABerm20DuneEx, ABerm30DuneEx, ABerm40DuneEx, and Dune10[1].

Alternative Comparison

All of the alternatives described above were modeled in Beach-fx using full (100 iteration) life-cycle simulations in order to calculate benefits and costs, resulting in the information in **Table ES-1-1**. These plans were evaluated using FY2015 price levels and the FY2016 federal water resources discount rate of 3.125%. The evaluation covered the span of a 50-year period of analysis with a base year of 2020. Benefit values in this table include those derived from land loss estimations and incidental recreation benefits. It

[1] These alternatives were determined too small for dredging so trucking costs were used in Beach-fx modeling.

is important to note that this table represents costs and benefits estimated during the alternative evaluation process based on best available information at that time.

The alternative with the highest net-benefits is ABerm20DuneEx, and with a BCR greater than 1.0, it becomes the National Economic Development (NED) Plan and the Tentatively Selected Plan (TSP). There is not a locally preferred plan at this time, but a locally preferred plan could be pursued.

Table ES-1-1. AAEQ Damages for Final Array of Alternatives (Screening-Level Costs).

Alternative Name	Brief Description	Total Costs (AAEQ)	Net Benefits (AAEQ)	BCR
ABerm20DuneEx	Existing Dune and 20' sacrificial berm	$ 1,327,721	$ 767,852	1.58
ABerm30DuneEx	Existing Dune and 30' sacrificial berm	$ 1,358,477	$ 733,004	1.54
ABerm40DuneEx	Existing Dune and 40' sacrificial berm	$ 1,356,253	$ 735,194	1.54
ABERM10DuneEx	Existing Dune and 10' sacrificial berm	$ 1,691,824	$ 401,904	1.24
Dune10	10' Dune Extension	$ 1,926,323	$ 161,395	1.08

The TSP consists of beach nourishment/renourishment along approximately 3.4 miles of shoreline between FDEP monuments R-98 and the Martin County line. The design beach fill template is characterized by a 20 foot berm extension (+7 ft-NAVD88) from the toe of the 2008[2] dune profile. Beach fill material required under the Base SLR case includes an average of 530,400 cubic yards for initial construction of the design beach profile and approximately 2 renourishment events averaging 380,000 cubic yards each. This project proposes to use sand from St. Lucie Shoal, which contains material compatible with the native sand within the study area, and has a sufficient quantity for a 50-year planning horizon.

Tentatively Selected Plan Benefits

The economic benefits of the plan are generated in the USACE certified Beach-fx model by reductions in erosion, wave, and inundation damages. The model results suggest that the TSP is highly effective at reducing nearly all damages. The 20 foot berm extension protects St. Lucie County from 94% of all damages in the project life. In R113, where damages in the FWOP were the most dramatic due to high-value structures on slab foundation, 99% of damages are avoided.

[2] In order to ensure that emergency nourishment efforts in response to the 2004 and 2005 hurricane season, and local fill project completed in May 2013 did not influence the outcome of the ongoing feasibility study, it was agreed that the "without-project" shoreline for the study would be established using survey data collected in the summer of 2006. However, subsequent analysis of the data showed that the 2006 survey did not provide adequate foreshore and offshore coverage of the project area to complete the Beach-fx analysis. A comparison of the available portions of the 2006 survey and a comprehensive shoreline survey taken in August 2008 showed insignificant difference in shoreline dimensions between the two. Therefore, the 2008 shoreline was determined to be a good representative of the 2006 shoreline and was adopted as the "without-project" condition.

Sea Level Rise (SLR)

The TSP performs satisfactorily in each SLR scenario and establishes itself as a robust option when considering risk and uncertainty. Benefits increase at a much greater magnitude than costs and the BCR nearly doubles from the base SLR to intermediate and though the returns are declining, there is still a significant increase in BCR from the intermediate SLR to the high SLR. The TSP remains an efficient and effective plan for any of the three possible SLR scenarios.

ENVIRONMENTAL CONSIDERATIONS

The proposed project is currently being coordinated with state and Federal agencies and will be compliant with Federal statutes and regulations at the time when it becomes a final report.

In accordance with permits issued by the State of Florida and USACE, the non-federal sponsor has placed beach quality material from the designated offshore borrow site along this shoreline in 2012/2013. The TSP proposes to continue using the same borrow site (St. Lucie Shoals). The TSP will construct a berm smaller than then local project, along a smaller reach of local sponsor's placement area (R98 to the Martin County line compared to R88 to the Martin County line).

During construction of the local project, the non-federal sponsor provided mitigation for impacts to hardbottom resources within the project area. Since the proposed TSP berm is smaller than the local project berm, hardbottom mitigation would not be required during construction of the project resulting from the TSP.

The beneficial effects of renourishment along the proposed project area include establishing a larger buffer beach to protect upland infrastructure and populations against storms and flooding, and additional habitat for beach flora and fauna as well as more space for recreational activities. National Marine Fisheries Service (NMFS) has designated loggerhead sea turtle habitat within the study area.

The proposed project would likely produce more favorable environmental conditions than exist at present, although construction operations would produce some temporary adverse effects. The affected resources would return to pre-construction conditions either immediately after dredging (with respect to resources such as aesthetics and noise) or within one or two years (with respect to sea turtle nesting and benthic resources).

Coastal Barrier Resource System (CBRS) unit P11 occupies approximately 12% of the project area proposed by the TSP (roughly R98 to R98+210 and R101.5 to R103.5). The purposes of the Coastal Barrier Resources Act (CBRA) include minimizing the loss of human life, wasteful expenditure of Federal revenues, damage to fish, wildlife, and other natural resources associated with CBRS units. There are limits to Federal expenditures related to actions that could affect a unit. Section 6 of the CBRA provides an exception to this limitation if the Federal expenditure is for non-structural[3] shoreline stabilization projects that are designed to mimic, enhance, or restore a natural stabilization system. There are a small number of privately owned parcels within the project area, and within P11, which are not under any perpetual conservation designation. Federal expenditures for any alternative implementation (including beach

[3] FWS includes beach and dune features as non-structural options.

nourishment) in this area would be prohibited by the CBRA due to the fact that such action could encourage development. A Section 6 CBRA exception would only apply if these private parcels were covered under a perpetual conservation easement which is not the case. However, non-federal funds could be used to nourish the beach in this area. Dollman Park, a publicly owned parcel within the project area, does meet the Section 6 exception since development is prohibited in this location; therefore, Federal funds could be used to nourish the beach adjacent to the park.

COST ESTIMATE AND IMPLEMENTATION

Table ES-1-2. Pertinent Project Information.

Tentatively Selected Plan (TSP) Description	The TSP includes:
Average # Nourishment Events	1 initial construction event, approximately 2 periodic nourishment events
Average Volume of Initial Construction	530,400 cubic yards
Average Volume of Each Periodic Nourishment	380,000 cubic yards
Average Periodic Nourishment Interval	approximately 18 years
Initial Construction Duration	approximately 4 months
TSP total project cost (including contingency)	$72,289,000 (October 1, 2015 (FY16) Price Level)
Cost sharing	Initial construction: 26% Federal / 74% non-federal Periodic nourishments: 21.5% Federal / 78.5% non-federal
Benefit-to-Cost Ratio (BCR)	2.1 (October 1, 2015 (FY16) Price Level and FY16 3.375% discount rate).

The total cost of initial project construction (based on average volume requirements) is estimated at $29,878,190. Future renourishment costs are estimated at $21,313,370 per nourishment, with periodic nourishment expected at approximately 18 year intervals[4]. Under the base SLR case, an estimate of the total cost incurred over the 50-year project life is $72,289,000.

Assessing the performance of the project is a two-part process consisting of 1) shoreline monitoring and 2) assessing measured wind, wave, and water level information, in conjunction with sea level rise assessments.

First, physical monitoring of the project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year project life. The monitoring plan will include systematic measurements of the beach profile shape. Profile surveys should provide accurate assessments of dune and beach fill volumes and a basis for assessing post-construction dune and beach fill adjustments, as well as variation in the profile shape due to seasonal changes and storms. Monitoring will play a vital role in determining if project renourishment is necessary.

[4] Note that vegetating the dune for periodic nourishment events (after initial construction) is a non-federal responsibility and cost, per U.S. Army Corps of Engineers (USACE) Policy Guidance Letter No. (PGL) 27, dated 17 November 1992. For this project, it is assumed that dune vegetation for periodic nourishment will occur by natural recruitment, and therefore no cost is associated with periodic dune vegetation.

Post-construction monitoring activities include topographic and bathymetric surveys of the placement area on an annual basis for 3 years following construction and then biannually until the next construction event. Other monitoring efforts include bathymetric mapping of the borrow site to assess capacity, which will be done as part of the pre-construction engineering and design (PED) phase prior to each nourishment.

Second, measured wind, wave, and water level information will be obtained from the best available existing data sources. This data will be applied in support of the shoreline and borrow site monitoring efforts. It will also be used to periodically assess the state of sea level rise and to determine if reassessment of the project volumes and/or renourishment intervals based on an intermediate of high sea level rise case is required.

COORDINATION WITH AGENCIES AND THE PUBLIC

An initial scoping period for the project was conducted from May 31 through June 30, 2006. National Atmospheric Oceanographic and Administration (NOAA) responded to the scoping letter with concerns about the proposed dredging of the offshore shoals and requested that the EFH assessment and NEPA documents on this action be prepared with sufficient detail. This assessment is included in Sections 2.3.4 and 4.1.10 of this report.

The Florida Department of Environmental Protection (FDEP) coordinated a review of the scoping letter and the proposed project with the appropriate state agencies. FDEP stated that "based on the information contained in the public notice and the enclosed state agency comments, the state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program."

Other stakeholders raised concerns regarding the use of St. Lucie Shoal as a borrow site, impacts to hardbottom resources, and cumulative impacts.

The non-federal sponsor was issued USACE and state permits for the local beach nourishment project conducted in the study area in 2012/2013. An Environmental Impact Statement (EIS) was prepared and completed in 2012 as part of the issuance of the USACE permit, which was subsequently coordinated with the agencies and general public. The EA for this study tiers off of that EIS.

A public meeting is being scheduled for June 2016, which will occur during the public review period of this document. The format of the meeting will include an overview of the TSP as well as a formal comment period.

All correspondence associated with this NEPA scoping process is included in Appendix H of the main report.

RESIDUAL RISK

Analysis in the **Economics Appendix** for the future without project conditions modeling analysis concludes with four important points: 1) damages in the study area are largely driven by storm events rather than gradual erosion; 2) the overwhelming majority of the damage is structural in nature (commercial structures which include hotels and condominiums) and accounts for well over half of all damages); 3) the

proximity to the shoreline and exposure to recurring damages are the most important factors for determining structural damage; and 4) damages in the future without project condition (FWOP) increase dramatically in the sea level rise (SLR) scenarios.

It is important to note that the volumes discussed throughout the report are average volumes. The methods of monitoring and data assessment (while periodically revisiting sea level rise trends) described earlier will be crucial for adaptive management to manage risk.

1 Introduction

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1 INTRODUCTION*

Please refer to informational foldout REF-1 throughout Chapter 1.

1.1 FEDERAL PROJECT PURPOSE*

Coastal Storm Risk Management (CSRM) projects have been authorized for a variety of purposes: beach erosion control, shore/shoreline protection, hurricane/hurricane wave protection, and storm protection. The Water Resources Development Act (WRDA) of 1986 assigns costs of Federal projects to appropriate project purposes. Project reaches that provide hurricane and storm damage reduction are assigned a 65% Federal share for initial construction. Specifically for beach renourishment projects, WRDA 1999 assigned a 50% Federal share for future renourishments. Project reaches that provide for separable recreation are not federally cost shared. The Federal government does not participate in work realizing separable recreation benefits such as constructing a beach only for recreational purposes (and not hurricane and storm damage reduction purposes) or constructing recreation facilities. Recreation is not considered to be a high priority output or primary project output under current Department of Army policy, as described in ER 1105-2-100. This policy precludes Federal funds to support construction of CSRM projects which depend on separable recreation benefits for economic justification, or for which incidental recreation benefits are greater than 50% needed for justification (ER 1105-2-100 section 3-4.b(4)(a)).

1.2 STUDY BACKGROUND AND LOCATION*

St. Lucie County is located along the east coast of south-central Florida, approximately 225 miles south of Jacksonville and 100 miles north of Miami (REF-1). The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island, bordered by the Atlantic Ocean to the east, and the Indian River Lagoon (Atlantic Intracoastal Waterway) to the west. Hutchinson Island is split by Fort Pierce Inlet into North Hutchinson Island and South Hutchinson Island. As a point of reference, St. Lucie Inlet is located approximately 7 miles south of the project area, in Martin County.

The scope of the feasibility study includes a 7.4[5] mile stretch of shoreline located on Hutchinson Island. This area extends along the southern region of St. Lucie County's Atlantic coastline, from FDEP survey range monuments[6] R77, which corresponds to a region of shoreline extending from approximately 1 mile north of the Florida Power and Light Nuclear Power Plant (FPL power plant) southward to the St. Lucie County/Martin County line.

[5] See Section 1.5 for a discussion on the study area length and authorities.
[6] FDEP reference (R) monuments are located approximately every 1000 feet along the shoreline and serve as geographic reference points for historic and contemporary shoreline monitoring. They are used as reference points throughout this report.

The study area is largely dominated by a large U.S. Fish and Wildlife Service (USFWS) designated Coastal Barrier Resource System (CBRS) unit, known as CBRS unit P11.

According to the USFWS website, Congress recognized that certain actions and programs of the Federal Government have historically subsidized and encouraged development on coastal barriers, resulting in the loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. To remove the federal incentive to develop these areas, the Coastal Barrier Resource Act of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS), and made these areas ineligible for most new federal expenditures and financial assistance. CBRA encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-federal parties bear the full cost.

In particular, CBRS unit P11 extends from approximately R77 to R103, with three relatively small gaps, known as "excluded" areas, at approximately R080 to R084, R088.5 to R090, R098+600 feet to R101, and from R103 to R115+1000 feet (REF-1). Of the approximate 7.4 miles of shoreline within the study area, roughly 3.4 miles of shoreline are in the CBRS. The three CBRS excluded areas have a total length of about 1.4 miles of shoreline. The non-CBRS affected shoreline is the southernmost part of St. Lucie County and stretches 2.6 miles from approximately R103 to the St. Lucie/Martin County line at approximately R001. All together, the CBRS comprises about 46% of the study area.

The area has been delineated into four reaches:

- North Hutchinson Island (R77 to R80): This reach is approximately .57 miles long, with an average erosion rate of -1.8 feet per year. There is no development in this reach and it is entirely within the CBRS unit.
- Power Plant Area (R80 to R90): This reach is approximately 1.9 miles long, with an average erosion rate of +0.06 feet per year. The only structure in this reach is the Florida Power and Light (FPL) Nuclear Power Plant. With the exception of the power plant, the remainder of the reach is entirely within the CBRS unit.
- Narrows of Hutchinson Island (R90 to R98): This reach is approximately 1.5 miles long and the average erosion rate is -1.0 feet per year. The area consists of low density of development within the CBRS unit, with the exception of one excluded area with one condominium development.
- South Hutchinson Island (R98 to R115 plus 1000 feet (to the Martin County line)): This reach is approximately 3.4 miles long and the average erosion rate is -.4 feet per year. A small portion of the CBRS unit ends at approximately 200 feet south of R98, and begins again at roughly R101.5 to R103.5 (Dollman Park), and then ends for the remainder of the reach.

State Road A1A is the only north/south access road for Hutchinson Island and is the island's only hurricane evacuation route. Development along the study area portion of Hutchinson Island consists mainly of the FPL power plant near the north end of the project area, parks and multi-story condominiums on the east (ocean) side of SR A1A, and a couple of single-family residential developments west of A1A in the southern

portion of the study area. The Nettles Island community is located west of R106 and the Waveland community is located between R111 and R115. There is no coastal armoring (such as seawalls or revetments) within the study area.

Within the study area there are 4 county parks which provide public parking and beach access. These parks and their related parking and access are located on the east side of A1A within the project area and are discussed in Chapter 2 and Chapter 3.

1.3 STUDY SPONSOR

The non-federal sponsor is St. Lucie County, Florida, represented by the Board of County Commissioners. A Feasibility Cost Sharing Agreement was executed on 29 June 2004.

1.4 STUDY PURPOSE AND NEED

The purpose of this study is to investigate the feasibility of providing coastal storm risk management (CSRM) within the study area of the St. Lucie County, Florida coastline. St. Lucie County's barrier Islands can be eroded by frequent winter storms (northeasters) as well as tropical storms and hurricanes.

There is a need to reduce the damages to coastal infrastructure during hurricane and tropical storm events, in the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida. Based on National Hurricane Center (NHC) records, 55 hurricanes and tropical storms have passed within this 50-mile radius over the 154-year period of record. Statistically, an average of one storm every 2.8 years.

Historic records for St. Lucie County indicate that the most memorable and damaging storms affected the county in September 1928, September 1933, September 1947, August 1949, October 1964 (Hurricane Isbell), March 1962 (the "Ash Wednesday northeaster"), 1979 (David), 1999 (Irene), and 2004 (Frances and Jeanne), and 2012 (Hurricane Sandy).

- During the 1947 hurricane, storm tides at Ft. Pierce were over 5 feet above mean sea level.
- The 1962 Ash Wednesday northeaster produced tides of over 6 feet above mean sea level at Ft. Pierce and caused the most severe beach erosion on record in St. Lucie County (Bush et al, 2004).
- Hurricane Irene in 1999, a Category 2 storm caused significant erosion and cost approximately $6 million in damages to St. Lucie County as it made landfall on the west coast of Florida and exited the east coast directly over the county (Bush et al, 2004).
- In 2004, Hurricanes Frances and Jeanne significantly impacted St. Lucie County, prompting emergency dune restoration efforts in the southern half of the county.
- In 2012, Hurricane Sandy passed through St. Lucie County, with 49 mile-per-hour winds, damaging boardwalks, sand dunes and beach crosswalks. The storm was reported to cause nearly $12

million in damages along the Treasure Coast (which includes Indian River County, St. Lucie County and Martin County), according to county officials.

The purpose and scope of this study are also influenced by USACE Environmental Operating Principles and USACE Campaign Plan Fiscal Year (FY) 2015-2019, which are discussed further in Chapter 2.

1.5 STUDY AUTHORITIES

A Reconnaissance Study (Section 905(b), WRDA 1986 Analysis) was initiated on 25 February 2002 as an initial response to two Resolutions by the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The two resolutions are listed below:

> **Resolution Docket 2634 St. Lucie County, Florida Shore Protection dated 11 April 2000 states:** *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie County in the area north of the Ft. Pierce Inlet, the southern five miles of St. Lucie County, and adjacent shorelines.*
>
> **Resolution Docket 2757 St. Lucie County, Florida Shore Protection dated 23 July 1998 states:** *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie County from the current project for Ft. Pierce Beach, Florida southward to the Martin County Line.*

The final St. Lucie County, Florida Section 905(b) Reconnaissance Study was approved on 1 August 2003 and resulted in the finding that there was a Federal interest in proceeding into the feasibility phase.

Approval for moving from the reconnaissance study phase into the feasibility study phase is contained in a memorandum dated 1 August 2003 from USACE South Atlantic Division (SAD).

At the initiation of the study, there was discussion within the USACE vertical team as to whether the full study area boundary of 7.4 miles (R77 to the Martin County line) fits within the Authorization. The discussion was resolved in favor of pursuing the 7.4 mile study area, given that 1) The 905(b) Reconnaissance Report included a map of the 7.4 mile area, 2) the 1998 resolution docket referenced an area between Ft. Pierce to the Martin County line, which would include the additional length, and 3) the 2000 resolution docket mentioned to study not only the southernmost 5 miles of St. Lucie County and the

area north of Ft. Pierce, but also the adjacent shorelines. This was taken to mean including the shorelines in between those two points in the study area.

1.6 REPORT APPROVAL

This feasibility report provides an interim response to Resolution Dockets 2634 and 2757, and will be sent as a decision document to the Secretary of the Army for review and consideration for approval.

1.7 RELATED DOCUMENTS*

1.7.1 RELATED USACE AND NEPA STUDIES

A summary of primary Federal study most relevant to this study is as follows:

- Section 905(b) (WRDA 86) Analysis, St. Lucie County, FL, Hurricane and Storm Damage Reduction Study November 2002, APPROVED August 2003. This report concluded that there is Federal interest in participating in a cost-shared feasibility study for hurricane and storm damage reduction in the study area of Hutchinson Island, St. Lucie County, Florida.

  The only prior Federal study of the subject project area is the section 905(b), WRDA 1986 analysis which was approved in August 2003 and subsequently authorized this feasibility study for the southern 5 miles of St. Lucie County and "adjacent shorelines." Given the close proximity and influence of the Fort Pierce Inlet Project and Fort Pierce Hurricane and Storm Damage Reduction project to the north, there are several other Federal studies completed for Fort Pierce which are relevant to this particular study. A list of Federal reports pertaining to Fort Pierce Inlet and the hurricane and storm damage reduction project is provided below:

- U.S. Army Corps of Engineers (USACE). 1963. Beach Erosion Control Report on Cooperative Study of Fort Pierce, Florida. October 1963. This report recommended restoration of 1.3 miles of shoreline south of Fort Pierce Inlet with periodic nourishment as needed for a period of ten years following initial construction of the project. The authorization allowed for project construction by the non-federal sponsor, St. Lucie County, with subsequent reimbursement of the Federal share of costs.

- U.S. Army Corps of Engineers (USACE). 1982. Section 111 Report for Fort Pierce Beach, St. Lucie County, Florida.: This study disclosed that the combined effects of the jetties and the required maintenance dredging of the Federal Navigation Project at Fort Pierce Inlet causes about 60% of the historical erosion along 6,900 feet of shoreline immediately south of the inlet.

- U.S. Army Corps of Engineers (USACE). 2004 Fort Pierce Shore Protection Project, St. Lucie County, Florida. General Re-evaluation Report (GRR) with Draft Environmental Assessment. April 2004. This GRR was submitted in September 2004 to USACE Jacksonville District by Taylor Engineering, Inc. on behalf of St. Lucie County, the local sponsor. The September 2004 draft GRR evaluated project alternatives, including shoreline stabilization structures, for both 15-year and 50-year analysis

periods. The 15-year project evaluated the project over its remaining authorized life, currently scheduled to expire in 2020. The 50-year project evaluation, conducted at the request of the local sponsor, examined the project over a renewed 50-year life, beginning in circa 2005. A crucial recommendation of the Independent Technical Review (ITR) was to split the September 2004 draft GRR into two documents: 1) a Limited Re-evaluation Report (LRR) to address the 15-year project life remaining in the original authorization and 2) a GRR to address the renewed 50-year project life. This report also provides a comprehensive list of Federal and non-federal studies pertaining to Fort Pierce Inlet and shore protection.

- U.S. Army Corps of Engineers (USACE). 2005. Project Information Report (PIR), Rehabilitation Effort for the Fort Pierce, Florida, Hurricane and Storm Damage Reduction Project.: USACE Jacksonville District prepared this report in support of the 2005 Fort Pierce Shore Protection Project (SPP) renourishment. The report provides a history of the project and the 2004 hurricane season and summarizes the economics for emergency rehabilitation efforts and the requirements to restore the Federal project.

- U.S. Army Corps of Engineers (USACE). 2006. Fort Pierce Shore Protection project, St. Lucie County, Florida: Limited Reevaluation Report (LRR) including Final Environmental Assessment (1998) and Final Environmental Impact Statement (2002). This Limited Reevaluation Review (LRR) evaluated and updated the Fort Pierce SPP for current conditions as of 2004. The report summarized a cooperative cost-shared feasibility study on shore protection problems along the shoreline of Fort Pierce, St Lucie County, Florida. This LRR stemmed from the Independent Technical Review (ITR) process of the 1998 General Reevaluation Report (GRR) for the Fort Pierce Shore Protection Project.

- Final Environmental Impact Statement, St. Lucie County South Beach and Dune Restoration Project, St. Lucie County, Florida, Prepared by Taylor Engineering, February 2012. This document was prepared by Taylor Engineering on behalf of the St. Lucie County Erosion District for a local nourishment from R-87.7 to R90.3 and R98 to the St. Lucie/Martin County line at R-115+1000 feet, consisting of a beach fill and dune restoration. The EIS found that the project would impact .57 acres of hardbottom habitat, and therefore would require .78 acres of nearshore hardbottom reef construction (this was later changed to .97)

1.7.2 PRIOR NON-FEDERAL STUDIES

Many studies and reports relevant to the project have been completed by non-federal interests in relation to the shorelines of St. Lucie County. A list of the most relevant studies is provided in the references of this report. Included is a select list of historic and current studies which were evaluated during the development of this feasibility study for southern St. Lucie County:

- University of Florida (UF). 1958. Coastal Engineering Study of Fort Pierce Beach, Florida. University of Florida, Coastal Engineering Laboratory. Gainesville, Florida. September 1958: This report is one of the first detailed coastal engineering studies completed for St. Lucie County. It was completed for the Fort Pierce Beach Erosion District (FPBED). The report provides data on beach erosion and accretion in the FPBED, the quantity of littoral drift; the development and stability of beach and offshore profiles, recommendations for protective measures including an estimate of the amount of

material needed for artificial nourishment of the beach, and measures to prevent breakthrough of the barrier island south of Fort Pierce Inlet during extreme storm and tide conditions.

- Coastal Technology Corporation. 2007. St. Lucie County, Florida, South County Beach Project Conditions Assessment. This report provides data on environmental resources as well as shoreline conditions.

- Coastal Technology Corporation. Updated January 2010. St. Lucie County, South County, Beach and Dune Restoration Project, Design Document. This report documents the rationale, data, and design for the local St. Lucie County beach and dune restoration project.

1.8 FEDERAL PROJECTS NEAR THE STUDY AREA

Fort Pierce Federal Navigation Project

Fort Pierce Inlet is located in central St. Lucie County and serves as the northern terminus of the Fort Pierce Shore Protection Project. Fort Pierce Inlet is a manmade inlet initially cut in 1921. The existing north and south jetties were built in 1926, 900 feet apart and 1,800 and 1,200 feet long. The Federal government assumed responsibility for maintaining the inlet and jetties in 1935. The St. Lucie County Port and Airport Authority is the non-federal sponsor for authorized modifications to the existing Federal Navigation Project at Fort Pierce Harbor. Fort Pierce Harbor was last modified between June 1995 and April 1996.

Maintenance dredged beach quality material from the Federal Navigation Project at Fort Pierce Harbor has been placed on the shoreline south of Fort Pierce Inlet since 1973 between R-34 to R-37 (the northern 3,000 feet of the Federal Fort Pierce Shore Protection Project (SPP)).

Fort Pierce Shore Protection Project

The River and Harbors Act of 1965 (PL 89-298, 79 Stat. 1089, 1092) in accordance with the recommendations of the Chief of Engineers in House Document (HD) 84, 89th Congress authorized the Fort Pierce, Florida Shore Protection Project in St. Lucie County[7]. The authorization provided for the restoration of 1.3 miles of shoreline (R34-R41) south of Fort Pierce Inlet and for periodic nourishment as needed. Initially constructed in 1970, the current period of Federal participation extends until 2020.

Initial construction occurred in 1970 with 718,000 cubic yards of fill placed along the 1.3-mile project shoreline. A Limited Reevaluation Report (LRR), completed in 2006, resulted in a change of the renourishment interval and updated cost-sharing to include results of a Section 111 Study for Fort Pierce, approved in 1982. The current draft General Reevaluation Report (GRR), being completed by the local sponsor, evaluates alternatives over a new 50-year period.

[7] This document was also an authorization for the St. Lucie County study.

Martin County Beach Erosion Control Project

The Martin County Beach Erosion Control Project was authorized by the Water Resource Development Act (WRDA) of 1990 (Public Law 101-640) in accordance with the Chief of Engineers Report dated 20 November 1989. The project is 4 miles long, extending southward from the St. Lucie County line to near the limit of Stuart Public Park (Florida Department of Environmental Protection, FDEP, monuments R1 to R25). The initial project renourishment interval was 11 years, but was later revised to a renourishment interval (for full beach nourishment) of 13 years. Initial construction was completed in 1996. During the summer of 2000, six acres of nearshore artificial reef was created to mitigate for impacts to nearshore hardbottom in the project area. Partial nourishments were constructed in 2001 and 2002. The project was fully nourished in 2005 using Flood Control and Coastal Emergencies (FCCE) funds in response to 2004 hurricane impacts.

1.9 OTHER NON-FEDERAL STUDIES AND PROJECTS ADJACENT OR NEAR TO STUDY AREA

In the past decade several Beach Erosion Control activities have been undertaken by St. Lucie County and other private interests including the following:

- From November 1999 through February 2000 an FDEP field permit was issued for temporary placement of sand bags along the shoreline 400 feet north and south of R099.

- In February 2002, an FDEP field permit was issued for beach scarping from approximately R099 to R101.

- In February 2004, an FDEP field permit for dune restoration by truck haul was issued, permitting placement of approximately 4,000 cubic yards of sand from an upland borrow source to the beaches between approximately R099 and R101.

Following Hurricanes Frances and Jeanne in 2004, a regional emergency dune restoration project was permitted:

- Initial dune restoration was conducted from March to May 2005 by St. Lucie County. This material was hauled in by truck and included placement of about 162,000 cubic yards of sand along the dune from R098.4 to R101.5, and from R103.3 to the Martin County line (PBS&J, 2005). This dune restoration provided over 15,500 feet of dune, corresponding to a fill density of about 10 cubic yards/foot.

- A February through March 2006 dune remediation event required removal of approximately 80,000 cubic yards of previously placed material. This material was replaced with dune overwash material that was removed and screened from Blind Creek, a coastal wetland extending from R075.5 to R079.

- Another dune segment, previously untouched, was restored by truck haul in February 2007 with approximately 11,000 cubic yards of material trucked in from an upland borrow area. This event nourished dunes from R088.5 to R090.3.

- In April 2011 the St. Lucie County Mosquito Control and Coastal Management Services Department initiated an emergency dune fill project which added 60,000 cubic yards of sand (100 feet of beach width) to 1,700 feet of shoreline immediately south of Ft. Pierce Inlet.

- In 2012/2013, in a response to Hurricane Sandy in 2012, St. Lucie County constructed a local beach fill and dune restoration project, placing a total of approximately 658,654 cubic yards of fill on approximately 3.4 miles of shoreline from R98 to the St. Lucie/Martin County line at R-115+1000 feet.

2 Existing and Future Conditions

TABLE OF CONTENTS

2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS

2.1 GENERAL SETTING*

Please refer to informational foldout REF-1 and REF-2 throughout Chapter 2.

ASSUMPTIONS

In a letter of response to the Sponsor, signed by the Deputy Director of Civil Works dated 12 October 2006 (**Appendix H**) it was agreed that a reasonable eroded shoreline would define the "without-project" condition for the Feasibility study. In order to ensure that emergency nourishment efforts in response to the 2004 and 2005 hurricane season and local nourishment project (completed in May 2013) did not influence the outcome of the ongoing feasibility study, it was agreed that the "without-project" shoreline for the study would be established using survey data collected in the summer of 2006. However, subsequent analysis of the data showed that the 2006 survey did not provide adequate foreshore and offshore coverage of the project area to complete the Beach-fx analysis. A comparison of the available portions of the 2006 survey and a comprehensive shoreline survey taken in August 2008 showed insignificant difference in shoreline dimensions between the two. Therefore, the 2008 shoreline was determined to be a good representative of the 2006 shoreline and was adopted as the "without-project" condition.

This chapter describes conditions as they currently exist, and as they are projected to exist if a project is not implemented, within the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida. St. Information gathered in this step helps to describe the problems and opportunities and forecast future conditions. The future without-project (FWOP) condition is the most likely condition of the study area without construction of a Federal project over the next 50 years.

The St. Lucie County, South Hutchinson Island study area, totals approximately 7.4 miles, spanning 4 island segments. The islands are separated from the mainland by the Atlantic Intracoastal Waterway (AIWW).

The Coastal Barrier Resource System (CBRS) unit P11 comprises about 46% of the study area. Of the approximate 7.4 miles of shoreline within the study area, roughly 3.4 miles of shoreline are in the CBRS. The three excluded areas have a total length of about 1.4 miles of shoreline. The non-CBRS shoreline is the southernmost part of St. Lucie County and stretches 2.6 miles from approximately R103.5 to the St. Lucie/Martin County line at R115+1000 feet (approximately R001).

The study area shoreline consists of a naturally narrow sandy beach, bounded along the landward side by a thin line of dunes. The natural beach berm width along the majority of the study area is relatively thin. The natural beach slope is fairly steep, typically about 1 vertical to 8 horizontal, sloping directly from the sand dunes downward to the waterline with very little flat berm width. This type of beach is common along southeast Florida and has relatively coarse grained, carbonate rich, beaches. Several areas of environmentally sensitive nearshore limestone and worm rock formations exist within the littoral zone

throughout the study area, and in various densities. Nearshore limestone and worm rock formations occur within the study area.

Existing ground elevations along Hutchinson Island are generally less than 10 feet mean low water (MLW), and the width of the island varies from over a mile in the vicinity of the Florida Power and Light (FPL) power plant (R082) to less than 500 feet along the central portion of the study area (The Narrows of Hutchinson Island, R095).

There is no coastal armoring in the study area, with the exception of revetment in front of the FPL power plant, on the northernmost reach. This is due to the coastal construction control line (CCCL) Pursuant to Section 161.053, Florida Statutes, which restrict coastal armoring in St. Lucie County, unless specific triggers are met.

The biological communities found in the general project area are comprised of the sandy beach shoreline and the open waters of the Atlantic Ocean. The sand substrate is dominated by crustaceans, mollusks, and polychaete worms, in relatively low concentrations, typical of nearshore and surf zone sand habitats. Nesting sea turtles and shore/seabirds use the sandy beach shoreline within the project area. The nearshore waters of the project area are composed of sand bottom with mapped hardbottom resources. Additional hardbottom occurs north and south of the project area. Hardbottom habitats identified in the general nearshore project area are differentiated by the amount of relief above the general floor of the ocean and the number and density of flora and fauna inhabitants. This hardbottom habitat may serve as developmental and foraging habitat for juvenile sea turtles and essential fish habitat (EFH) for coral/hardbottom biota and reef fishes. The offshore project area is un-vegetated sand bottom at the southwest end of the St. Lucie Shoal complex. Typical inhabitants include relatively low densities of polychaete worms, bivalves, and nematodes, with some echinoids and small crustaceans.

There are 4 county parks within the study area (Normandy Beach, Dollman Park, Wavelands Beach, and Glascock Beach) which provide public parking and beach access.


2.2 NATURAL (GENERAL) ENVIRONMENT*

2.2.1 VEGETATION

EXISTING CONDITIONS

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 non-federal sponsor implemented a dune restoration/revegetation project in southern St. Lucie County (Coastal Tech 2009: Design Document). The dune system from R98 to R101.4 and from R103.3 to the St. Lucie/Martin County line was revegetated primarily with sea oats with occasional railroad vine, sea grapes, and sea purslane interspersed.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

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 the beach profile and displacing vegetation.

2.2.2 FISH AND WILDLIFE RESOURCES (OTHER THAN THREATENED AND ENDANGERED SPECIES)

EXISTING CONDITIONS

2.2.2.1 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. 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 R98 to R99, R107 to R109, and R112 to R2 and consist of primarily fine, unconsolidated sand substrate. 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.

2.2.2.2 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).

2.2.2.3 NEARSHORE HARDBOTTOM FISH ASSEMBLAGES

An investigation conducted during 2009 documented the fish assemblage associated with the nearshore hardbottom of the project area. 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. 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 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.

2.2.2.4 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.

2.2.2.5 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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Species that utilize the beach environment may decrease in number due to continued erosion of the beach and dune system in the future without-project condition. No changes to fish and wildlife resources that reside below the swash zone would occur in the future without-project condition.

2.2.3 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 2-1** as potentially occurring in St. Lucie County. Of the species listed in **Table 2-1**, 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, rufa red knot, and beach jacquemontia.

Table 2-1. Federally Listed Threatened and Endangered Species that May Occur in St. Lucie County, Florida, or marine environments.

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	-
Rufa Red knot	*Calidris canutus rufa*	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*	-
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

2.2.3.1 SEA TURTLES

EXISTING CONDITIONS

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.

NESTING HABITAT

Sea 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; personal communication, Beth Brost, FWC, March 2016).

Between 2011 and 2015, approximately 89.6% of the total sea turtle nests in the study area were loggerhead, followed by 9% green, and 1.4 % leatherback. During this time period, there were a total of 17,368 loggerhead, 1,745 green, and 280 leatherback sea turtle nests recorded in the study area for a grand total of 19,393 nests. The data are only for the survey period of 15 May - 31 August, and nesting does occur outside those dates (personal communication, Beth Brost, FWC, March 2016).

The study area has been delineated into four reaches, and these reaches overlap with the Index Nesting Beach Survey (INBS). Sea turtle nesting for each of these reaches is provided in **Figures 2-1, 2-2, 2-3 and 2-4.**

Figure 2-1. Sea turtle nesting data for North Hutchinson Island (R77 to R80, INBS Zones 13-14) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. The data are only for the survey period of 15 May - 31 August, and nesting does occur outside those dates. **Source Florida Fish and Wildlife Conservation Commission.**

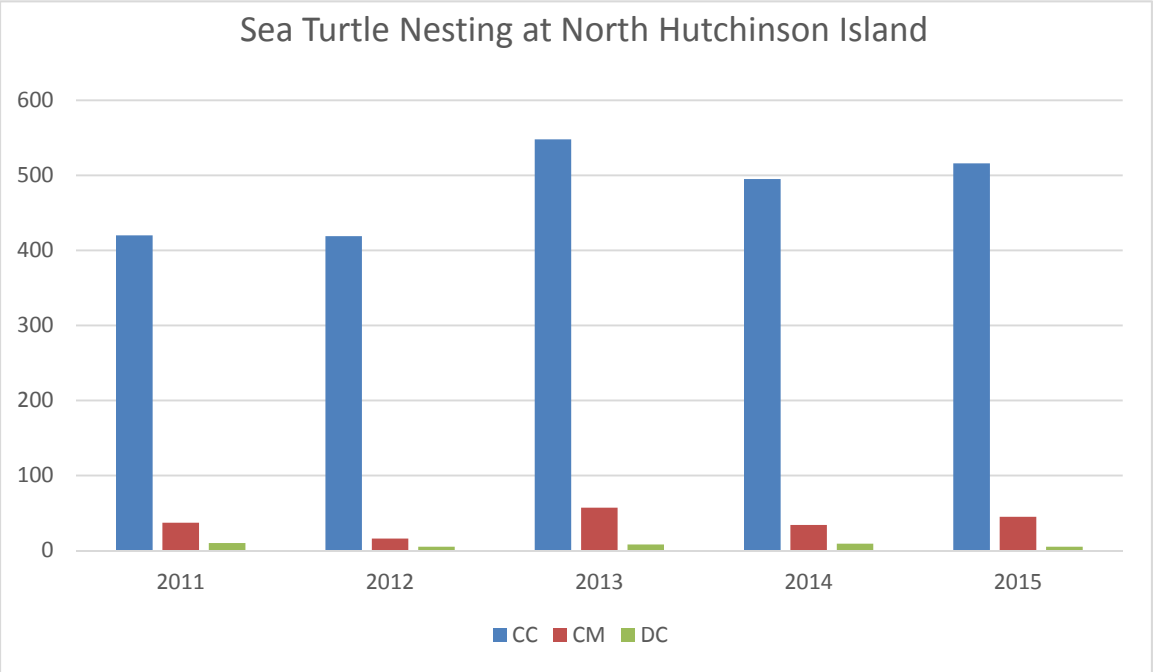


Figure 2-2. Sea turtle nesting data for Power Plant Area (R80 to R90, INBS Zones 15-17) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. Source Florida Fish and Wildlife Conservation Commission.

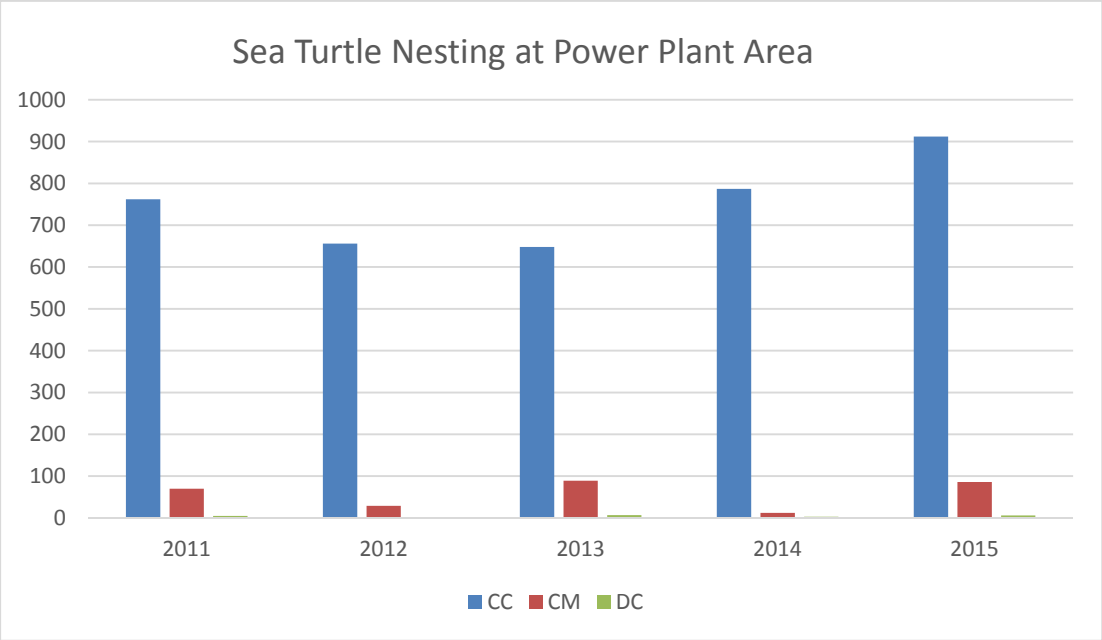


Figure 2-3. Sea turtle nesting data for Narrows of Hutchinson Island (R90 to R98, INBS Zones 18-20) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. **Source Florida Fish and Wildlife Conservation Commission.**

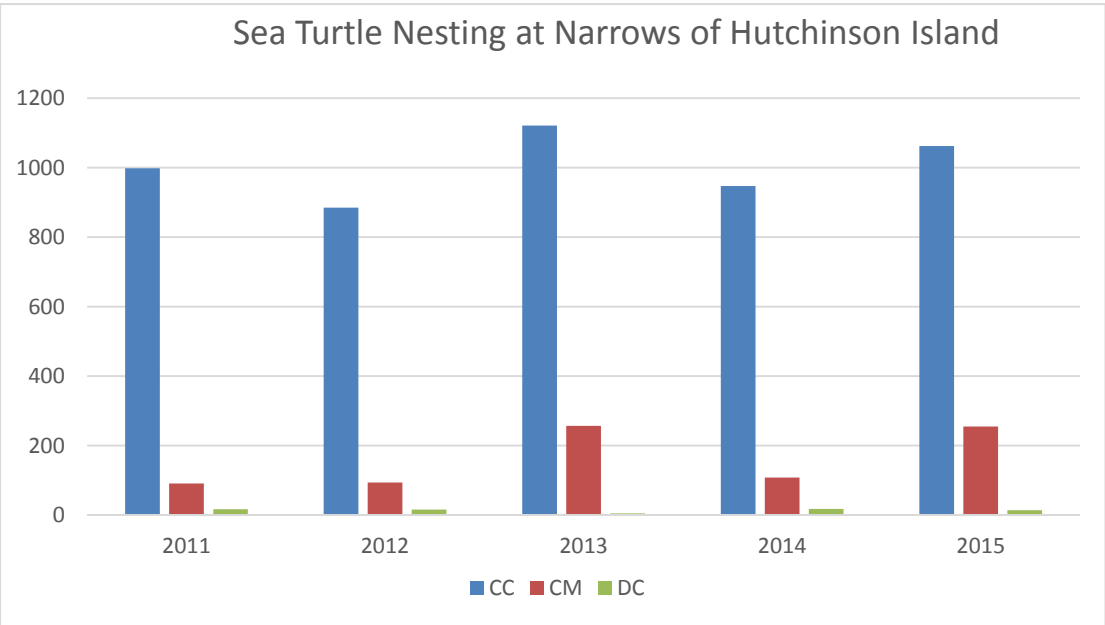
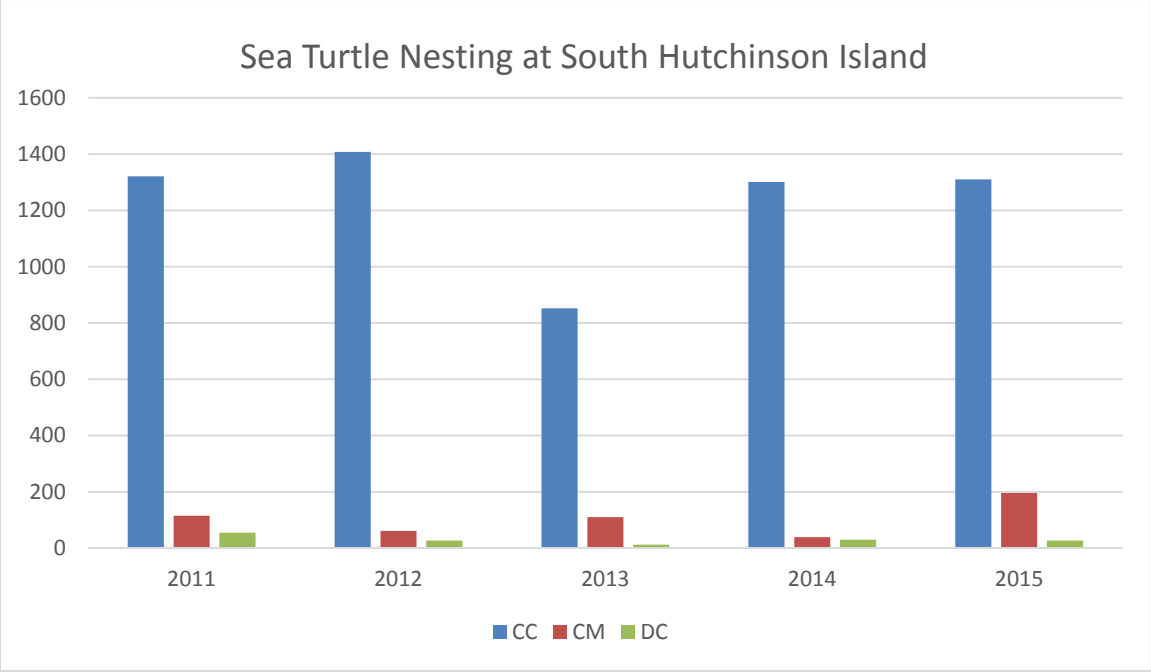


Figure 2-4. Sea turtle nesting data for South Hutchinson Island (R98 to R115 plus 1000 feet, INBS Zones 20-25) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. **Source Florida Fish and Wildlife Conservation Commission.**



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 2-6**). The table orders the several species from highest to lowest abundance.

Table 2-6. 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.

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). The study area beach lies within designated critical habitat unit LOGG-T-FL-09. Marine waters adjacent to the beach lie within designated nearshore reproductive and migratory critical habitat unit LOGG-N-18.

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).

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. There is no designated critical habitat for this species within the project area.

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).

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. There is no designated critical habitat for this species within the project area.

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, and g). There is no designated critical habitat for this species within the project area.

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, 2009 a, b, c, d, e, f, and g). Critical habitat has not been designated for this species.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the Future Without-Project Condition, the beach is predicted to continue to erode. This will reduce the shoreline area available for nesting sea turtles. It will also increase turtle nest vulnerability to storm washout, as nests would be located closer to the mean high water line. As adjacent shorelines are currently available for nesting, it is unknown whether the overall nesting would be affected. In addition to increased erosion, it is likely that the length of shoreline hardened by structures would increase. This could further decrease the area available for nesting sea turtles due to the fact that the hard structures

constructed would likely be seawalls and revetments (where permitted) that could negatively impact the width of beach available for nesting if not constructed in conjunction with beach nourishment.

2.2.3.2 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 2-7**). The table orders the several species by relative abundance (highest to lowest).

Table 2-7. 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.

FLORIDA MANATEE

EXISTING CONDITIONS

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, Non-Federal sponsor'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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the Florida manatee are not expected to be different from the Existing Conditions described above.

HUMPBACK WHALE

EXISTING CONDITIONS

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. Critical habitat has not been designated for this species.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the humpback whale are not expected to be different from the Existing Conditions described above.

NORTH ATLANTIC RIGHT WHALE

EXISTING CONDITIONS

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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the right whale are not expected to be different from the Existing Conditions described above.

2.2.3.3 SMALLTOOTH SAWFISH

EXISTING CONDITIONS

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. There is no designated critical habitat for this species within the project area.

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).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the sawfish are not expected to be different from the Existing Conditions described above.

2.2.3.4 PIPING PLOVER

EXISTING CONDITIONS

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). Ecological Associates, Inc. (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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The continued erosion of the shoreline in the proposed placement area may reduce some habitat that could potentially be utilized by the plover; however, the infrequent usage of this area by this species suggests that the Future Without-Project Conditions would be similar to the Existing Conditions with respect to the plover.

2.2.3.5 RUFA RED KNOT

EXISTING CONDITIONS

The rufa subspecies of the red knot (*Calidris canutus rufa*), listed as threatened, is a small shorebird that can occur along the Atlantic and Gulf coasts during migration. It is also known to overwinter in low numbers along both coasts. Florida is home to the largest concentration of wintering *rufa* in the United States, with the main concentration occurring in the greater Tampa Bay region (A.C. Schwarzer et al. 2012). In migration and winter, it prefers coastal mudflats, tidal zones, and sometimes open sandy beaches where it feeds on small invertebrates such as small mollusks, marine worms, and crustaceans (Kaufman 1996). The knot population has declined primarily due to reduced food availability from increased harvests of horseshoe crabs (USFWS 2015). Their numbers appear to have stabilized in the past few years, but they remain at low levels relative to earlier decades (USFWS 2015). Critical Habitat has not been designated for this species.

Red knots have been observed at Fort Pierce Jetty Park in St. Lucie County (St. Lucie Audubon 2014), and have also been known to occur in St. Lucie Inlet Preserve State Park (FDEP 2014). They may occasionally occur within the study area.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The continued erosion of the shoreline in the proposed placement area may reduce some habitat that could potentially be utilized by the knot; however, the infrequent usage of this area by this species suggests that the Future Without-Project Conditions would be similar to the Existing Conditions with respect to the knot.

2.2.3.6 BEACH JACQUEMONTIA

EXISTING CONDITIONS

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. Critical Habitat has not been designated for this species.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the Future Without-Project Condition, the upper beach and dune may continue to erode. This may reduce the habitat for jacquemontia.

2.2.4 HARDBOTTOM HABITAT

EXISTING CONDITIONS

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.

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). 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*.

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.

Field survey data were used to identify the hardbottom communities as Community One or Community Two. 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 (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.

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 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. 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 (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 R101, 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 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). 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 2-8** provides a synopsis of dominant hardbottom community components, ordered by relative abundance.

Table 2-8. 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, three scleractinian coral polyps were observed in one quadrat on one transect (R104.5). No scleractinian corals were observed in any quantitative or qualitative video transects. One octocoral was observed during the point count analysis of one transect (R78.7). Octocorals constituted less than 1% mean coverage along transect R78.7, which is outside the project area. One stony coral species (*Phyllangia americana*, cup coral) also constituted less than 1% mean coverage along transect R110.5, a transect that starts 188 m from the mean high water line and would not be affected by the project.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The quality of hardbottom habitat in the study area is not likely to be different from the existing conditions if the project were not constructed.

2.2.5 ESSENTIAL FISH HABITAT (EFH)

EXISTING CONDITIONS

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 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.

2.2.5.1 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 sargassum fish 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).

2.2.5.2 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. 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.

2.2.5.3 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.

2.2.5.4 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).

2.2.5.5 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.

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).

2.2.5.6 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).

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).

2.2.5.7 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. 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*.

2.2.5.8 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.

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, 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).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The quality of EFH in the study area is not likely to be different from the existing conditions if the project were not constructed.

2.2.6 OFFSHORE BORROW AREA RESOURCES

EXISTING CONDITIONS

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. 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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions of the offshore borrow area resources are not expected to be different from the Existing Conditions described above. However, the borrow area may be used for other projects.

2.2.7 COASTAL BARRIER RESOURCES

EXISTING CONDITIONS

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 2-1**).

The May 27, 2009 FWS CBRA Consistency Determination letter (**Appendix H**) describes the project area CBRS Unit P-11 as follows:

> This area 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 beaches of St. Lucie County support the fifth highest nesting density of sea turtles in Florida.

Figure 2-5. CBRS Unit P-11 (Hutchinson Island), St. Lucie County South Beach and Dune Restoration Project.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions of the CBRS unit are not expected to be different from the Existing Conditions described above.

2.2.8 WATER QUALITY

EXISTING CONDITIONS

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 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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The water quality in the study area is not likely to change from the Existing Conditions in the Future Without-Project Conditions.

2.2.9 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

EXISTING CONDITIONS

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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The absence of hazardous or toxic wastes in the study area is not likely to change from the Existing Conditions in the Future Without-Project Conditions.

2.2.10 AIR QUALITY

EXISTING CONDITIONS

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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The air quality in the study area is not likely to change from the Existing Conditions in the Future Without-Project Conditions.

2.2.11 NOISE

EXISTING CONDITIONS

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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

While the area may experience a slight decrease in tourist activity, noise levels in the study area are not likely to change significantly from the Existing Conditions in the Future Without-Project Conditions.

2.2.12 AESTHETIC RESOURCES

EXISTING CONDITIONS

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 R90 and R100. From R103 to R109, the slightly accreted beaches advanced slightly seaward.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The aesthetics of the study area are anticipated to decline in the Future Without-Project Condition due to increased erosion and the continued narrowing of the beach.

2.2.13 RECREATION RESOURCES

EXISTING CONDITIONS

Beaches within the project area are somewhat less congested than other nearby beaches due to limited public beach access points (there are five throughout the study area from R77 to the Martin County line) 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.

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.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The recreational usage of the study area is anticipated to decline in the Future Without-Project Condition due to increased erosion and the continued narrowing of the beach, which will make it less suitable for recreating.

2.2.14 CULTURAL RESOURCES AND HISTORIC PROPERTIES

EXISTING CONDITIONS

All portions of the proposed project area, including the offshore borrow area and the sand placement template have been subjected to cultural resource surveys. New South Associates conducted a Phase I cultural resources survey of the sand placement area in October 2007 (Smith et al. 2008). The survey extended from the Martin/St. Lucie County line to approximately 0.5 miles north of the Florida Power and Light (FPL) Nuclear Power Plant and included the area currently under review. The Phase I survey consisted of background research, surface reconnaissance, systematic shovel testing, metal detection in areas adjacent to recorded locations of historic shipwrecks, artifact identification and analysis, and report preparation. Background research indicated that all previously recorded historic and prehistoric sites are located outside of the current project area — on or west of the back dune along or west of U.S. A1A. No cultural resources were identified as a result of the surface and sub-surface testing.

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 report recommended a finding of no effect on cultural resources listed or eligible for listing in the National Register of Historic Properties (NRHP), and recommended no further investigation of the project area. The State Historic Preservation Office (SHPO) reviewed the survey report and concurred with the final report findings and recommendations in a letter to the Corps dated 27 July 2010 (DHR File No. 2008-02141-B) (**Appendix H**).

A remote sensing survey of the proposed offshore borrow location was conducted by SEARCH between October 2007 and June 2008 (Krivor 2008). An additional remote sensing survey of a portion of the proposed shoal borrow area not previously investigated was also conducted by SEARCH in December 2010 (Krivor 2010). These surveys utilized a magnetometer, side scan sonar, and sub bottom profiler to identify any potentially significant submerged cultural resources. In addition to the remote sensing surveys, SEARCH conducted a refinement survey of reported wreck sites near the project area, including the *America* (8SL28) and the *Halsey* (8SL30).

SEARCH identified one cluster of magnetic anomalies associated with side scan sonar imaging within the project area. The cluster of magnetic targets are unidentified; however, the magnetic signature suggests these targets may represent a potentially significant submerged cultural resource (Krivor 2008). The *Halsey* was relocated outside of the current borrow area; however, the *America* was not relocated as a result of the remote sensing survey, and is believed to be south of the coordinates provided by the Florida Master Site File. No potentially significant submerged cultural resources were identified as a result of the 2010 SEARCH survey.

The remote sensing surveys recommended that the project avoid submerged cultural resources during dredging by utilizing a buffer zone around the cluster of magnetic anomalies and recommended no further investigation of the area. Based on these recommendations, the proposed project was determined to have no effect on cultural resources listed or eligible for listing in the NRHP. The SHPO reviewed both reports and issued letters dated 20 January 2011 concurring with the report findings and recommendations (DHR File No. 2011-00114 and 2011-00231) (**Appendix H**).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of cultural resource are similar to the existing conditions described above. Selection of the No-action alternative would have no effect on cultural resources listed or eligible for listing in the NRHP.

2.2.15 NATIVE AMERICANS

EXISTING CONDITIONS

No portion of the proposed project area exists within or adjacent to known Native American-owned lands, reservation lands, or Traditional Cultural Properties. However, Native American groups have lived throughout this region in the past, and their decedents continue to live within the State of Florida and throughout the United States. Pursuant to Section 106 of the National Historic Preservation Act (16 USC 470), obligations regarding the Corps' Trust Responsibilities to federally-recognized Native American Tribes, and in consideration of the Burial Resources Agreement between the Corps and the Seminole Tribe of Florida, prior consultation on the project has not indicated any historic use of the project area, although it certainly remains possible. Consultation with the appropriate federally-recognized tribes is ongoing and will be updated prior to project implementation.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of Native American groups are similar to the existing conditions described above. Selection of the No-action alternative would have no effect on Native American groups.

2.2.16 PUBLIC SAFETY

EXISTING CONDITIONS

Issues of public safety along the beach placement area principally include those typically associated with beach- and water-related recreation, including sun exposure and injuries or drowning from high surf or run-outs. The submerged rock outcrops in shallow water along the shoreline can also result in injuries to bathers. Most public beach parks are staffed by County or municipal lifeguards during periods of normal to high beach use. Crime and related activities are of a low to moderate nature and are not considered to be of a significant nature.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The public safety of the study area is not anticipated to significantly change in the Future Without-Project Condition; however, due to increased erosion and the continued narrowing of the beach, the number of people recreating on the beach is expected to decline and this may affect public safety statistics for this area.

2.3 PHYSICAL ENVIRONMENT (CONDITIONS)

The study area consists of an open sandy coast subject to frequent storm events. Adjacent properties to the shoreline can be categorized as urban and include residential, commercial, and recreational properties. Many factors influence the coastal processes characteristic to the St. Lucie County, Florida shoreline. Factors include winds, tides, currents, waves, storm effects, and sea level rise. Human-related (anthropogenic) factors include other shore protection projects, navigation projects, and development. The role of each of these factors and their contribution to beach erosion in St. Lucie County are briefly described in the following paragraphs.

2.3.1 STUDY REACHES

EXISTING CONDITIONS

The area has been delineated into four reaches. The Florida Department of Environmental Protection (FDEP) has designated four erosion reaches in St. Lucie County. The FDEP defines a critically eroded area as "a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost". The reaches are discussed below:

- North Hutchinson Island (R77 to R80): This reach is approximately .57 miles long, with an average erosion rate of -1.8 feet per year. There is no development in this reach and it is entirely within the CBRS unit. This reach is designated as non-critically eroded by FDEP.
- Power Plant Area (R80 to R90.3): This reach is approximately 1.9 miles long, with an average erosion rate of +0.06 feet per year. The only structure in the reach is the Florida Power and Light (FP&L) Nuclear Power Plant. With the exception of the power plant, the remainder of the reach is entirely within the CBRS unit. This reach is designated as critically eroded by FDEP.
- Narrows of Hutchinson Island (R90 to R98): This reach is approximately 1.5 miles long and the average erosion rate is -1.0 feet per year. The area consists of low development within the CBRS unit, with the exception of one excluded area with one condominium development. This reach is designated as non-critically eroded by FDEP.

- South Hutchinson Island (R98 to R115 plus 1000 feet): This reach is approximately 3.4 miles long and the average erosion rate is -.4 feet per year. There is a small CBRS unit which ends 600 feet south of R98, begins again at roughly R101.5 to R103.5 (Dollman Park), and then ends for the remainder of the reach. This reach is designated as critically eroded by FDEP.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The reaches will generally remain the same in the future without-project condition.

2.3.2 GEOLOGY

EXISTING CONDITIONS

South Hutchinson Island is part of a chain of sandy barrier islands separated by narrow inlets from Cape Canaveral to Palm Beach. These barrier islands rarely exceed one mile in width or 20 feet in elevation. Separating South Hutchinson Island form the mainland is the Indian River, a shallow lagoon, approximately 2 miles in width. During high seas and storms, the island may be overwashed by the sea, which spreads the sands into the lagoon, forming a fan or delta shape.

Offshore of the beaches and modern barrier islands is the continental shelf. It is a broad, shallow, low relief shelf that extends from 80 miles offshore near Jacksonville, to only a few miles offshore near Miami. The shelf contains relic Pleistocene and Holocene terraces and submerged beach sand ridges. The wave climate and sediment transportation system creates a linear sandy coastline.

The east coast of Florida, from the state line at the Georgia border to Miami Beach (350 miles), consists of a series of sandy barrier islands broken occasionally by inlets. The barrier islands are characterized by dunes and shore parallel beach ridges. Many of the islands display relic beach ridges formed during higher stands of sea level. The barrier islands often have a distinctive drumstick-shape with an accreting bulbous end and a slender eroding end. These barrier islands were formed from waves and longshore currents reworking marine and fluvial sediments. Lagoons and marshes are typically located between the barrier islands and the mainland.

The quartz component of the modern barrier island sand was deposited from sand migrating southward along the Atlantic coast, from the reworking of the Pamlico Sand that was previously deposited over the entire region. The remaining component of coastal sediments are typically carbonates, locally produced by calcite-producing plants and animals. Additional carbonate materials are from reworked materials from outcropping Pleistocene formations offshore (Duane and Meisburger, 1969).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The geology in the future without-project condition would be expected function and/or change according to the conditions described above.

2.3.3 NATIVE BEACH

EXISTING CONDITIONS

The native beach on South Hutchinson Island was sampled by Coastal Tech in February 2007 to characterize the recent native beach sediments and assess compatibility with the potential sand source material. The project beach area has not previously been nourished. Sixty (60) native beach sediment samples were obtained from R77, R80, R85, R90, R95, R98, R100, R105, R110, and R115. Samples were collected from the toe of dune, mid-berm, mean high water, mean low water and near the -3 foot contour. Samples were obtained from approximately 5" below the surface (Coastal Tech, 2010). Gradation analysis was performed using 20 sieves ranging from ¾-inch to No. 230 at ½ phi intervals, including the No. 4 and No. 200 sieves. Compositional analyses through Loss on Ignition, as well as Munsell color analysis were performed. These data show that, in 2007, the native South Hutchinson Island beach consisted of light gray to very pale brown, moderately to poorly sorted, medium grained sand with 50% carbonate. More details can be found in the **Geotechnical Appendix**.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of the native beach are similar to the existing conditions described above.

2.3.4 SAND SOURCES

EXISTING CONDITIONS

Several offshore sand sources were investigated in 2006 by Coastal Planning & Engineering; However, St. Lucie Shoal is the main area of focus for this report. The shoal is located in Federal water, approximately three to seven miles offshore of the study area**,** and is comprised of two main parts: the North St. Lucie Shoal and the South St. Lucie Shoal. The North St. Lucie Shoal covers an area of approximately 2 square miles and contains approximately 8.3 million cubic yards of beach-quality material. The South St. Lucie Shoal sand source covers an area of approximately 1.2 square miles. The South St. Lucie Shoal contains approximately 2.3 million cubic yards of beach-quality material.

In general, the beach-quality material encountered within the St. Lucie Shoal consists of olive brown to olive gray, fine to medium-grained skeletal sand with few to some fine-grained quartz and few to some gravel-size shell. More details can be found in the **Geotechnical Appendix.**

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future, it is possible that this sand source could be mined for sand by another agency or for another Federal project. However, at this time, there are no plans to use it.

2.3.5 SHORELINE CHANGE AND EROSION RATES

EXISTING CONDITIONS

Due to a combination of geographic and natural factors, the St. Lucie County shoreline experiences regions of both erosion and accretion. Based on all available survey data (January 1970 to August 2008), the northern (less developed) portion of the project (R77 to R99) experiences an annual erosion rate of -0.31 feet per year, while the southern (significantly developed) portion of the project (R100 to R115) experiences an annual erosion rate of -0.18. The most developed, southernmost portion of the project which is not in the CBRS unit (R104 to R115) has experienced an average annual erosion rate of -0.12 feet per year during this time period. Overall, the project area (R77 to R115), has fairly uniform erosion as a whole with an annual erosion rate of -0.26 feet per year.

Prior to the 2004 hurricane season, the northern and southern portions of the project experienced an average annual shoreline change rates of +0.18 feet per year and -0.36 feet per year, respectively. The southernmost portion of the project had an annual shoreline change rate of -0.38 feet per year for the same time period. The overall average annual erosion rate for the same time period was -0.04 feet per year. This indicates that prior to the impact of severe storms, the northern portion of the project experienced mild accretion while the southern portions of the project have been historically erosional.

Both the north and south portions of the project experienced dramatic erosion due to the 2004 and 2005 storm seasons. This has been followed by significant post-storm recovery.

Shoreline erosion is detailed further in the **Engineering Appendix**.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project shoreline profile is assumed to be the 2008 profile (see explanation earlier in this chapter), with erosion until the base year of 2020, and forecasted out to 2070. The shoreline should experience similar rates of erosion and accretion in the future without-project condition as described in the existing conditions section above.

2.3.6 WINDS

EXISTING CONDITIONS

Local winds in the project area are the primary means of generating the small-amplitude, short period waves which are the primary mechanisms of daily (non-storm related) sand transport along the south-central Florida shoreline.

Predominant winds from the east-southeast quadrant are generally mild in nature and occur in the spring and summer months. Elevated wind speeds from the north-northeast quadrant in fall and winter months occur during passage of nor'easters which can cause extensive beach erosion and shorefront damage. Occasionally the area is impacted by the passage of tropical storms that can generate devastating winds, waves, and storm surge, which can cause direct damage to coastal structures and infrastructure.

The **Engineering Appendix** provides additional detail on winds.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of winds are similar to the existing conditions described above.

2.3.7 WAVES

EXISTING CONDITIONS

The wave energy dissipation that occurs as waves enter the nearshore zone and break is the principal driver for sediment transport. Wave height, period, and direction, in combination with tides and storm surge, are the most important factors influencing the behavior of the beach and dune system.

The St. Lucie County study area is exposed to open-ocean swells originating from north-northeast to just north of due east. Open-ocean swells originating from south of due east are blocked by two large shoals north and west of the Bahamas known as the Little Bahama Bank and the Great Bahama Bank, respectively. Water depths across the Bahama Banks average about 30 feet, so longer-period swells are reduced or eliminated by bottom friction or the presence of land masses as they traverse the Bank. The minimum fetch between the western edge of the Banks and the St. Lucie County study area is about 65 miles, which allows ample distance for the generation of shorter-period wind waves in the deep waters of the Florida Straits. During severe storm events such as hurricanes and tropical storms, high wind velocities can generate large, damaging waves over the relatively short distance between the Bahamas and Florida.

The project area experiences daily (non-storm related) sediment transport due to typical seasonal wave conditions. This results in variable, generally low level, rates of erosion and accretion dependent on incident wave direction and intensity. Prolonged periods of daily erosion can lead to the undermining of structures and roads over time. However, the main cause of damage to the St. Lucie County shoreline and upland development are the large storm waves which are produced primarily by tropical disturbances, including hurricanes, and by fall/winter “northeasters”.

The study area is exposed to the open ocean toward the northeast. This orientation makes the coastline vulnerable to wave attack from distant storms as well seasonal conditions. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast will produce large swells which are capable of causing erosion along the St. Lucie County shoreline.

The Engineering Appendix provides additional detail on waves.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of waves are similar to the existing conditions described above.

2.3.8 ASTRONOMICAL TIDES

EXISTING CONDITIONS

Astronomical tides are created by the gravitational pull of the moon and sun and are well understood and predictable in magnitude and timing. The National Oceanic and Atmospheric Administration (NOAA) regularly publishes tide tables for selected locations along the coastlines of the United States and selected locations around the world. These tables provide times of high and low tides, as well as predicted tidal amplitudes.

Tides in the St. Lucie County area are semidiurnal: two high tides and two low tides per tidal day (24 hours 50 minutes). Two measures of tidal range are commonly used: the mean tide range is defined as the difference between Mean High Water (MHW) and Mean Low Water (MLW), and represents an average range during the entire lunar cycle (27.3 days). The range of tidal elevations between successive high and low tides is typically greater at any location during periods of a new or full moon. The spring tide range is the average semidiurnal range which occurs semimonthly when the moon is new or full.

Tide ranges are relatively low along the St. Lucie County region of Florida's east coast. The nearest tide station to the study area is NOAA Tide Station #8722212, located at the Ft. Pierce Inlet south jetty, about 12 miles north of the center of the study area. The mean tide range at this station is found to be 2.56 feet and the spring tide range is 3.59 feet (based on 2010 averages).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of tides are similar to the existing conditions described above.

2.3.9 CURRENTS

EXISTING CONDITIONS

The primary ocean current in the project area is the Florida Gulf Stream. With the exception of intermittent local reversals, it flows northward. The average annual current velocity is approximately 28 miles per day, varying from an average monthly low of 17 miles per day in November to an average monthly high of approximately 37 miles per day in July. The Gulf Streams lies approximately 25 miles offshore of the project area.

The near-shore currents in the project vicinity are not directly influenced by the Gulf Stream, but may be influenced indirectly via interaction with incident waves. Littoral currents affect the supply and distribution of sediment on the sandy beaches of St. Lucie County. Longshore currents, induced by oblique wave energy, generally determine the long-term direction and magnitude of littoral transport. Cross-shore currents may have a more short term impact, but can result in both temporary and permanent erosion. The magnitude of these currents is determined by the wave characteristics, angle of waves from offshore, local tides, configuration of the beach and the nearshore profile. For St. Lucie County beaches, the net sediment transport is from north to south.

Influence of Ft. Pierce Inlet and St. Lucie Inlet ebb and flood currents on local currents is negligible. In both cases the distance between the inlet and the project area (8 miles and 7 miles, respectively) places the study area outside the influence of inlet tidal fluctuations.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of currents are similar to the existing conditions described above.

2.3.10 STORM EFFECTS

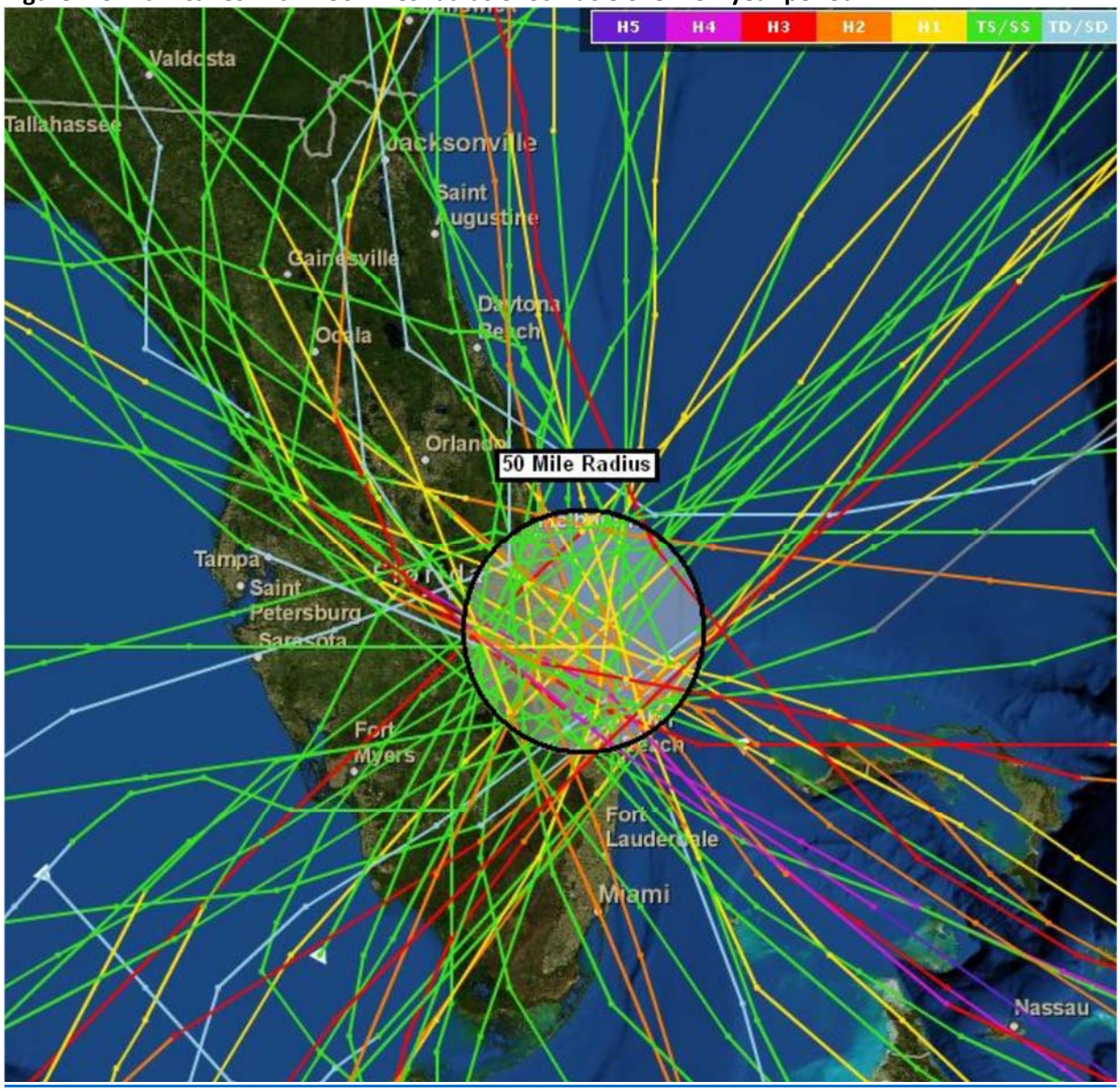
EXISTING CONDITIONS

The study area is located in a region of considerable hurricane activity, resulting in relatively frequent hurricane impacts.

Figure 2-6 shows historic tracks of hurricanes and tropical storms from 1851 to 2010, as recorded by the National Hurricane Center (NHC) and available from the National Oceanic and Atmospheric Administration. The circle in the center of this figure indicates a 50 mile radius from the center of the study area. Based on NHC records, 55 hurricanes and tropical storms have passed within this 50-mile radius over the 154-year period of record. Statistically, an average of one storm every 2.8 years.

The 50-mile radius was chosen for display purposes because any tropical disturbance passing within this distance, even a weak tropical storm, would be likely to produce some damage along the shoreline. Stronger storms are capable of producing significant damage to the coastline from far greater distances. For example, Hurricane Andrew made landfall in southern Dade County in 1992 as a Category 5 storm. This storm produced significant coastal erosion along St. Lucie County, over 120 miles north of the storm track.

Figure 2-6. Hurricanes within 50 miles radius of St. Lucie over 154-year period.



In recent years, a number of named storms have significantly impacted the project area, including hurricanes Mitch (1998), Irene (1999), and Tropical Depression #4 (2000). However, the most severe storm events in recent years are due to the multiple storms of the 2004 and 2005 hurricane seasons. In August 2004 the study area was impacted by hurricane Charley, followed by Hurricanes Frances, Jeanne, Ivan, and a strong northeaster in September 2004. Of these storms, Hurricanes Frances and Jeanne were considered to be 100-year storm events, and caused considerable erosion along this coastline. Hurricanes Frances and Jeanne made landfall only three weeks apart and within 2 miles of each other. This season marked the first time that Florida (or any individual state) has been impacted by four hurricanes in one tropical season since weather records began in 1851. In 2005 the St. Lucie County area was again

impacted, by Hurricanes Dennis (July), Katrina (August), Ophelia (September), Rita (September), and Wilma (October).
Damages to hurricane/shore protection projects from these combinations of storms in 2004 and 2005 included substantial erosion and damage from wind, wave, and water action beyond that which would ordinarily be expected by an individual storm. This is due, in part, to the fact that protective beach fill initially moved offshore by a storm did not have ample time to return onshore before the beach was impacted by the next storm. The large size of these hurricanes also contributed to damage levels along the St. Lucie County coastline as several storms inflicted damages far from their landfall points.

Since the study area is exposed to the open ocean toward the northeast, the coastline is vulnerable to wave attack from distant storms as well. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast are capable of producing large swells which are capable of causing erosion along the study area, within the St. Lucie County shoreline.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of storm effects are similar to the existing conditions described above.

2.3.11 STORM SURGE

EXISTING CONDITIONS

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure which accompanies storms also contributes to a rise in water surface elevation. The combination of extremely high wind velocities coupled with low barometric pressures (such as those experienced in tropical storms, hurricanes, and very strong northeasters) can produce very high, damaging water levels. In addition to wind speed, direction and duration, storm surge is also influenced by water depth, length of fetch (distance over water), and frictional characteristics of the nearshore sea bottom. An estimate of storm surge is required for a complete assessment of shoreline response and coastal storm risk. An increase in water depth may increase the potential for coastal flooding and allow larger waves to attack the shore.

The study area is a low, flat barrier island and is particularly susceptible to overtopping from storm surges. Topographic surveys show that much of the island is less than 5 feet in elevation. Maximum elevations of 10-15 feet occur, but are almost exclusively along the oceanfront dune line. A series of existing hurricane storm-surge maps have been produced by the Florida Division of Emergency Management of all of Florida's coastal counties.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of storm effects are similar to the existing conditions described above.

2.3.12 SEA LEVEL CHANGE

EXISTING CONDITIONS

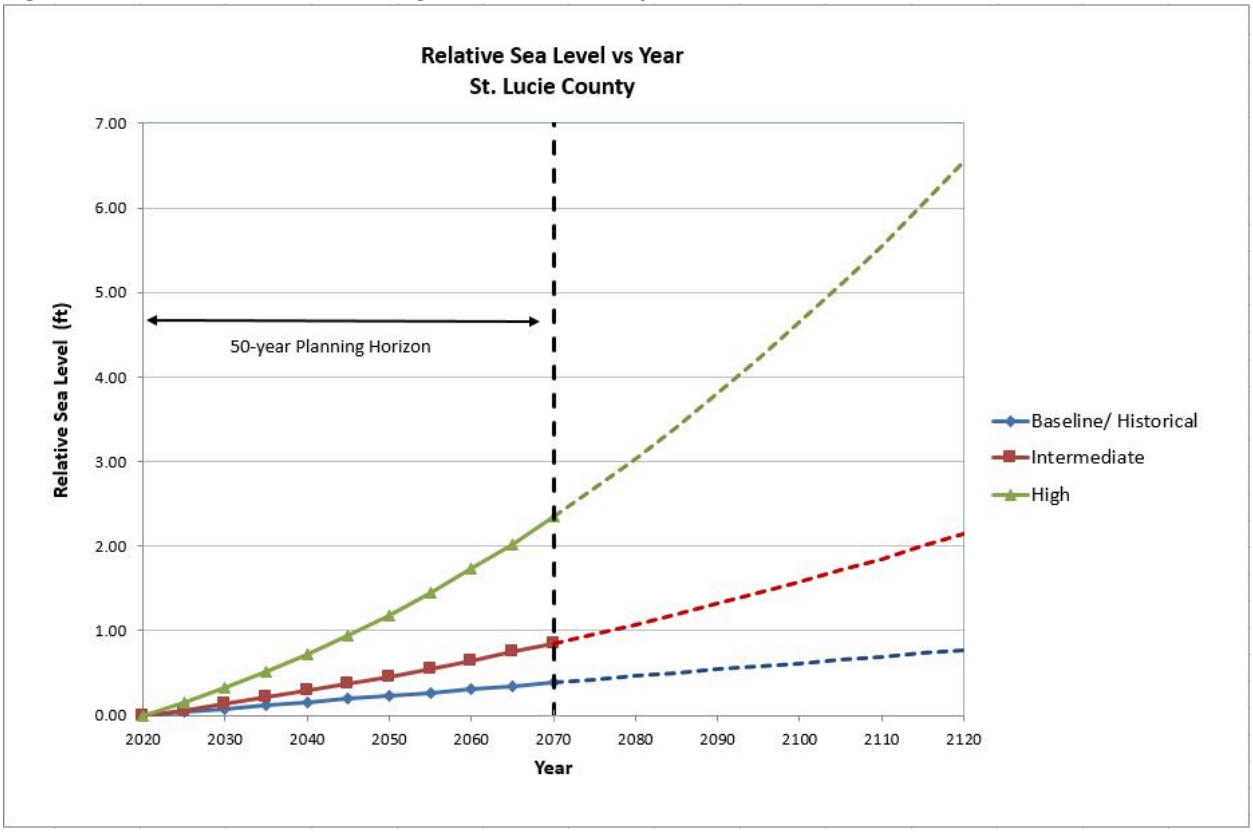
It is anticipated that the global mean sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form of Engineering Regulation, ER 1100-2-8162 and Engineering Technical Letter (ETL) 1100-2-1. Three estimates are required by the guidance, a Baseline (or "Low") estimate, which is based on historic sea level rise and represents the minimum expected sea level change; an Intermediate estimate; and a High estimate representing the maximum expected sea level change.

The study area is located approximately 101 miles from the NOS gage #8723170 at Miami Beach, Florida, and approximately 132 miles from NOS gage #8721120 at Daytona Beach Shores, Florida. Due to the distance, the historic sea level change at St. Lucie was approximated by a linear interpolation between the Miami and Daytona gages. The resulting averaged historical sea level change rate for St. Lucie County then equals 2.36 mm/yr. Given a project base year of 2020 a table of sea level change rates was produced for each of the three required scenarios through the 50-year planning horizon and up to the year 2120. Additional detail on sea level change is provided in the Engineering Appendix.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Figure 2-7 provides a graphic representation of the three levels of projected future sea level change over a 100-year period. The project area can expect to see sea level rise 0.04 to 2.2 feet above its current position within the 100-year planning horizon as predicted by the low and high sea level change rates, respectively.

Figure 2-7. Relative sea level change, St. Lucie County, FL.

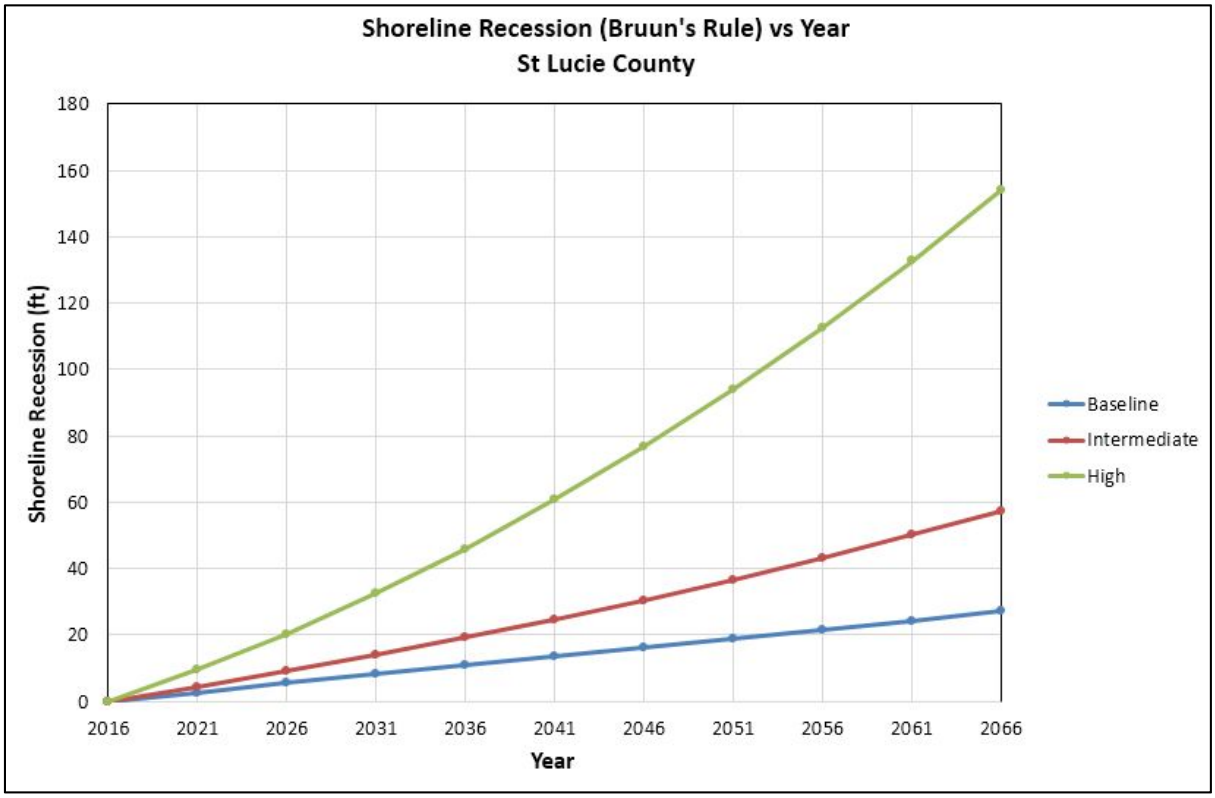


2.3.12.1 SHORELINE CHANGE RESULTING FROM SEA LEVEL RISE

An estimate of the rate of shoreline recession can be based on the local rate of sea level change in some cases. With a change in sea level, the beach profile will attempt to reestablish the same bottom depths relative to the surface of the sea that existed prior to sea level change. That is, the natural profile will be translated upward and shoreward to maintain equilibrium. If the longshore littoral transport in and out of a given shoreline is equal, then the quantity of material required to re-establish the nearshore slope must be derived from erosion of the shore.

The above estimation is applicable to long straight sandy beaches with an uninterrupted supply of sand and should only be used for estimating long-term changes. Additional detail is given in the **Engineering Appendix. Figure 2-8** provides an estimate of the potential shoreline changes within the project area attributable to projected changes in sea level.

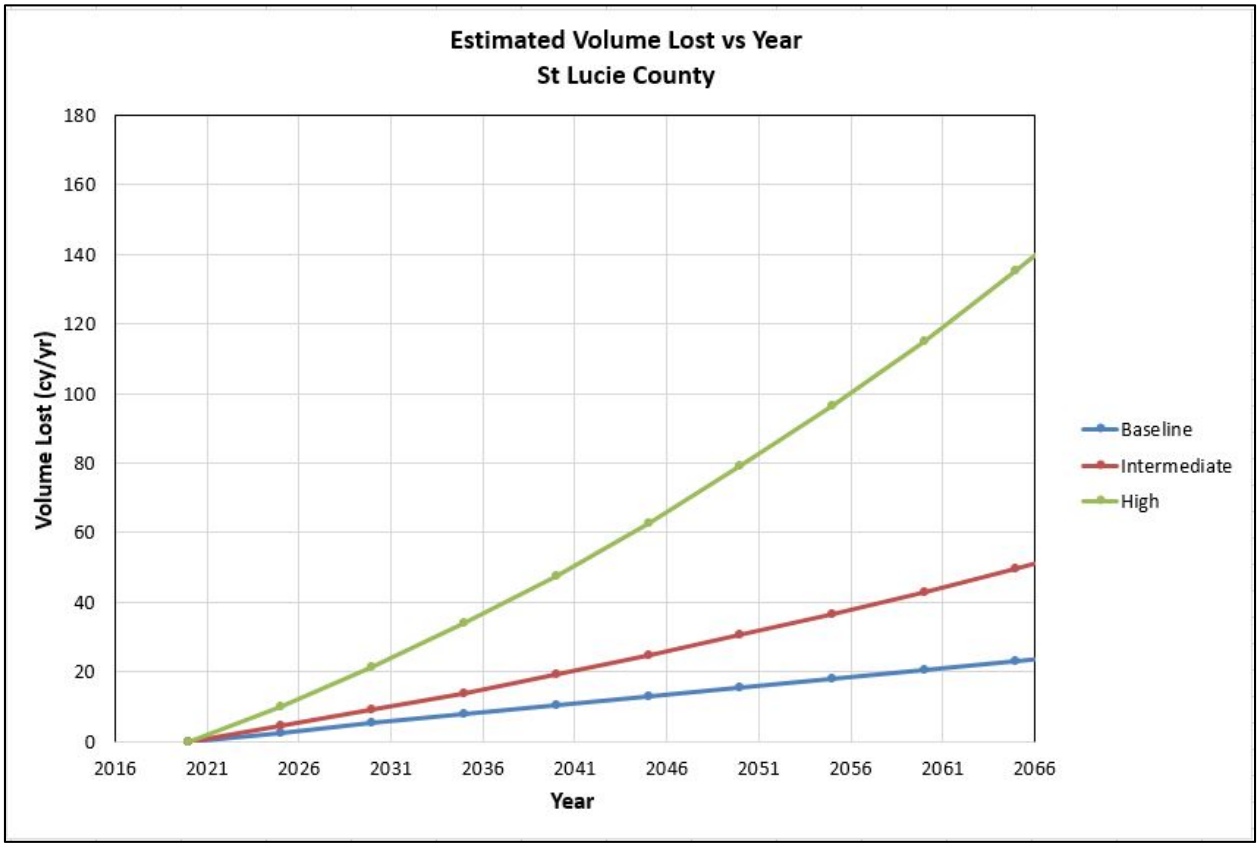
Figure 2-8. Estimated shoreline recession rate due to sea level rise.



2.3.12.2 VOLUMETRIC CHANGE RESULTING FROM SEA LEVEL RISE

Engineering Manual (EM) 1110-2-3301 (USACE, 1995) gives guidance on how to calculate beach volume based on berm height, depth of closure, and translation of the shoreline (in this case, shoreline recession). **Figure 2-9** provides an estimate of the shoreline volume loss as a result of the three Sea Level Rise scenarios.

Figure 2-9. Estimated volume lost per year due to sea level rise.



2.3.12.3 INCORPORATION OF ER 1100-2-8162 AND ETL 1100-2-1: GUIDANCE FOR SEA LEVEL CHANGE

The Sea-Level Change (SLC) Engineering Technical Letter (ETL) 1100-2-1 supporting ER 1100-2-8162, suggests a tiered analysis to determine the risk of potential SLC and resulting incorporation into the plan formulation process. Incorporation of potential SLC into the USACE Planning process will require active focus on risk-based scoping to define pertinent needs, opportunities, and the appropriate level of detail for conducting investigations. In particular, close attention is needed at the beginning of each study in order to screen planning/scoping decisions. The tiered analysis for SLC is incorporated into the 6-step planning process used in this report. Mean Sea Level (MSL) is used as an elevation reference in this section of the report as it is generally more intuitive for readers when describing changes to existing water elevations.

In order to evaluate SLC impacts to infrastructure, critical resources, and the population residing in the study area, a qualitative matrix was developed in **Table 2-2,** which evaluates the resources on which the study area depends. Resources evaluated in the matrix were based on those identified by the USACE Coastal Systems Portfolio Initiative (CSPI). CSPI describes the resource risk in a project area relative to the density of the resource, the population density that the resource serves, or in the case of environment/habitat and recreation, the value placed on the resource. See http://navigation.usace.army.mil/CSPI for more information. The evaluation criteria shown in the table is from, *Technical Review of Coastal Projects: Storm Risk Management, Navigation and Ecosystem Restoration for Nation's Coastlines* (USACE, Spring 2012.)

In addition to the CSPI evaluation criteria, **Table 2-2** evaluates the vulnerability to resources from potential SLC, or Sea Level Rise (SLR) in the case of the study area. Averaging the "Vulnerability from SLR" to resources gives an average of 1.7, equating to a low to medium overall resource vulnerability within the 50 year period of analysis.

Table 2-2. Qualitative Matrix describing vulnerability of resources from potential accelerations in SLC.

Resource	Risk Rating from CSPI - Value or density of resource or dependent population (3=high, 2=med, 1=low, x=none present)	Description	Vulnerability from SLR (3=high, 2=medium, 1=low, x =none present)	Description
Residential/Commercial Structures	2	Mostly residential (condominiums). Most ground floor elevations of structures are built on the existing ground level elevation, roughly 4.5 feet NAVD88. Most ground floor elevations with the Tentatively Selected Plan (TSP) area are approximately 4.5 feet NAVD88.	2	Projected high SLC would place Mean Sea Level (MSL) near infrastructure within the 50 year year planning horizon. Typical storm tide expected in the 50 year planning horizon was reported to be +8.6 feet NAVD88 (FDOT, 2003). This indicates that the high SLR scenario combined with the potential 8.6 foot of storm tide could reach the top of the dune.
Environmental and Habitat	3	Beach/dune habitat. Fairly narrow steep beach backed by dune which averages 11.5 feet high NAVD88.	2	Beach berm and dune system is located between 5 and 11.5 feet NADV88 throughout the study area. Sub aerial habitat is located thorought this system.
Infrastructure (roads, water/sewer lines, boardwalks, navigation structures)	2	Water/sewer lines, septic tanks, and dune walkovers exist. State Road A1A is located at an average of 5 feet NAVD88 throughout the study area and TSP area. Most other infrastructure would not be impacted until water level, including storm surge, reached above this point.	1	See explanantion for State Road A1A in Eveacuation routes. Other infrastructure is located at or above this elevation is also adequately elevated. Wooden boardwalks have portions lower than this elevation and are more subject to damage. However, they are not high value or critical infrastructure.
Critical Facilities (police, fire, schools, hospitals, and nursing homes)	3	FPL Power Plant is located in northern portion of study area; however, it is not within the TSP area.	2	The most critical facility (FPL) is elevated 20 feet and would remain above MSL under any SLC scenario. Additionally, the power plant is not in the TSP area.
Evacuation routes	3	State Road A1A is the main north/south evacuation route, located approximately 5 feet NAVD88 within the TSP area.	2	State road A1A is set back from the shoreline by a mininum of approx. 350 feet. In the TSP area, in some locations it is roughly midway between the ocean side and marsh side; in other areas, it is buffered by both the offset to the shoreline and marsh. It could be potentially affected under the high SLC scenario past the 50 year horizon, or as a result of the high storm tide plus high SLC on the ocean side towards the end of the 50 year planning horizon.
Recreation	3	Reasonable recreational use of beaches.	1	Beach berm is between 5 and 11.5 feet NAD88 throughout the study area. Recreational use of beach is high around public access points.
		Average =	1.7	Low to Medium Vulnerability

Upland elevations within the study area (Atlantic Ocean side of the island) average approximately 4.5 ft-NAVD88. These uplands are fronted by a dune system with an average elevation of 11 ft-NAVD88 over a majority of the project area (R98 to R111). South of R111 (R112 to the county line), however, the average dune elevation rises to 13 ft-NAVD88. Elevations on the marsh side of the island also average approximately 4.5 ft-NAVD88. Although the marsh side of the island is not within the current study area, stakeholders should be aware of increased risk to infrastructure as sea level rises. Based on lidar topographic survey data, contoured over the barrier island between R77 and R115, key cross-island ground elevations were identified. **Table 2-3** provides the key ground elevations according to R-monument and grouped by similar shoreline dimensions (see the **Engineering Appendix** for details on profile groupings).

Table 2-3: Key Elevations Along Cross-Island Profiles.

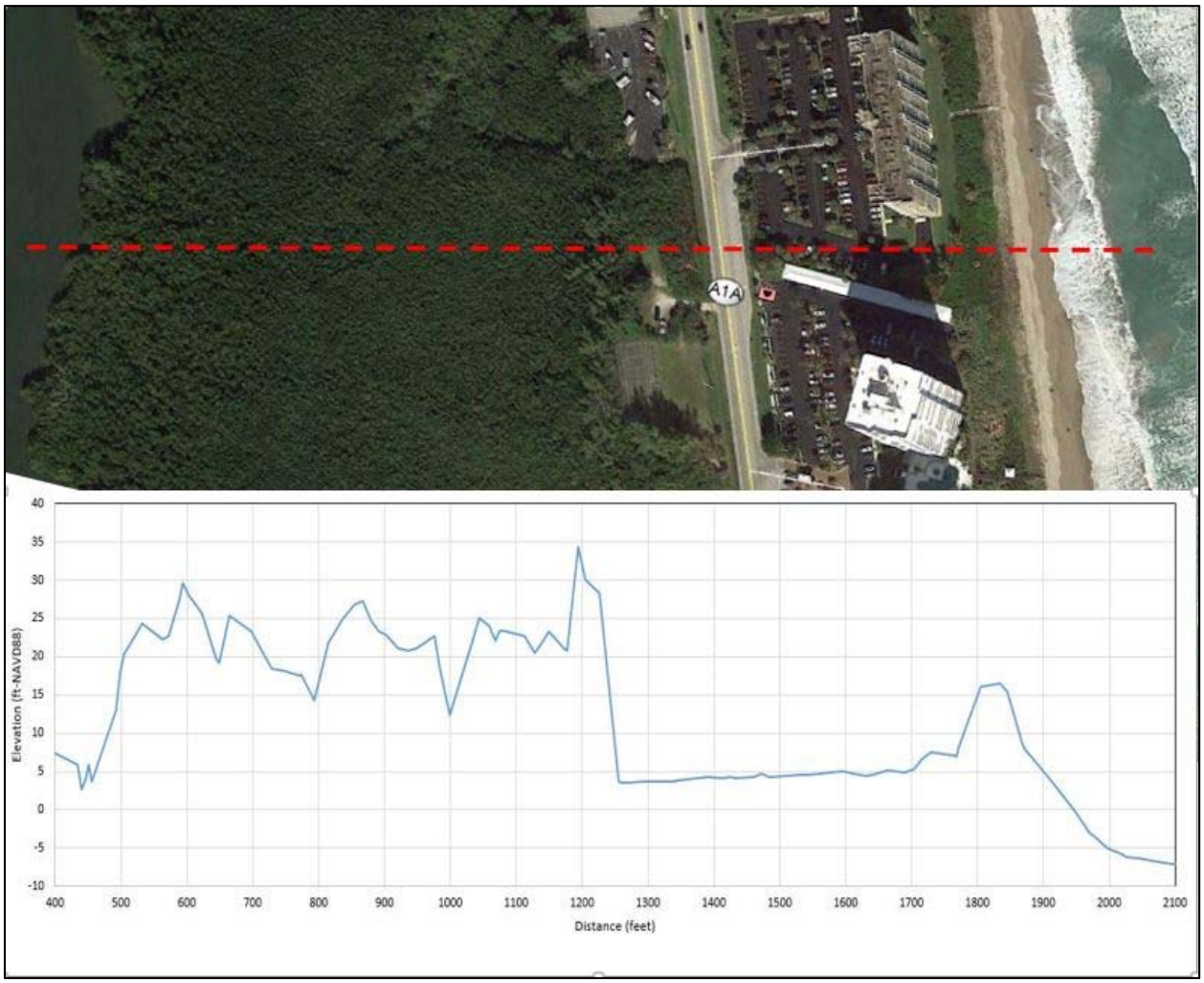
R-Monument	Ground Elevations (feet-NAVD88)			
	Average Dune Elevation	State Road A1A	Atlantic Side Structures	Marsh Side Structures
77-80, 84-102	11	4.5	4.5	4.5
81-83	13	4.5	5	4.5
103-104	11	5	5	5
105-106	11	5	3	5
107-110	11	5	3	5
111	11	5	6	4.5
112	14	5	5	5
113-115	13	5	5	5
Average for Study Area (R-98 to R-115)	11.5	5.0	4.5	4.5

A representative island profile, taken in the vicinity of R107, is show in **Figure 2-10**. Note that the topographic survey from which the profile was drawn was not "bare earth". Therefore elevations include vegetation and structures. The profile was positioned to avoid structures, but vegetation is evident, particularly on the marsh side. The ground elevations in **Table 2-3**, determined from full contour plots are the most representative of the project area.

The width of the barrier island varies over the length of the project. Typically the marsh side of the island is fronted by an expanse of heavy vegetation. In some regions, however, development extends from seaside to marsh side.

A key question when assessing the vulnerability of the study area to SLC is when critical thresholds will be crossed. Throughout the study area, the dune crest height represents a critical threshold. The average dune height from **Table 2-3** is 11.5 ft-NAVD88. SR A1A and other infrastructure are located at a lower elevation, approximately 4.5- to 5.0 ft-NAVD88. Since the dune lies between the ocean and infrastructure, the dune height will be the ocean side critical elevation.

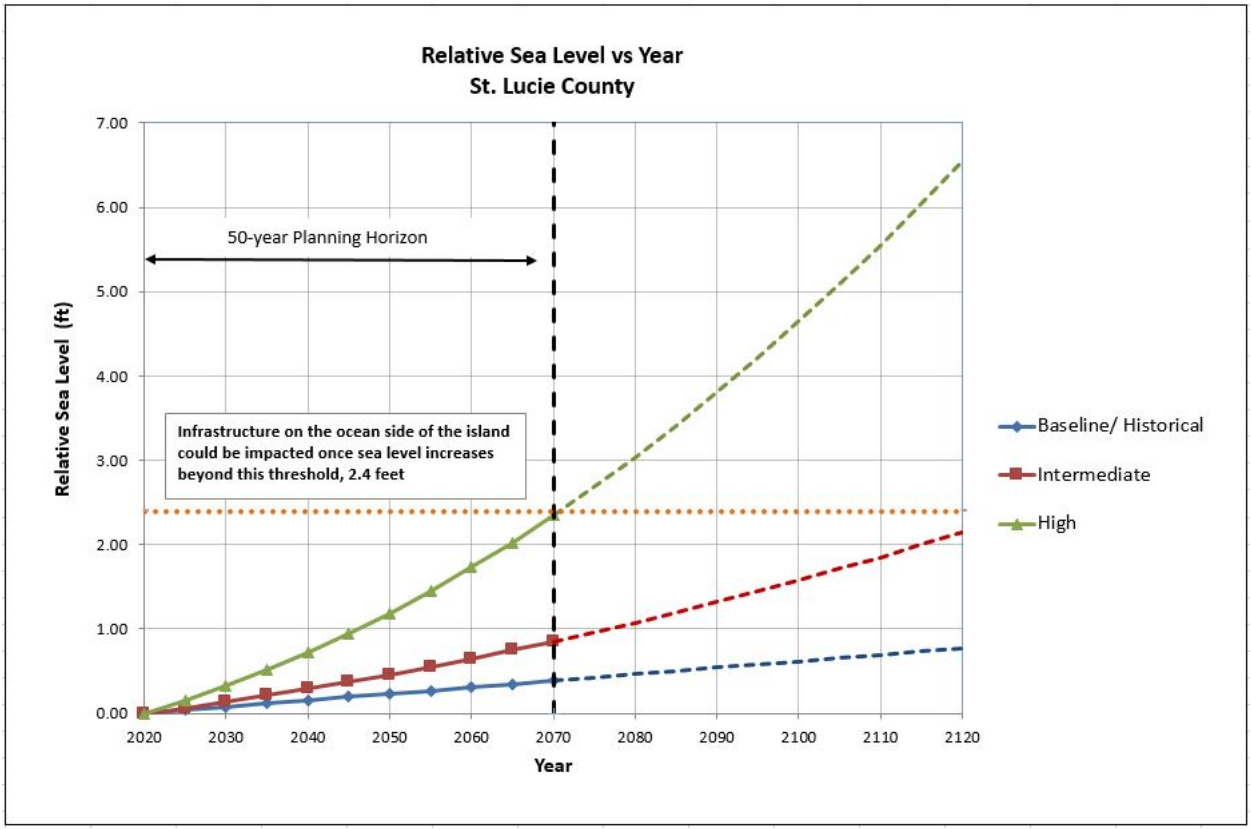
Figure 2-10. Cross-island Profile in the Vicinity of R107.



The 50-year storm tide elevation for the study area has been determined to be +8.6 ft-NAVD88 (FDOT, 2003). Water elevations during such storm events could reach the top of the dunes once sea level increases by 2.4 feet (8.6 feet of storm tide + 2.4 feet of SLC = 11 feet) (between R98 to R111). Because overtopping of the dune north of R111 would cause flooding over the full extent of the project, the higher dune crests (R112 to county line) are not considered to have any preventative significance against SLC.

At the end of 50 years (2070), the High SLC scenario predicts that sea level will reach the critical threshold **(Figure 2-11)**. Projected out 100 years, the High SLC scenario remains the only scenario that predicts levels exceeding 2.4 feet.

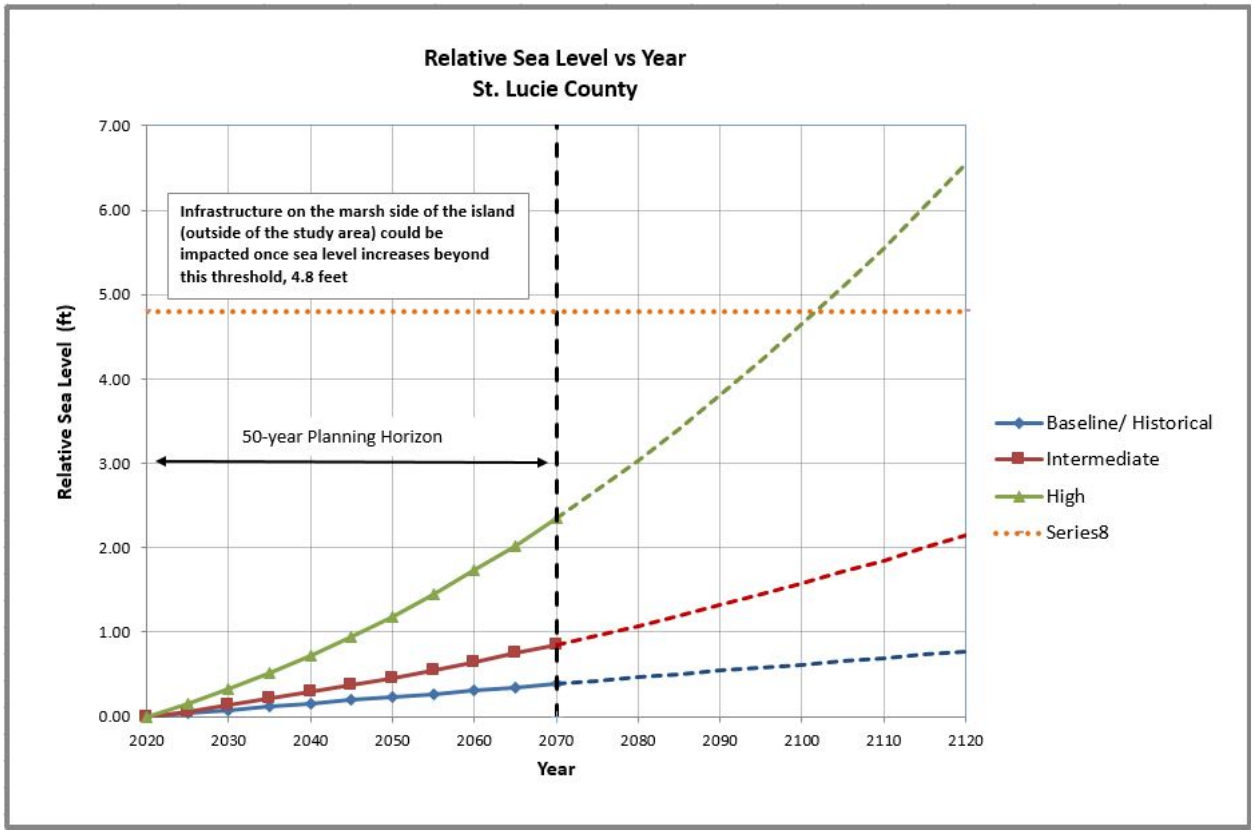
Figure 2-11. Threshold Vulnerability on the Ocean Side of the Island.



ETL 1100-2-1 recommends that systems related to, but existing outside, the study area should also be evaluated for vulnerability to SLC. The marsh side of the island does not contain any critical infrastructure on which the study area depends, such as hospitals or emergency services. This analysis only brings attention to the vulnerability of the marsh side of the island for stakeholder knowledge.

Infrastructure on the marsh side is generally built at approximately 4.5 ft-NAVD88. This side of the island is mainly affected by tides, not storm surge. Tidal range on the marsh side of the island is smaller than the ocean side. Mean Higher High Water (extreme high tide) is -0.28 ft-NAVD88 on the marsh side (+0.28 ft-NAVD88 on the ocean side). Factoring in extreme high tide, infrastructure could be periodically impacted once sea level increases by about 4.8 feet (-0.28 feet + 4.8 feet = 4.5 feet). At the end of 50 years, sea level is not expected to rise as much as 4.5 feet for any of the SLC scenarios (**Figure 2-12**). Projected out 100 years, only the High SLC scenario predicts levels exceeding 4.8 feet (between the years 2100 and 2105). In such a case, infrastructure on the back side of the island would be impacted during higher high tide events, dependent on current and future construction to protect against elevated water levels such as seawalls and bulkheads.

Figure 2-12. Threshold Vulnerability on the Marsh Side of the Island.



Reference: Florida Department of Transportation (FDOT), 2003. "Design Storm Surge Hydrographs for the Florida Coast", University of Florida, Gainesville, Florida.

2.3.13 EFFECTS OF OTHER COASTAL STORM RISK MANAGEMENT (CSRM) AND NAVIGATION PROJECTS

EXISTING CONDITIONS

OTHER CSRM PROJECTS

To date, no Federal large-scale beach renourishment projects have been constructed along the study area (R77 to R115). However, several Federal beach fill placements have been made on either side of the study area.

To the north of the study area, several large-scale placements of material have been made under the authority of the Federal shore protection project at Ft. Pierce, with the Ft. Pierce Shore Protection Project (SPP). Additionally, numerous placements of smaller volumes of material dredged from the Federal navigation project at Ft. Pierce Inlet have been made along this same reach of shoreline over the past 26 years. These two Federal projects result in the periodic placement of large volumes of material along the shoreline about 12 miles north of the study area of this report. Due to the predominant southward littoral transport of material along this region of coast, these fill placements may provide indirect nourishment of the study area.

South of the study area, the Martin County Shore Protection project extends from St. Lucie Inlet northward to the Martin County/St. Lucie County line, which is the southern limit of this study. Material placed along northern Martin County near the county line can be transported northward from the fill area by diffusion (end) losses, and may provide a source of nourishment along the southernmost reach of the St. Lucie County study area.

In addition to the large-scale Federal projects at Ft. Pierce and Martin County, several small-scale shore protection projects have been implemented along the study area. In 1990, a beach-scraping project was performed along the southern reach of the project. Several privately-funded shore protection measures have also been constructed in front of individual properties.

Each of the various projects as mentioned above is described in more detail in the **Engineering Appendix.**

OTHER NAVIGATION PROJECTS

Ft. Pierce Inlet is a Federal navigation project located in northern St. Lucie County in the proximity of R33 and R34. Following completion of the initial dredging of the Ft. Pierce navigation project by local interests in 1930, severe scouring occurred along the channel across the Indian River, leading to an increase in the volume of littoral material and a resulting pattern of accretion along most of the shoreline adjacent to the inlet. After the inlet channel stabilized (1930-1935), erosion began to occur along the shoreline south of the inlet. Research conducted in support of the Ft. Pierce SPP has determined that there is no evidence that the inlet has significantly affected sediment transport processes further south of the inlet than 14,000 feet (R48) (USACE, 2000).

St. Lucie Inlet is a Federal navigation project located in northern Martin County (just south of St. Lucie County) in the proximity of R44 and R45. Initially excavated in 1892, St. Lucie Inlet separates Hutchinson Island to the north and Jupiter Island to the south. The introduction of a north jetty in the late 1920

worsened erosional patterns already present due construction of the inlet. The north jetty trapped south moving sand, stabilizing the northern shoreline (southern Hutchinson Island) while causing shoreline erosion on Jupiter Island. Due to the predominantly southern transport of material, inlet impacts are to the south of the inlet channel, along approximately 5.8 miles of Jupiter Island shoreline (FDEP, 1995).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of other CSRM and navigation projects are similar to the existing conditions described above.

2.4 BUILT ENVIRONMENT

2.4.1 HURRICANE EVACUATION ROUTES AND ZONES

EXISTING CONDITIONS

National Scenic Highway, Florida State Road A1A (SR A1A), is the only evacuation route for the region and a major north-south thoroughfare for the area.

For the 4 reaches described above, this highway is a major evacuation route, but is set back from the shoreline to avoid damages in most instances. The Florida Department of Transportation (FDOT) maintains this road and has not expressed interest or need for a Federal project.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future without-project condition the FDOT would continue to operate and maintain A1A.

2.4.2 PUBLIC ACCESS AND PARKING

EXISTING CONDITIONS

Federal participation in CSRM projects involving placement of sand is limited to shorelines open to public use. Guidance is provided in Engineering Regulation (ER) 1105-2-100 and ER 1165-2-130. Cost sharing for any recommended plan is based on shoreline ownership, use, and the availability of public access.

There are currently 4 suitable parking and access points within the study area of R98 to R115+1000 feet to R001 **(REF-3)**. From north to south: Normandy Beach is located at R98; Dollman Park is located at R101.5 to R103.5; Waveland Beach is located at R110 to R111; and Glascock Beach (Martin County line) is located on the Martin County line (approximately R001).

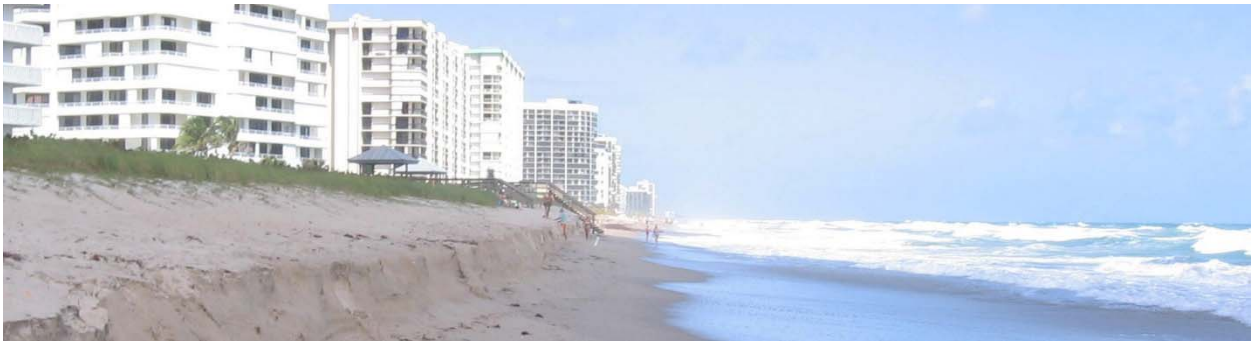
USACE policy in ER-1105-2-100 states: “Lack of sufficient parking facilities for the general public (including nonresident users) located reasonably near and accessible to the project beaches may constitute a restriction on public access and use, thereby precluding eligibility for Corps participation…Generally,

parking on free or reasonable terms should be available within a reasonable walking distance of the beach…Reasonable access is access approximately every one-half mile or less."

Based on existing information, there are gaps larger than ½ miles between the existing parking/access. The non-federal sponsor, St. Lucie County, is willing to create additional public access/parking as needed to qualify for maximum Federal cost-sharing. More information can be found in Chapter 3, Plan Formulation and the Tentatively Selected Plan.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future without-project condition, in absence of a Federal project, there is sufficient parking for recreational use and St. Lucie County would generally not have a need to create additional public access.



2.5 ECONOMIC ENVIRONMENT

EXISTING CONDITIONS

Information on the existing economic conditions along the St. Lucie County coastline was collected for economic modeling purposes. The information on the coastal assets detailed in this section was collected from St. Lucie County mapping resources, site visits, and contractors.

2.5.1 DAMAGE ELEMENTS – STRUCTURE AND CONTENTS VALUE

Beach-fx is an event-driven life-cycle model that estimates damages and associated costs over a period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Damages to developed shorelines include damages to buildings, pools, patios, parking lots, roads, utilities, seawalls, revetments, bulkheads, replacement of lost backfill, etc., all classified as "damage elements."

Economists, real estate specialists, and engineers have collected and compiled detailed information on damage elements within the study area[8] including:

- 1 single family residences
- 1 multi-family residences
- 52 commercial structures (including traditional commercial structures, as well condominiums and hotels)
- 35 dune walks
- Several parking lots, gazebos, garages, pools, tennis courts, and bath houses

In total, attribute information for 241 separate damage elements was populated for economic modeling using Beach-fx. The proximity of these damage elements to the beach makes them potentially vulnerable to erosion, wave attack, and inundation.

[8] This references South Hutchinson Island reach only, which is the only reach where damage elements were collected, due to screening of the upper 3 reaches during plan formulation. More information can be found in Chapter 3.

Beach-fx handles economic considerations at the damage element level. These considerations include extent of damage, cost to rebuild, and time to rebuild. Real Estate professionals from SAJ provided updated depreciated replacement costs for all of the damage elements in April 2015. An uncertainty of +/- 15% was assigned to these costs. The value of contents was assumed to be 50% of the structure value for all habitable structures per ER 1105-2-100. Non-habitable structures (dune walks, bathhouses, pools, etc...) had zero contents value.

2.5.2 STRUCTURE INVENTORY

The economic value of the existing structure inventory represents the depreciated replacement costs of damageable structures and their associated contents within the study area along the coastline. The damage element inventory includes 241 damageable structures with an overall estimated value of $670,000,000, with structure and content valuations of $579,000,000 and $91,000,000 respectively. **Table 2-4** provides the distribution of structure and content values broken down by Beach-fx Reach.

Table 2-4. Distribution of Structures and Structure Value by Reach.

Reach	Structure Value	Content Value	% Total Value	# Damage Elements	% of Damage Elements
R098	$ 868,902.27	$ 91,773.15	0.1%	5	2.1%
R099	$ 70,328,170.49	$ 11,335,908.92	12.2%	18	7.5%
R100	$ 65,393,014.73	$ 8,938,155.87	11.1%	7	2.9%
R101	$ 33,292,909.48	$ 4,583,020.93	5.7%	12	5.0%
R102	$ 510,685.00	$ -	0.1%	2	0.8%
R103	$ 382,169.00	$ -	0.1%	1	0.4%
R104	$ 59,638,936.30	$ 8,233,070.10	10.1%	16	6.6%
R105	$ 50,671,440.86	$ 6,935,733.30	8.6%	12	5.0%
R106	$ 38,827,603.52	$ 5,262,028.06	6.6%	10	4.1%
R107	$ 23,131,258.80	$ 3,342,885.26	3.9%	14	5.8%
R108	$ 67,674,190.47	$ 9,683,230.57	11.5%	16	6.6%
R109	$ 36,383,413.42	$ 5,941,501.65	6.3%	18	7.5%
R110	$ 23,862,725.12	$ 3,165,471.52	4.0%	11	4.6%
R111	$ 26,672,081.83	$ 4,018,669.57	4.6%	20	8.3%
R112	$ 31,434,921.66	$ 4,406,245.96	5.3%	12	5.0%
R113	$ 26,669,669.63	$ 6,969,432.38	5.0%	19	7.9%
R114	$ 1,393,214.69	$ 217,112.45	0.2%	17	7.1%
R115	$ 22,365,139.75	$ 7,626,234.68	4.5%	31	12.9%
Total	**$ 579,500,447.02**	**$ 90,750,474.43**	**100%**	**241**	**100%**

2.5.3 BEACH-FX MODEL SET-UP

FUTURE WITHOUT-PROJECT CONDITIONS

The **Economic Appendix** provides a complete description of the Beach-fx model set-up and use. Data on historic storms, beach survey profiles, and private, commercial and public structures within the project area is used as input to the Beach-fx model. The model is then used to estimate future damages resulting from hurricanes and coastal storms.

The future without-project damages are used as the base condition against which potential alternatives will be compared. The difference between with and without-project damages are used to determine project benefits.

2.5.4 BEACH-FX MODEL ASSUMPTIONS

- **Start Year:** The year in which the simulation begins is 2008.
- **Base Year:** The year in which the benefits of a constructed federal project would be expected to begin accruing is 2020.
- **Period of Analysis:** 50 years (2020 to 2070)
- **Discount Rate:** 3.125% FY2016 Federal Water Resources Discount Rate

Damage Functions: For the vast majority of structures within this study the damage functions used were those developed by the Institute for Water Resources (IWR), within the Coastal Storm Damage Workshop (CSDW), Coastal Storm Damage Relationships Based on Expert Opinion Elicitation in 2002. However, the various high-rise buildings located within the project area proved to be the exception since the IWR wave-damage function did not adequately address these structures. Empirical evidence on the performance of high-rise structures during major hurricanes[9] was used for the analysis for high-rise structures.

Coastal Armor:

- There is no existing coastal armor in the project area.
- For all lots in the study area, state permit requirements for the coastal construction control line (CCCL) for armor construction determine if a lot is able to be protected by armor, or not, once erosion reaches the seaward edge of the lot. In St. Lucie County, due to the restrictions of the CCCL, it was assumed that no local armoring would occur.

Number of Times Rebuilding Allowed: The term "rebuilding" is defined for modeling purposes and assumptions as repairing part of a structure, rather than rebuilding the entire structure. It is conservatively assumed that any existing vacant lots will remain vacant up to the base year and throughout the project life. Issuing emergency permits for rebuilding on lots meeting a minimal setback restriction is generally the rule, not the exception in Florida. Common practice and historical evidence also show that rebuilding lost structures, provided setback restrictions are met, occurs frequently. As a result, the number of rebuilds within the model has been limited to reflect this behavior as follows:

[9] Sources: FEMA Mitigation Assessment Team Report for Hurricane Katrina (July 2006) and Hurricane Sandy (November 2013)

- Public Access Structures[10]: 124X
- Commercial Recreation Facilities[11]: 62X
- Remaining: 31X

Additionally, after long-term erosion has claimed more distance on the oceanfront lot than the building requires the model ceases to reinstate the same property. The model also considers a lot "condemned" once 50%[12] of the total value of that lot is damaged. These assumptions will prevent overestimation of the without-project damages.

Future value of structures: The future structure inventory and values are the same as the existing condition. This conservative approach neglects any increase in value due to future development. Due to the uncertainty involved in projections of future development, using the existing inventory is considered conservative for Florida where coastal development has historically increased in density and value.

2.5.5 BEACH-FX FUTURE WITHOUT PROJECT DAMAGE RESULTS

- Structure Damage: Economic losses resulting from the structures situated along the coastline being exposed to wave attack, inundation, and erosion damages. Structure damages account for approximately 71% of the damages for the future without-project (FWOP) damages.

- Contents Damage: The material items housed within the aforementioned structures (usually air-conditioned and enclosed) that are potentially subject to damage. Content damages are approximately 29% of the total damages.

Table 2-5 provides greater detail on the type of structures within each category as well as the composition of the FWOP damages within those categories.

Table 2-5. Distribution of FWOP Damages by Category and Type.

Category	Type	Structure	Contents	Total	% of Total
Commercial	BUILDING-1	$ 45,678,775.25	$ 23,331,162.27	$ 69,009,937.53	83.30%
	COMM-1	$ 20,144.20	$ 8,382.24	$ 28,526.45	0.03%
	HIGHRISE-1	$ 778,118.18	$ 113,309.67	$ 891,427.85	1.08%
	HIGHRISE-2	$ 988,656.23	$ 137,557.45	$ 1,126,213.67	1.36%
	HIGHRISE-3	$ 1,153,621.63	$ 149,471.28	$ 1,303,092.91	1.57%
Commercial Subtotal		$ 48,619,315.50	$ 23,739,882.91	$ 72,359,198.41	87.34%
Public Access & Recreation Structures	DECK	$ 397,772.57	$ 0.00	$ 397,772.57	0.48%
	DUNEWALK	$ 6,266,873.05	$ -	$ 6,266,873.05	7.56%
	GARAGE	$ 36,932.06	$ 27,635.02	$ 64,567.09	0.08%
	GARAGE-U	$ 216,293.46	$ 108,146.73	$ 324,440.19	0.39%
	GUARDSHACK	$ 10,475.47	$ 1,467.47	$ 11,942.94	0.01%
	PARKING	$ 799,913.17	$ -	$ 799,913.17	0.97%
	PATIO	$ 931.85	$ -	$ 931.85	0.00%
	POOL	$ 2,042,506.32	$ -	$ 2,042,506.32	2.47%
	POOLHEATER	$ 511.98	$ -	$ 511.98	0.00%
	PUBLIC-1	$ 2,005.33	$ 281.73	$ 2,287.06	0.00%

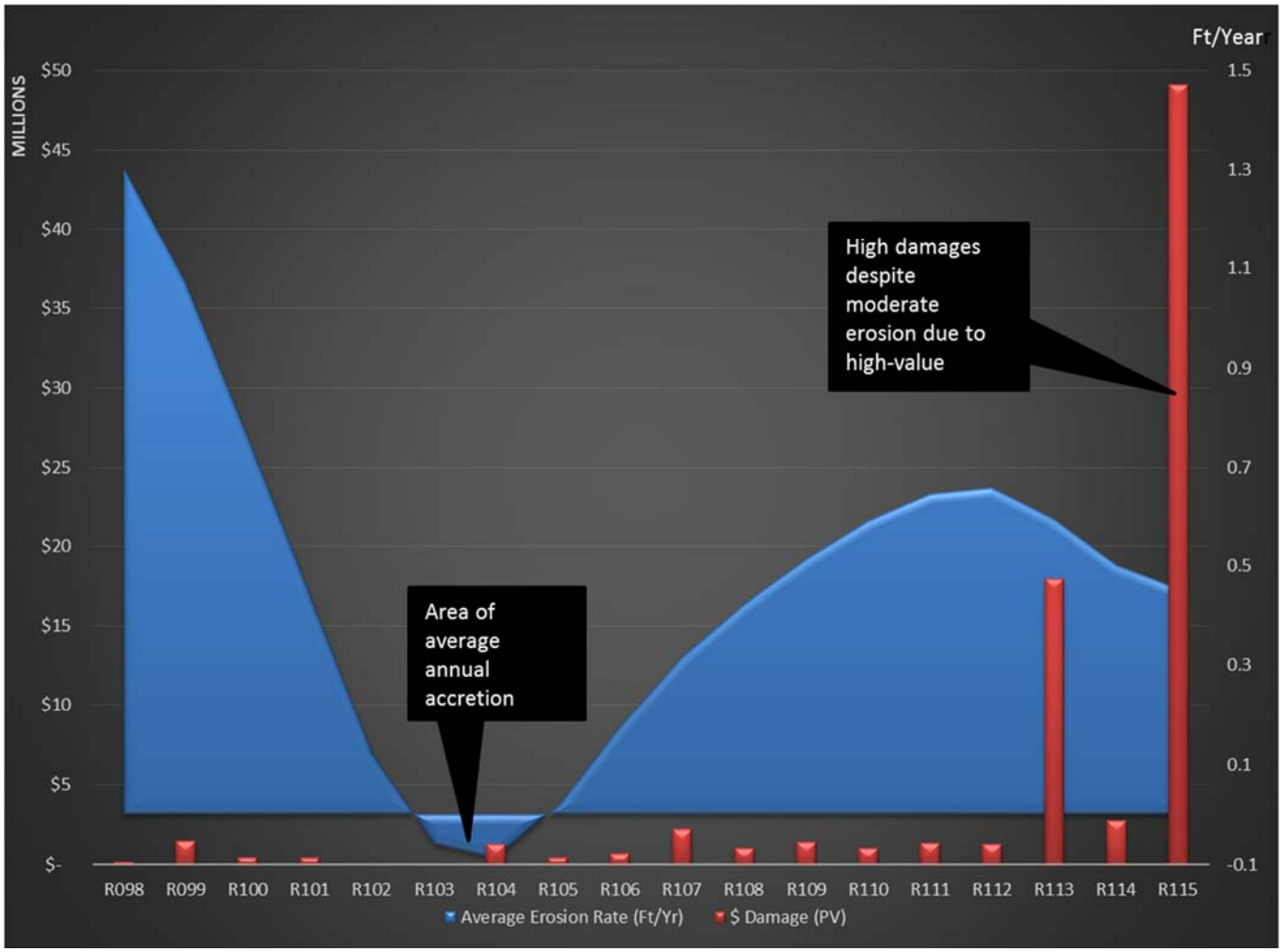
[10] Examples of public access structures include dunewalks, shelters, guard shacks and roads
[11] Examples of commercial recreation facilities include pools, parking areas, and tennis courts
[12] This amount, the lot condemnation ratio, can be manipulated within the model as needed but is set to 50% for this study.

	SHELTER	$ 495,528.63	$ -	$ 495,528.63	0.60%
	STORAGE	$ 1,912.19	$ 1,185.56	$ 3,097.75	0.00%
	ROAD-1	$ 104.94	$ -	$ 104.94	0.00%
	TENNIS	$ 455.24	$ -	$ 455.24	0.00%
PA & Rec Subtotal		$ 10,272,216.27	$ 138,716.52	$ 10,410,932.79	12.57%
Residential	MFR-3	$ 15,407.32	$ 4,329.99	$ 19,737.32	0.02%
	SFR-3	$ 32,676.90	$ 21,879.63	$ 54,556.52	0.07%
Residential Subtotal		$ 48,084.22	$ 26,209.62	$ 74,293.84	0.09%
GRAND TOTAL		**$ 58,939,615.99**	**$ 23,904,809.05**	**$ 82,844,425.04**	**100%**

2.5.5.1 SPATIAL DISTRIBUTION OF WITHOUT-PROJECT DAMAGES

Reaches R113 to R115 account for around 84% of the damages, while the remainder of the damages are relatively evenly distributed; R098, R100 to R103 are the only reaches that account for less than one-percent of damages. R115 accounts for 60% of the total damage due in large part to a few valuable condominium complexes that are on slab foundations rather than deep-pile. Structures on slab foundation are far more susceptible to damages from erosion than those with a deep-pile foundation. **Figure 2-13** illustrates the spatial distribution of erosion rate, existing structure value, and FWOP damages and costs by reach.

Figure 2-13. Spatial Distribution of Damages and Erosion Rates by Reach.



2.5.5.2 DAMAGE DISTRIBUTION BY DAMAGE DRIVING PARAMETER

Most of the FWOP damages and costs are attributable to erosion. The distribution of damages by driving parameter is as follows:

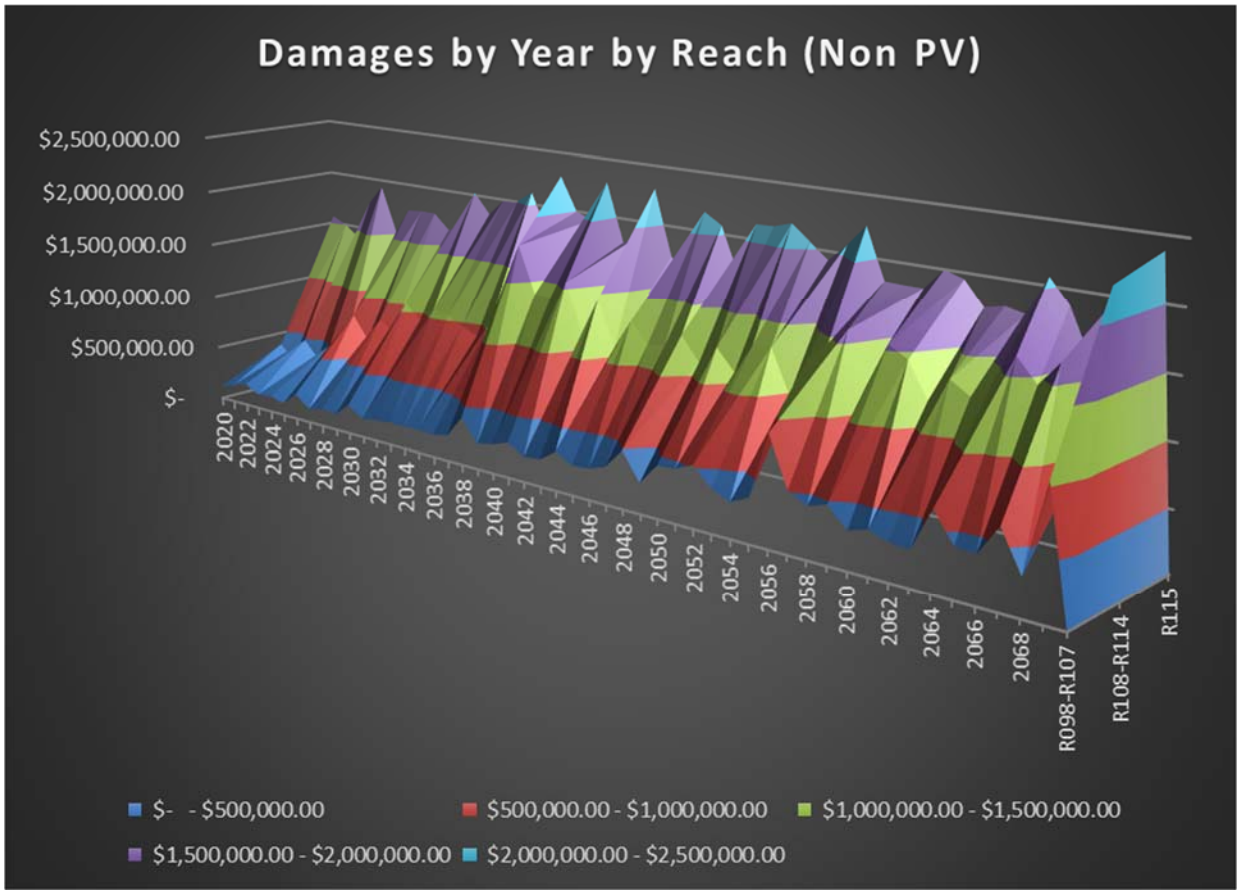
- Erosion: 95.06%
- Inundation: 4.28%
- Wave Attack: .67%

2.5.5.3 TEMPORAL DISTRIBUTION OF DAMAGES

Figure 2-14 illustrates the non-present value damages over time by Beach-fx reach. The timing of FWOP damages and armor costs varies across the model reaches. There is a great deal of variability in the amount of damages among the Beach-fx reaches. This is explained by the large number of variables, all of which the Beach-fx model takes into account. Examples of variation between the reaches result from the following:

- Density and amount of development
- Typical size and value of structures
- Typical distance between structures and mean-high water
- Size, shape and location of the dunes and coastal morphology
- Rate of erosion for each reach

Figure 2-14. Damages Over Time by Combined Reaches (Non-PV$).



2.5.5.4 FWOP DAMAGES IN ALTERNATIVE SEA LEVEL RISE (SLR) SCENARIOS

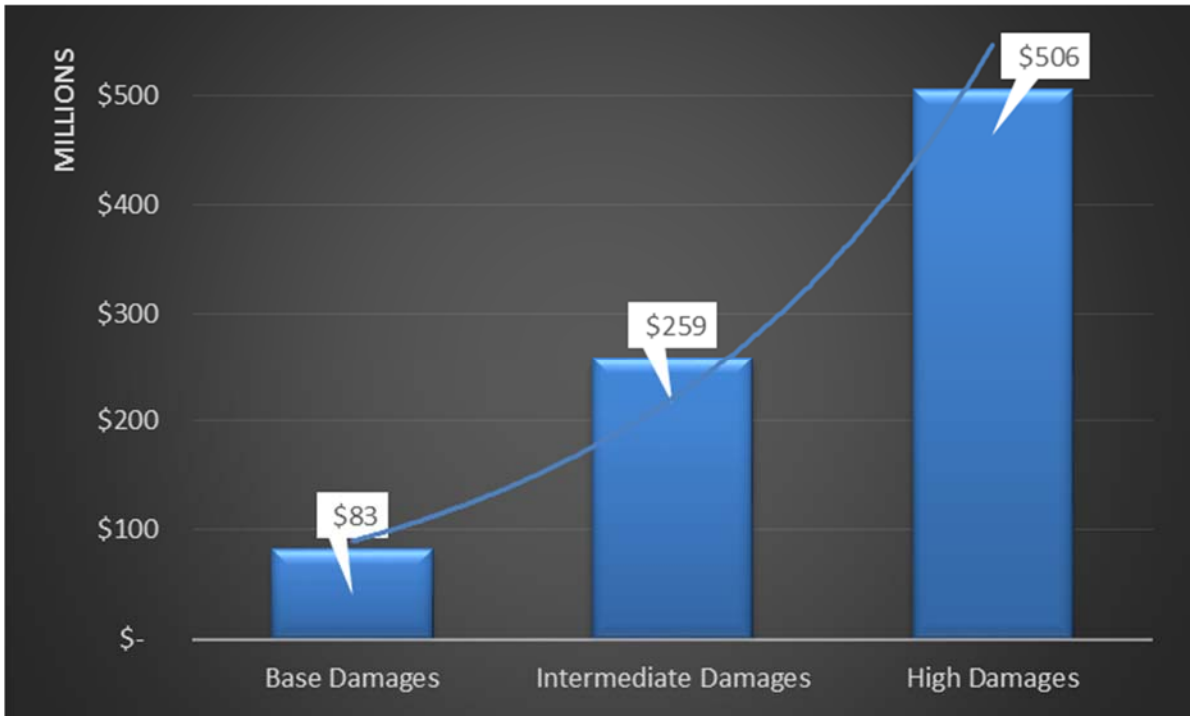
The FWOP condition was modeled for three Sea Level Rise (SLR) scenarios. ER 1110-2-8162 provides both a methodology and a procedure for determining a range of sea level rise estimates based on the local historic sea level rise rate, the construction (base) year of the project, and the design life of the project. The Beach-fx results presented above refer to the baseline scenario, which is based on the historic erosion rate. The results associated with the other two SLR scenarios are presented here.

Figure 2-15 provides an overall summary of FWOP average present value damage in each SLR scenario. The SLR results are intuitive in the sense that one would expect damages to be positively correlated with water levels (i.e. as water levels increase throughout the project life so do damages). What is important to note, however, is the magnitude of the effect. From the base to intermediate SLR scenario the difference in average SLR was .0086 ft./year, yet resulted in an increase of roughly 212%, or $175.9 million, worth of damages. From intermediate to high SLR, there was a .0276 ft./year average rise with a corresponding increase of 95%, or $246.8 million, in damages. From base to high SLR, damages increase over 510%.

There is also an interesting shift in what drives the damages in each scenario. It is very common for erosion to be the main cause of damages in Florida studies. However, as sea levels rise, inundation begins to take on more of the share of damages. In the high SLR scenario, damages caused by erosion fall from 95% to 51% with inundation accounting for most of the difference.

Additional detail on results from the SLR analysis is provided in the **Economics Appendix.**

Figure 2-15. Total Damages by SLR Scenario.



2.5.5.5 FUTURE WITHOUT PROJECT CONDITION CONCLUSION

The following points summarize the future-without project (FWOP) conditions:

- Damages are largely driven by storm events instead of gradual erosion.
- The overwhelming majority of the damage is structural in nature. Commercial structures account for well over half of all damages.
- Proximity to the shoreline, vulnerability of structure type (i.e. slab foundation) and exposure to recurring damages are the most important factors for determining structure damage.
- Damages in the FWOP increase dramatically in the SLR scenarios.

3 Plan Formulation
and the Tentatively Selected Plan

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3 PLAN FORMULATION

3.1 PLAN FORMULATION RATIONALE

Please refer to informational foldouts REF-2 and REF-3 for Chapter 3.

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983), have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G," and will be cited throughout the plan formulation sections of this report.

Plan formulation is the process of developing alternative plans to address a given problem. The first step in plan formulation involves identifying all potential management measures for the given problems. A management measure is a structural or nonstructural action that can be implemented at a specific geographic site to address one or more planning objectives.

An alternative plan includes one or more management measures to address the problem. Alternative plans can differ by types of measures, or how measures are combined or defined, including dimensions, quantities, materials, locations or implementation time frames.

Four accounts (P&G 1983) facilitate the evaluation of management measures and display the effects of alternative plans.

- National Economic Development (NED) account: Includes consideration of a measure's potential to meet the planning objective to reduce storm damages, as well as decrease costs of emergency services, lower flood insurance premiums, and consider project costs. Costs and benefits used to fully evaluate the NED objective are not calculated at this stage; however, estimates can be made to gage the overall cost-effectiveness of a measure for this initial screening. Effects of sea-level change and a measure's adaptability to such change were considered under the National Economic Development (NED) account.

- Environmental Quality (EQ) account: Considers ecosystem restoration, water circulation, noise level changes, public facilities and services, aesthetic values, natural resources, air and water quality, cultural and historic preservation, and other factors covered by the National Environmental Policy Act (NEPA).

- Other Social Effects (OSE) account: Includes considerations for the preservation of life, health, and public safety; community cohesion and growth; tax and property values; and, the displacement of businesses and public facilities. For evaluation purposes, the OSE account is inclusive of the planning objectives to maintain recreation and maintain a safe evacuation route, and the planning constraint to avoid conflict with legal requirements.

- Regional Economic Development (RED) account: Considers the potential impacts on the local economy including employment, income, and sales volume.

The P&G require the NED plan to be Coastal Storm Risk Management (CSRM) Project's selected plan, unless an exception is granted. The NED plan must also be evaluated in consideration of the P&G criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan is formulated in consideration of these four criteria.

Preliminary plans were formulated by combining management measures. Each plan was formulated in consideration of the following four criteria described in the Principles and Guidelines (P&G):

1. **Completeness:** Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
2. **Effectiveness:** Extent to which the plan contributes to achieving the planning objectives
3. **Efficiency:** Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
4. **Acceptability:** Workability and viability of the alternative plan with respect to acceptance by Federal and non-federal entities and the public, and compatibility with existing laws, regulations, and public policies

3.2 SCOPING*

3.2.1 FEDERAL

An initial scoping period for the project was conducted from May 31 through June 30, 2006. The National Oceanic and Atmospheric Administration (NOAA) responded to the scoping letter with concerns about the proposed dredging of the offshore shoals as a borrow source and that the Essential Fish Habitat (EFH) assessment and NEPA documents on this action should be prepared with sufficient detail. This assessment is included in Sections 2.3.4 and 4.1.10 of this report. The Florida Department of Environmental Protection (FDEP) coordinated a review of the scoping letter and the proposed project with the appropriate state agencies. FDEP stated that "based on the information contained in the public notice and the enclosed state agency comments, the state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program." Other stakeholders raised concerns regarding the use of St. Lucie Shoal as a borrow site, impacts to hardbottom resources, and cumulative impacts.

All correspondence associated with this NEPA scoping process is included in **Appendix H**.

3.3 PROBLEMS AND OPPORTUNITIES*

A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable.

The purpose of this feasibility study is to develop an implementable and acceptable plan to change the future condition and address specific problems and opportunities in the study area. Problems and opportunities have been identified by the Project Delivery Team (PDT) in several ways, including previous USACE studies, reports completed by private contractors for St. Lucie County, as well as scoping letter comments received from local residents and stakeholders.

3.3.1 PROBLEMS

Existing problems in the study area include:

- Storm damages due to erosion, inundation, and waves threatening infrastructure
- Loss of natural habitat
- Shoreline erosion threatening recreational opportunities

Erosion, mainly storm induced, is the greatest problem in the study area as a negative impact to infrastructure. Additional problems associated with the eroding shoreline include loss of recreational resources (impacting tourism) and loss of natural habitat. Sea level rise and coastal storms will continue to exacerbate erosion in the study area.

Per the Florida coastal construction control line (CCCL) program, St. Lucie County is prohibited to install coastal armoring, unless the situation meets certain triggers. There is no coastal armoring in the area to date. To combat damages from storms, St. Lucie County has performed small truck fills after large storms, and an overall larger local nourishment in 2012/2013.

3.3.2 OPPORTUNITIES

Opportunities are positive conditions in the study area that may result from implementation of a Federal project such as:

- Reduction of storm damage to residential and commercial properties along the St. Lucie County shoreline
- Restoration of natural dune function, where possible, in the study area
- Protection of habitat for nesting sea turtles, benthic invertebrates, and shore birds
- Protection of the current hurricane evacuation route along Hutchinson Island
- Maintenance of existing recreation and tourism levels

These opportunities may be realized by implementing a single management measure or a combination of management measures which may be structural and/or non-structural. Management measures such as beach nourishment and dune creation/remediation include additional opportunities to protect natural habitat for sea turtles, shore birds, etc. While some natural functions, such as sea turtle nesting, may be

disrupted during construction activities, there is an opportunity for long-term benefits in preserving the beach habitat.

3.4 CONSTRAINTS

3.4.1 PLANNING CONSTRAINTS

A constraint limits the extent of the planning process. It is a statement of things or situations the alternative plans should avoid. Constraints are designed to avoid undesirable changes between the without and with-project future conditions. The planning constraints relative to this study are:

1. Avoid conflict with Federal regulations, as stated in Federal law, USACE regulations and Executive Orders, specifically the Coastal Barrier Resource Act (CBRA), Clean Water Act and Coastal Zone Management Act.
2. Avoid and/or minimize impacts to offshore hardbottom resources over a 50-year planning horizon (2020-2070).
3. Avoid impacts to sea turtle nesting habitat including the placement of fill during construction and / or nourishment during nesting season over a 50-year planning horizon (2020-2070).
4. Maintain the Hutchinson Island emergency evacuation route (SR A1A) over a 50-year planning horizon (2020 – 2070).
5. Consider impacts of Federal participation in designated Coastal Barrier Resource Units within the study area (2020 – 2070).
6. Floodproofing is a constraint in coastal high hazard Zones V and VE, per Federal Emergency Management Agency (FEMA) regulations.

3.4.2 LOCAL CONSTRAINTS

Local and state laws, such as Florida State statutes, do not constrain NED formulation. However, they may be considered in the selection of a Locally Preferred Plan (LPP).

3.5 OBJECTIVES

3.5.1 FEDERAL OBJECTIVES

The Federal objective, as stated in the P&G, is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the study area and the rest of the nation. The three basic criteria used in the planning process are: (1) the project must be economically justified and environmentally acceptable, (2) Federal participation is warranted, and (3) the project must meet current Administration budget priorities.

The Federal objective is to maximize net benefits to the nation, and as such, it does not seek to identify specific targets within objectives. For example, targeting a pre-defined storm frequency (100-year storm)

relative to the storm damage reduction objective would be inappropriate. Rather, the planning process includes formulation of alternative plans to maximize benefits relative to costs. The Federal objective to maximize net benefits would supersede any project-specific target output.

3.5.1.1 PLANNING OBJECTIVES

The overarching goal of this study is to formulate an alternative for coastal study risk management to determine if Federal participation in reduction of the damages caused by erosion and coastal storms to shorefront structures and infrastructure within the study area is warranted and economically justified. Specific study objectives have been developed to provide a means of determining whether individual management measures are capable of solving the study area's problems while taking advantage of the opportunities identified and avoiding the constraints. The following study objectives have been developed based on the St. Lucie County feasibility study area problems, opportunities, goals, and Federal and state objectives and regulations.

1. Objective 1: Reduce storm damages to property and infrastructure within the project area over a 50-year planning horizon (2020 – 2070).
2. Objective 2: Maintain environmental quality in the project area and adjacent areas, for human and natural use sea turtle habitat and aesthetics over a 50-year planning horizon (2020 – 2070).
3. Objective 3: Maintain recreational use of beach and nearshore areas in the project area including beach going, surfing, fishing, and wildlife viewing over a 50-year planning horizon (2020 – 2070).

3.5.1.2 FEDERAL ENVIRONMENTAL OBJECTIVES

USACE strives to balance the environmental and development needs of the nation in full compliance with the National Environmental Policy Act (NEPA) and other authorities provided by Congress and the Executive Branch. Public participation is encouraged early in the planning process to help define problems and environmental concerns relative to the study. Therefore, significant environmental resources and values that would likely be impacted, favorably as well as adversely, by an alternative under consideration are identified early in the planning process. All plans are formulated to avoid to the fullest extent practicable any adverse impact on significant resources. Significant adverse impacts that cannot be avoided are mitigated as required by Section 906(d) of WRDA 1986.

This report is an integrated feasibility study and environmental document. As with a separate NEPA document, it discusses and documents the environmental effects of the recommended plan and summarizes compliance with Federal statutes and regulations.

3.5.1.3 ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with the NEPA, USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities.

Sustainability can be achieved only by the combined efforts of Federal agencies, tribal, state and local governments, and the private sector each doing its part, backed by the citizens of the world. These

principles help the USACE define its role in that endeavor. The USACE Environmental Operating Principles are:

1. Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse and sustainable condition is necessary to support life.

2. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.

3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.

5. Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.

6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.

7. Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems that also protect and enhance the environment.

3.5.1.4 CAMPAIGN PLAN OF THE U.S. ARMY CORPS OF ENGINEERS (USACE)

The USACE Campaign Plan goals and objectives are derived, in part, from the Commander's intent, the Army Campaign Plan, and the Office of Management and Budget. The four campaign plan goals and their associated objectives also build on prior strategic planning efforts. Each campaign plan goal and objective is led by a USACE senior leader who manages and oversees actions to reach the goal and objectives.

The successful achievement of the campaign plan goals and objectives are dependent on actions implemented by the entire USACE team. The implementing actions supporting each goal and objective are contained in the headquarters staff and Major Subordinate Command (MSC) implementation guidance for the Campaign Plan. The four goals of the Campaign Plan are:

Goal 1: Deliver innovative, resilient, and sustainable solutions to the Department of Defense (DoD) and the nation.

Goal 2: Deliver enduring and essential water resource solutions, utilizing effective transformation strategies.

Goal 3: Deliver support that responds to, recovers from, and mitigates disaster impacts to the nation.

Goal 4: Build resilient People, Teams, Systems and Processes to sustain a diverse culture of collaboration, innovation and participation to shape and deliver strategic solutions.

These Campaign Plan goals and associated objectives will be addressed through the course of this feasibility study.

3.5.2 STATE AND LOCAL OBJECTIVES

The State of Florida is empowered by the Federal Coastal Zone Management Act (CZMA) and its implementation of regulations per 15 CFR 930 to review Federal activities within or adjacent to its coastal zone to determine whether the activity is consistent with the requirements of the state's approved management program for its coastal zone. The Federal CZMA requires Federal activities to be consistent with a state's coastal zone program to the maximum extent practicable; it does not require compliance with a state's program. Florida's Coastal Zone Management Program was established under the Coastal Management Act of 1978 (Chapter 380.20, Florida Statutes) and approved by the Federal Coastal Zone Management Office in 1981. Florida does not regulate its coastal zone through one comprehensive law but rather through several state statutes and administrative codes. Through Florida's comprehensive planning act, local governments are also given the opportunity to determine whether these activities are consistent with their coastal goals and policies. The FDEP is the lead state agency for the implementation of the Federal CZMA.

The Beach and Shore Preservation Act (Chapter 161, Florida Statutes) is Florida's primary statute for developing and implementing the state's strategic coastal management plan, regulating coastal construction seaward of the mean high water line, and regulating activities seaward of the coastal construction control lines. The act, administered by the FDEP, was first passed in 1965 and has since been significantly amended. The objective of the Beach and Shore Preservation Act is to preserve and protect Florida's sandy beaches and adjacent beach and dune systems. The FDEP strives to accomplish this objective with the following programs: Coastal Construction Control Lines, Joint Coastal Permit Program, Erosion Setbacks, Coastal Building Zone, Erosion Control Program, Erosion Control Line, and Inlet Management.

3.5.2.1 LOCAL COMPREHENSIVE PLANNING

The state's Local Government Comprehensive Planning Act of 1985 (Chapter 163) requires that all local governments prepare, adopt, and implement comprehensive plans that address community growth and development needs. It requires that local, regional, and state comprehensive plans be consistent with each other and requires coastal counties and cities to include a "coastal management element" in their local plans. This section of the plan must be based on an inventory of the beach/dune system and existing coastal land uses and an analysis of the effects of future land uses on coastal resources. Local governments must also address disaster mitigation and redevelopment, designation of coastal high-hazard areas, beach protection, and shoreline use.

The St. Lucie County Comprehensive Plan 2015 outlines unique features of the area, key coastal elements and related goals, objectives and policies, as well as existing and future land use.

3.6 SUMMARY OF MANAGEMENT MEASURES

Management measures are specific structural or nonstructural actions that would take place at geographical locations within the project areas. For the first iteration of evaluating measures, the entire project area was split into two geographical locations (REF-2):

1) The Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island reaches were grouped together due to their proximity and similarity in physical and built features.
2) The South Hutchinson reach was evaluated separately due to its erosive nature and higher development.

3.6.1 IDENTIFICATION OF MANAGEMENT MEASURES

Management measures were selected to accomplish at least one of the planning objectives for the St. Lucie County study. Both nonstructural (NS) measures and structural (S) measures were identified. All possible measures were considered, including those beyond the authority of USACE to implement. The following is a summary of the management measures to be considered for St. Lucie County.

Non-Structural

NS-1: No-Action: The no-action plan represents future conditions without the implementation of a project. Although this measure does not address any specific problems, it provides a comparison for all other measures. Information to describe this measure was collected during the inventory of existing conditions. The rate of shoreline change will be assumed to continue over the 50-year period of analysis. Present structures and replacement costs will be used into the future.

NS-2: Coastal Construction Control Line: A Coastal Construction Control Line (CCCL) that does not prohibit construction, but does provide stringent structural restrictions, was established in 1988 by the State of Florida for all of St. Lucie County. Evaluation of this management measure considers potential changes to the CCCL or building regulations that could be implemented by the State of Florida. Such changes could include moving the CCCL landward, increasing the setback for construction, or increasing the standards for construction to reduce storm damages. Erosion of the shoreline will be considered to continue at the present average rate, unabated by this measure.

NS-3: Moratorium on Construction: This management measure would not permit new construction in the area vulnerable to storm damages adjacent to the study area. As properties are damaged, reconstruction would not be permitted. The erosion of the shoreline would continue at the present rate, unabated by this measure. Although not a congressionally-authorized activity, this measure could be implemented by state or local governments.

NS-4: Establish a No-Growth Program: This management measure would allow for limited reconstruction of existing structures following storm damage, but would not allow for an increased number of new structures within the area vulnerable to storm damages adjacent to the study area. The erosion of the shoreline would continue at the present rate, unabated by this measure. Although not a congressionally-authorized activity, this measure could be implemented by state or local governments.

NS-5: Relocation of Structures: The relocation of structures measure will assume that shorelines in the study area will continue to erode. Vulnerable structures may be identified within the study which may be moved further landward on their parcels to escape storm damages. This would be accomplished as a Federal partnership with the non-federal sponsor, with the non-federal sponsor acting as the lead agency to oversee the process.

NS-6: Floodproofing of Structures: This management measure considers that various methods for non-structural flood proofing are available which may be implemented by homeowners and/or homeowners associations within the study area in the form of wet or dry floodproofing. Wet floodproofing involves making a series of modifications to a structure to allow an enclosed area below the base flood elevation to flood – it protects the building but not the contents of the building. Dry floodproofing makes building and site modifications to prevent water from entering during a flooding event. In the study area, the majority of affected buildings are condominiums, where dry floodproofing would be the least cost and most practical means to floodproof. Flood shields could be a potential type of dry floodproofing that could apply to condominium structures.

NS-8: Acquisition of Land and Structures:
This measure would allow the shoreline to erode in the study area with a loss of land. Structures within the area vulnerable to storm damage would be identified for acquisition. Structures on the acquired parcels would be demolished and natural areas restored. Such parcels would become public property and would reduce the number of structures vulnerable to storm damages.

Structural

S-1: Seawalls: The construction of concrete seawalls could provide a significant degree of storm damage protection. Seawalls could be constructed at some position seaward of the structures which they are designed to protect.

S-2: Revetments: This measure would involve placement of large rock, designed to withstand the wave environment, seaward of structures which are most vulnerable to storm damages which may result from shoreline erosion. The engineered structure would have a sloped profile designed to dissipate wave energy before it reaches the protected structures. The revetment could be covered by a dune or some degree of beach fill for additional protection and for aesthetic reasons. Construction would be from the beach, with intermittent access from roads. Impacts to the nearshore resources during construction would be avoided.

S-3: Sand Covered Soft Structures: This management measure includes construction of a dune composed of geotextile sand-filled forms (typically tubes or bags) and covered with sand. This forms a sand dune with a structured core. When storm erosion causes the structured geotextile core to become exposed the soft structure acts as armoring to prevent erosion from reaching further inland. Sand depth over the geotextile core would be maintained to an adequate depth to allow the dune to function as habitat and not inhibit sea turtle nesting.

S-4: Beach Nourishment: This management measure includes initial construction of a beach fill and future renourishments at periodic intervals. Renourishment of the beach would be undertaken periodically to

maintain the recreational and storm damage reduction features within design dimensions. Dimensions of the beach fill would be based on the degree of protection desired or economically justified, storm damage protection of given widths of beach, and the environmental impact to the nearshore resources. Beach nourishment material (sand) would need to be available in adequate quantities. Geotechnical investigations would be conducted to identify potential offshore borrow sources. The potential for use of upland sources, as well as the beneficial use of beach quality dredged material from other sources in the region would also be investigated.

S-5: Groins: A series of groins in the problem area would help hold a beach in front of existing development and prevent further losses of land. The construction of groins would have to be supplemented with beach nourishment so that adjacent beaches would not be starved of sand. For this reason, groins are considered a method to help hold the fill in place and to reduce periodic nourishment requirements. The beach nourishment material would come from the sources discussed in the beach nourishment structural measure, S-4. The groins would be constructed of large rocks, designed to interlock together, with a foundation designed to avoid subsidence. The groins would be placed perpendicular to the shoreline and would extend from above the mean high water line out into shallow water. The length, orientation, and head of the structure (T-head or not) would be designed based on wave conditions, storms, and sediment transport.

S-6: Submerged Artificial Reefs: This management measure would use the perched beach concept to limit the amount of underwater fill and retain the dry beach for a longer period. This would be accomplished by placement of a submerged artificial reef in shallow water with beach fill material placed "perched" landward of the reef structure. This measure may reduce initial fill quantities, reduce renourishment requirements and offer mitigation for the environmental impacts of potential nearshore hardbottom burial. The submerged artificial reef may be constructed using one of many various materials, and would sit on top of a foundation-type material to avoid subsidence. The beach fill material would come from the sources discussed in the beach nourishment structural measure, S-4.

S-7: Nearshore Berm Placement: Dredged material would be placed in the nearshore to provide wave attenuation benefits, passive nourishment of the active profile, or a combination of both. This method allows placement in water depths 15 feet and deeper, avoiding direct placement covering any potential nearshore hardbottom. This management measure assumes that a portion of the sand placed in shallow water will move towards the beach under normal wave conditions. Over time following construction, the sand bar will migrate towards the beach through natural sediment transport processes, become transported onto the beach, and shaped into the natural equilibrium profile of the beach, thus adding material and enlarging the beach. The dredged material would come from the sources discussed in the beach nourishment structural measure, S-4.

S-8: Emergent Breakwaters: The construction of breakwaters offshore along the Flagler County study area is considered as a management measure to stabilize the beach. Such structures reduce the amount of wave energy reaching the shoreline. As a result, the rate of annual erosion would decrease. The breakwaters would be constructed of large rock with foundation materials to prevent subsidence. The breakwaters would be trapezoidal in profile and would be placed parallel to the shoreline in shallow water. The breakwater would be constructed in segments, separated from each other, to prevent infilling between the beach and the breakwater. The elevation and length of each breakwater segment and the distance between segments would be designed considering the local wave and sediment transport characteristics.

S-10 - Dunes and Vegetation: The presence of dunes is essential if a beach is to remain stable and able to accommodate the natural forces applied by unpredictable storms and extreme conditions of wind, wave, and elevated sea surface. Dunes maintain a sand repository that, during storms, provides sacrificial sand reserves to the eroding beach profile before upland structures would be damaged. Following large erosional events, dunes are generally replenished by natural forces provided by the calmer weather conditions following a storm. The dune system provides a measure of public safety and property protection. Proper vegetation on dunes increases sand erosion resistance by binding the sand together via extensive root masses penetrating deep into the sand. Further, such vegetation promotes dune growth through its sand trapping action when significant wind action transports substantial quantities of sand. Additionally, healthy dune systems are visually attractive to beach visitors and contribute to the recreational beach experience and the general appearance of the beach community. This measure would include placement of beach compatible material, from either upland or offshore sources, in a dune feature adjacent to the existing bluff. The top elevation of the dune would tie into the bluff. The front slope of the dune would be a function of the material grain size and construction equipment. Vegetation would be planted after placement of the dune material.

3.7 SCREENING OF MANAGEMENT MEASURES

Screening is the ongoing process of eliminating measures which will no longer be considered, based on planning criteria.

3.7.1 PRELIMINARY SCREENING

Criteria for the St. Lucie Coastal Storm Risk Management (CSRM) Project were derived from the specific project objectives, four P&G accounts, as well as constraints. During this process, the interdependency, as well as the exclusivity of measures, is identified. This process serves to eliminate some measures from further consideration. Costs and benefits are not calculated at this stage.

In order to provide a metric for appraisal of the various management measures, a numeric score was applied by judging a measure's ability to meet planning objectives, avoid constraints, and to contribute to each of the four P&G accounts. The management measures were evaluated and rated in **Table 3-1** as follows: 0 = does not meet criteria, 1 = partially meets criteria, and 2 = fully meets criteria. If the total rating equals a number greater than 8, the measure partially meets, at least, over half of the objectives and constraints and is carried forward for further analysis. If the total rating is equal to or less than 8, the measure is not considered further. The final total rating should not be inferred to be a ranking of measures against one another. A measure's rating is only an indication of how likely it is to meet objectives given constraints and therefore carried forward or not. Conclusions from the matrixes are discussed below.

Table 3-1. Preliminary screening matrix.

St. Lucie County - Structural Management Measures for South Hutchinson Island Reach											
	Management Measures	**Planning Objectives**			**Constraints**	**Federal Objectives (4 Accounts)**					
		Reduce Storm Damages	Maintain Environmental Qulity	Maintain Recreation Opportunities	Avoid conflict with Federal and State Regulations	**National Economic Development (NED)** (potential to max. HSDR)	**Environmental Quality (EQ)** (maintain beach quality dune interaction)	**Other Social Effects (OSE)** (maintain beach and nearshore recreation consistent w/ laws)	**Regional Economic Development (RED)**	**Total Points**	**Carried Forward**
S-1	**Seawalls**	This measure could provide storm damage reduction to landward infrastructure during extreme storm conditions however, adjacent properties would become more vulnerable. Partially meets objective.	In the long term, sea walls can intensify erosion of the seaward profile and adjacent shorelines. This would reduce beach habitat. Does not meet objective.	This measure will likely cause decreased beach wisth over time. Does not meet the objective.	This measure is likely to be inconsistent with the state's Coastal Zone Management Plan when implemented at the scale being considered here. Partially meets objective.	Benefits not likely to out weigh costs of this measure as a stand alone measure. Could provide storm damage reduction if implemented in conjunction with a beach fill project. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Likely to have negative impacts on sea turtle nesting habitat. Not aesthetically appealing. Does not meet objective.	While this measure would provide a degree of storm damage reduction, reflection of wave energy off the seawall will likely intensify erosion and cause a range of public concerns. Does not meet this objective.	Increased erosion of the berm may negatively affect local tourism.		No
		1	0	0	1	0	0	0	0	2	
S-2	**Revetments**	This measure could provide storm damage reduction to landward infrastructure during extreme storm conditions however, adjacent properties would become more vulnerable. Partially meets objective.	In the long term, revetments can intensify erosion of the seaward profile and adjacent shorelines. This would reduce beach habitat. Does not meet objective.	This measure will likely cause decreased beach wisth over time. Does not meet the objective.	This measure is likely to be inconsistent with the state's Coastal Zone Management Plan when implemented at the scale being considered here. Partially meets objective.	Benefits not likely to out weigh costs of this measure as a stand alone measure, but could provide storm damage reduction if implemented in conjunction with a beach fill project. Fully meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Likely to have negative impacts on sea turtle nesting habitat. Not aesthetically appealing. Does not meet objective.	While this measure would provide a degree of storm damage reduction, reflection of wave energy off the seawall will likely intensify erosion and cause a range of public concerns. Does not meet this objective.	Increased erosion of the berm may negatively affect local tourism.		No
		1	0	0	1	2	1	1	1	7	
S-3	**Sand Covered Soft Structures**	This measure could provide storm damage reduction as a stand alone measure however requires a significant amount of maintenance and can become very aesthetically unappealing. Partially meets objective.	If sand cover is not maintained over the structure then environmental quality is lost. Partially meets objective	This measure may preserve, but not enhance, existing recreational opportunities. Partially meets the objective.	This measure has not been a favored alternative of the State in the past due to aesthetic and structural quality issues experienced in recent similar projects. Partially meets objective.	Benefits could possibly out weigh costs of this measure as a stand alone measure. Would provide some degree of storm damage reduction if implemented. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Sand would need to be maintained on top of the soft structures to ensure environmental quality. Would protect dune habitat, but could be detrimental if it became uncovered and remained that way. Partially meets objective.	Could provide storm damage reduction although these are not aesthetically pleaseing when not maintained. Could cause some public concerns. Partially meets this objective.	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.		No
		1	1	1	1	1	1	1	1	8	
S-4	**Beach Nourishment**	This measure would reduce storm damages to infrastructure landward of the nourished area and would not create erosion problems for adjacent shorelines. Could function as a stand alone measure. Fully meets objective.	Would result in significant impacts to nearshore hard bottom habitat however may preserve beach habitat. Would require a large amount of mitigation. Partially meets objective.	This measure will enhance existing recreation opportunities. Fully meets the objective.	Not likely to conflict with any State or Federal regulations. Fully meets objective.	This measure could contribute to NED if size and scale are optimized based on economics. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Would result in permanant negative impacts to nearshore resources although sea turtle nesting habitat will likely be maintained. Partially meets objective.	The recreational beach berm would be extended although nearshore recreation and resources will be affected. Does not conflict with any laws. This is the sponsor's favored alternative. Partially meets the objective.	Likely to positively impact on the regional economy. Partially meets this objective.		Yes
		2	1	2	2	1	1	1	1	11	
S-5	**Groins**	In combination with a beach fill. Groins could be used to stabilize "hot spot" erosional areas and maximize storm damage reduction. Fully meets objective.	This measure may have a minor affect on nearshore habitat but would help preserve beach habitat to a degree. Partially meets objective.	This measure may help preserve recreation and may enhance some recreational opportunities such as surfing and fishing. Partially meets the objective.	Likely to not be permitted by the state. Partially meets objective.	Could possibly contribute to NED if economically justified. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Periodic renourishments could be reduced. Positive impacts to sea turtle nesting habitat. Possible entrapment hazard for hatchling sea turtles. Partially meets objective.	Because only select areas would benefit, groins would not likely receive support from the entire community. In select areas the recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected. Partially meets this objective.	Could possibly have a minor positive impact on the regional econom. Needs to be implemented with a beach fill. Partially meets this objective.		Yes
		2	1	1	1	1	1	1	1	9	
		Carried Forward	Eliminated	2 Fully Meets Objective	1 Partially Meets Objective	0 Does Not Meet Objective					

St. Lucie County - Structural Management Measures for South Hutchinson Island Reach

	Management Measures	Planning Objectives			Constraints	Federal Objectives (4 Accounts)					
		Reduce Storm Damages	Maintain Environmental Qulity	Maintain Recreation Opportunities	Avoid conflict with Federal and State Regulations	**National Economic Development (NED)** (potential to max. HSDR)	**Environmental Quality (EQ)** (maintain beach quality dune interaction)	**Other Social Effects (OSE)** (maintain beach and nearshore recreation consistent w/ laws)	**Regional Economic Development (RED)**	**Total Points**	**Carried Forward**
S-6	**Submerged Artificial Reefs**	Could provide storm damage reduction if constructed in conjunction with a beach fill. Fully meets objective.	Could potentially enhance nearshore habitat although it is likely that there may already be exposed hard botoom habitat in much of the area where this measure would need to be constructed. Partially meets	May help to maintain the recreational beach berm. Could have possitive and/or negative effects on other nearshore recreation activities such as surfing or fishing. Partially meets the objective.	May not be permitted by the state. Partially meets objective.	Could possibly contribute to NED if economically justified. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Could enhance nearshore fish and beach habitat although would likely affect existing nearshore resources. Partially meets objective.	May create a safety hazard for swimmers. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing will be affected. This measure will be significant to the public. Partially meets this	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.		Yes
		2	1	1	1	1	1	1	1	9	
S-7	**Nearshore Berm Placement**	This measure could hypothetically reduce some degree of storm damages in the project area. Partially meets objective.	This measure would likely have a significant impact on existing nearsore resources. Does not meet objective.	May help maintain beach recreation but is likely to negatively interfere with other recreation opportunities. Partially meets the objective.	Likely to not be permitted by the state and/or Federal government due to environmental impacts. Does not meet this objective.	Could possibly contribute to NED if environmentally justified. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Would have significant impacts on nearshore resources. Partially meets this objective.	This measure is most likely to have all negative public perceptions because of environmental impacts and minimal storm damage protection. This is opposed by	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.		No
		1	0	1	0	1	1	0	1	5	
S-8	**Emergent Breakwaters**	Could provide storm damage reduction if constructed in conjunction with a beach fill. Partially meets objective.	This measure could create some degree of nearshore habitat however would likely impact existing resources. Partially meets objective.	May help maintain beach recreation but is likely to negatively interfere with other recreation opportunities. Partially meets the objective.	May not be permitted by the state. Partially meets objective.	Could possibly contribute to NED if economically and environmentally justified. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require	Could affect the nearshore resources. May affect turtle nesting lanes. Could create nearshore habitat. May have a negative effect on adjacent shorelines. Partially	May not be aesthetically pleasing. Could be a navigational hazard for boaters and may pose a safety risk for swimmers. Not favored by the public or the sponsor. Does not	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.		No
		1	1	1	1	1	1	0	1	7	
S-9	**Dunes and Vegetation**	This measure could provide a significant degree of storm damage reduction as a stand alone measure. Fully meets objective.	Dune habitat would be enhanced and expanded. Not likely to have negative impcts on existing resources. Fully meets objective.	Existing recreational opportunities would not be affected. Partially meets the objective.	Not likely to conflict with any State or Federal regulations. Fully meets objective.	This measure is most likely to contribute to NED based on the low relative cost and potential for effective storm damage reduction. Fully meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Dune habitat would be enhanced and expanded. Not likely to have any negative impacts. Aesthetically appealing. Fully meets objective.	This measure is currently supported by the community. Stable dunes maintain beach and nearshore recreation without negatively affecting environmental resources. Several local dune rehabilitation projects have been completed successfully in	This measure would maintain the existing regional economic conditions associated with storm damage protection and beach recreation. Could possibly have a minor positive impact on the regional economy. Partially meets this objective.		Yes
		2	2	1	2	2	2	2	1	14	

Carried Forward | Eliminated | 2 Fully Meets Objective | 1 Partially Meets Objective | 0 Does Not Meet Objective

St. Lucie County - Non-Structural Management Measures for South Hutchinson Island Reach

	Management Measures	Planning Objectives			Constraints	Federal Objectives - (4 Accounts)					
		Reduce Storm Damages	Maintain Environmental Quality	Maintain Recreation Opportunities	Avoid conflict with Federal and State Regulations	**National Economic Development (NED)** (potential to max. HSDR)	**Environmental Quality (EQ)** (maintain beach quality dune interaction)	**Other Social Effects (OSE)** (maintain beach and nearshore recreation consistent w/ laws)	**Regional Economic Development (RED)**	Rank	Carried Forward
NS-1	**No-Action**	This measure makes no attempt to reduce storm damages to coastal infrastructure. Does not meet the objective.	The beach berm and dunes will continue to function naturally through time. There is a potential for loss of habitat for shorebirds, sea turtles, etc. Nearshore hardbottoms will remain undisturbed. Existing conditions remain Fully meets the objective.	Existing conditions would continue into the future, not affecting current recreation opportunities. Fully meets objective.	Does not conflict with any laws. Fully meets objective.	No NED benefits are realized through this measure. No damages are prevented. No project costs. Makes no attempt to keep infrastructure from being damaged. No change in economic outputs. Does not contribute to this account/objective.	The beach berm and dunes will continue to erode naturally through time, causing a potential loss of habitat for shorebirds, sea turtles, etc, this may be offset by private dune restoration measures which could benefit dune habitat and storm damage protection. Nearshore	Coastal residents may experience loss of property and land, small scale protection measures may be implemented by home/condo owners, no storm damage reduction is provided, property values may decrease, public facilities likely	Does not contribute to RED.		yes*
		0	2	2	2	0	1	1	0	8	
NS-2	**Coastal Construction Control Line**	Relocating the CCCL or increasing construction setbacks will not meet this objective. A majority of the study area is undeveloped and protected by CBRA, southern shorelines are fully developed mostly with large, permanent structures. Does not meet objective	Rezoning in the northern study area could provide additional protection for existing environmental resources which are already protected by CBRA. The southern-most areas are already fully developed. Partially meets objective	Existing conditions would continue into the future, not affecting current recreation opportunities. Public recreation could be partially limited by decreased beach width. Partially meets objective.	Would require changes to State law. Partially meets objective.	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. This measure could partially contribute to NED. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	Enforcing setbacks will improve safety and improve the quality of the dunes. Individual private shore protection measures may affect dune habitat. Partially meets objective.	Ocean front property owners may not like this. Beach berm may continue to erode causing a gradual loss of beach recreation. Near shore recreation will not be affected. Would require changes to state law. Does	Does not contribute to RED.		No
		0	1	1	1	1	1	0	0	5	
NS-3	**Moratorium on Construction**	This would have little impact on storm damage reduction to existing infrastructure. Does not meet objective	The majority of the northern study area already has permanent status as public land, and is protected by CBRA. The southern study is already fully developed.Does not meet objective.	Existing conditions would continue into the future, not affecting current recreation opportunities. Public recreation could be partially limited by decreased beach width. Partially meets objective.	Attempts to implement moratoriums on construction have resulted in lawsuits in the past. Changes to local laws would be needed. This measure does not avoid conflict with existing laws and regulations.	Would only provide damage reduction benefits for potential future structures. NED benefits would be minimal. Makes no attempt to keep existing infrastructure from being damaged, but would reduce damages in the future. Partially meets objective. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	Quality of the existing coastal habitat could be preserved but there is also continued possibility of loss of habitat from continued erosion. Partially meets objective.	Property and tax revenue may decrease. May have an unfavorable public perception. Attempts to change local laws may result in lawsuits. OSE contribution is mostly negative.	Does not contribute to RED.		No
		0	0	1	0	1	1	0	0	3	
NS-4	**Establish a No-Growth Program**	This would have no impact on storm damage reduction to existing infrastructure. Does not meet objective	The majority of the northern study area already has permanent status as public land, and is protected by CBRA. This measure would preserve existing coastal habitat. Partially meets objective.	Existing conditions would continue into the future, preserving current recreation opportunities. This measure may limit future private property restrictions. Partially meets objective.	Changes to local laws would be needed. This measure may conflict with existing laws and regulations.	Makes no attempt to keep prevent damages to existing infrastructure but may reduce potential damage in the future. May partially contribute to NED benefits. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	The quality of existing coastal habitats would be maintained but they would also be at risk to future increased erosion. Partially contributes to EQ.	Property and tax revenue may decrease. Existing conditions will continue in regard to the environment and recreation. This may require changes to local law. Partial OSE result.	Potential for loss of property value and tax revenue.		No
		0	1	1	0	1	1	1	0	5	
NS-5	**Relocation of Structures**	If feasible this measure could reduce storm damages to infrastructure however, most vulnerable structures are too large to be relocated. Partially meets the storm damage reduction objective.	This measure has minimal potential to affect shorelines in the northern study areas and is impractical in the southern areas. If most vulnerable structures were relocated, natural environmental quality may be partially preserved.	This measure would have no impact on existing recreation unless the structures to be moved were related to existing public facilities. Partilly meets objective.	There would likely be no conflict with laws unless trying to relocate a historic structure. Partially meets objective.	Benefits not likely to out weigh costs in this study area. The structures in the most vulnerable areas are mostly large condos which are too big to reasonably relocated. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	Moving buildings back from the coast would provide more area for natural beach and dune habitat. If feasible, this measure could produce possitive EQ benefits.	This measure would displace large amounts of people during imlementation. Not likely to be feasible or cost-effective, public likely to dissent. Does not result in favorable OSE.	Does not contribute to RED.		No
		1	1	1	1	0	2	0	0	5	
NS-6	**Flood Proofing of Structures**	Various forms of flood proofing could provide significant storm damage reduction benefits. Fully meets objective.	This measure will have no impact on existing envornmental quality. Existing environmental conditions will continue into the future. Fully meets objective.	This measure will have no impact on recreation. Existing recreation opportunities will continue into the future. Fully meets objective.	The dry flood proofing does not comply with Section 2.1.7 of ASCE 24 (per FEMA), where dry flood proofing is not permitted in Coastal High Hazard Areas (Zone V)	Damage reduction benefits for structures would be realized. Flood proofing could significantly reduce structural and content damages to buildings. Fully meets objective to contribute to NED. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory unless structural upgrades to existing structures are required. Impacts more structures than NS-2.	No adverse effects would be created by this measure, nor would any positive benefits be realized. Partially meets objective.	This will improve safety, reduce storm damages and reduce insurance premiums. Natural coastal conditions will continue and beah and near shore recreation will not be affected. May be implemented privately at a cost to home/condo owners. Partial OSE result .	Does not contribute to RED.		No
		2	2	2	0	2	1	1	0	8	
NS-7	**Acquisition of Land and Structures**	This would not reduce storm damages, rather allow them to take their course. Does not meet objective.	Aquired land could be used to create public environmental and recreational preserves. Erosional conditions will continue at natural rates. Given the amount of condominiums in the study area, this would likely be cost prohibitive. Partially meets objective.	Aquired land could be used to create public environmental and recreational preserves. Erosional conditions will continue at natural rates. Partially meets objective.	By law, a government could, in the public interest, condemn land or structures. This alternative is most reasonable in undeveloped areas. Public agencies are very unlikely to receive authority to condemn private structures in developed areas. Partially meets objective.	Benefits could possibly outweigh the costs. Condemnation of most at risk structures and conversion of land to a natural areas will eliminate damages to infrastructure. This is likely to be met with extreme legal opposition. Partially meets objective. Sea Level Rise (SLR) rates: Would not	Condemnation of structures and their removal would provide more area for dune habitat and could improve environmental quality through creation of natural areas. Fully meets objective.	Acquired land could be converted to public property. Shorefront property owners would not like this. Likely to be met with extreme legal opposition from current property owners. OSE likely mostly negative.	Acquired land used for public parks could contribute to regional recreation and tourism economic benefits but necessarily create an economic boom. Partial contribution to RED.		No
		0	1	1	1	1	2	0	0	6	

Carried Forward | Eliminated | 2 Fully Meets Objective | 1 Partially Meets Objective | 0 Does Not Meet Objective | *The no-action plan is always carried forward.

St. Lucie County - Structural Management Measures for North, Power Plant, and Narrows

	Management Measures	Planning Objectives			Constraints	Federal Objectives (4 Accounts)					
		Reduce Storm Damages	Maintain Environmental Qulity	Maintain Recreation Opportunities	Avoid conflict with Federal and State Regulations	National Economic Development (NED) (potential to max. HSDR)	Environmental Quality (EQ) (maintain beach quality dune interaction)	Other Social Effects (OSE) (maintain beach and nearshore recreation consistent w/ laws)	Regional Economic Development (RED)	Total Points	Carried Forward
S-1	Seawalls	This measure could provide storm damage reduction to landward infrastructure during extreme storm conditions however, adjacent properties would become more vulnerable. Partially meets objective.	In the long term, sea walls can intensify erosion of the seaward profile and adjacent shorelines. This would reduce beach habitat. Does not meet objective.	This measure will likely cause decreased beach wisth over time. Does not meet the objective.	This measure is likely to be inconsistent with the state's Coastal Zone Management Plan when implemented at the scale being considered here. Partially meets objective.	Benefits not likely to out weigh costs of this measure as a stand alone measure due to little to zero structures to protect in the area. Does not meet objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Likely to have negative impacts on sea turtle nesting habitat. Not aesthetically appealing. Does not meet objective.	While this measure would provide a degree of storm damage reduction, reflection of wave energy off the seawall will likely intensify erosion and cause a range of public concerns. Does not meet this objective.	Increased erosion of the berm may negatively affect local tourism.		No
		1	0	0	1	0	0	0	0	2	
S-2	Revetments	This measure could provide storm damage reduction to landward infrastructure during extreme storm conditions however, adjacent properties would become more vulnerable. Partially meets objective.	In the long term, revetments can intensify erosion of the seaward profile and adjacent shorelines. This would reduce beach habitat. Does not meet objective.	This measure will likely cause decreased beach wisth over time. Does not meet the objective.	This measure is likely to be inconsistent with the state's Coastal Zone Management Plan when implemented at the scale being considered here. Partially meets objective.	Benefits not likely to out weigh costs of this measure as a stand alone measure due to little to zero structures to protect in the area. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Likely to have negative impacts on sea turtle nesting habitat. Not aesthetically appealing. Does not meet objective.	While this measure would provide a degree of storm damage reduction, reflection of wave energy off the seawall will likely intensify erosion and cause a range of public concerns. Does not meet this objective.	Increased erosion of the berm may negatively affect local tourism.		No
		1	0	0	1	1	0	0	0	3	
S-3	Sand Covered Soft Structures	This measure could provide storm damage reduction as a stand alone measure however requires a significant amount of maintenance and can become very aesthetically unappealing. Partially meets objective.	If sand cover is not maintained over the structure then environmental quality is lost. Partially meets objective	This measure may preserve, but not enhance, existing recreational opportunities. Partially meets the objective.	This measure has not been a favored alternative of the State in the past due to aesthetic and structural quality issues experienced in recent similar projects. Partially meets objective.	Benefits could possibly out weigh costs of this measure as a stand alone measure, but there are little to zero structures to protect. Would provide some degree of storm damage reduction if implemented. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Sand would need to be maintained on top of the soft structures to ensure environmental quality. Would protect dune habitat, but could be detrimental if it became uncovered and remained that way. May not be permittable. Does not meet objective.	Could provide storm damage reduction although these are not aesthetically pleaseing when not maintained. Could cause some public concerns. Partially meets this objective.	Does not meet this objective.		No
		1	1	1	1	1	0	1	0	6	
S-4	Beach Nourishment	This measure would reduce storm damages to infrastructure landward of the nourished area and would not create erosion problems for adjacent shorelines. Could function as a stand alone measure. Partially meets objective.	Would result in significant impacts to nearshore hard bottom habitat however may preserve beach habitat. Would require a large amount of mitigation. Partially meets objective.	This measure will enhance existing recreation opportunities. Fully meets the objective.	Not likely to conflict with any State or Federal regulations. Fully meets objective.	This measure could contribute to NED if size and scale are optimized based on economics, but unlikely as there are little to zero structures to protect. Does not meet objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Would result in permanant negative impacts to nearshore resources although sea turtle nesting habitat will likely be maintained. Partially meets objective.	The recreational beach berm would be extended although nearshore recreation and resources will be affected. Does not conflict with any laws. This is the sponsor's favored alternative. Partially meets the objective.	Does not meet this objective.		No
		1	1	2	2	0	1	1	0	8	
S-5	Groins	In combination with a beach fill. Groins could be used to stabilize "hot spot" erosional areas and maximize storm damage reduction. Fully meets objective.	This measure may have a minor affect on nearshore habitat but would help preserve beach habitat to a degree. Partially meets objective.	This measure may help preserve recreation and may enhance some recreational opportunities such as surfing and fishing. Partially meets the objective.	Likely to not be permitted by the state. Partially meets objective.	Could possibly contribute to NED if economically justified, but unlikely. Does not meet objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Periodic renourishments could be reduced. Positive impacts to sea turtle nesting habitat. Possible entrapment hazard for hatchling sea turtles. Does not meet objective.	Because only select areas would benefit, groins would not likely receive support from the entire community. In select areas the recreational beach berm would be extended. Nearshore recreation such as surfing and fishing may be affected. Does not meet this objective.	Does not meet this objective.		No
		1	1	1	1	0	0	0	0	4	

Carried Forward | Eliminated | 2 Fully Meets Objective | 1 Partially Meets Objective | 0 Does Not Meet Objective

St. Lucie County - Structural Management Measures for North, Power Plant, and Narrows

	Management Measures	Planning Objectives			Constraints	Federal Objectives (4 Accounts)					
		Reduce Storm Damages	Maintain Environmental Quality	Maintain Recreation Opportunities	Avoid conflict with Federal and State Regulations	National Economic Development (NED) (potential to max. HSDR)	Environmental Quality (EQ) (maintain beach quality dune interaction)	Other Social Effects (OSE) (maintain beach and nearshore recreation consistent w/ laws)	Regional Economic Development (RED)	Total Points	Carried Forward
S-6	Submerged Artificial Reefs	Could provide storm damage reduction if constructed in conjunction with a beach fill although they don't always perform to their design standards. Partially meets objective.	Could potentially enhance nearshore habitat although it is likely that there may already be exposed hard botoom habitat in much of the area where this measure would need to be constructed. Partially meets objective.	May help to maintain the recreational beach berm. Could have possitive and/or negative effects on other nearshore recreation activities such as surfing or fishing. Partially meets the objective.	May not be permitted by the state. Partially meets objective.	Could possibly contribute to NED if economically justified but unlikely. Does not meet objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Could enhance nearshore fish and beach habitat although would likely affect existing nearshore resources. Does not meet objective.	May create a safety hazard for swimmers. The recreational beach berm would be maintained. Nearshore recreation such as surfing and fishing will be affected. This measure will be significant to the public. Does not meet this objective.	Does not meet this objective.		No
		1	1	1	1	0	0	0	0	4	
S-7	Nearshore Berm Placement	This measure could hypothetically reduce some degree of storm damages in the project area. Partially meets objective.	This measure would likely have a significant impact on existing nearsore resources. Does not meet objective.	May help maintain beach recreation but is likely to negatively interfere with other recreation opportunities. Partially meets the objective.	Likely to not be permitted by the state and/or Federal government due to environmental impacts. Does not meet this objective.	Could possibly contribute to NED if environmentally justified. Partially meets objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Would have significant impacts on nearshore resources. Does not meet this objective.	This measure is most likely to have all negative public perceptions because of environmental impacts and minimal storm damage protection. This is opposed by the public and does not meet the objectives.	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.		No
		1	0	1	0	1	0	0	1	4	
S-8	Emergent Breakwaters	Could provide storm damage reduction if constructed in conjunction with a beach fill. Partially meets objective.	This measure could create some degree of nearshore habitat however would likely impact existing resources. Partially meets objective.	May help maintain beach recreation but is likely to negatively interfere with other recreation opportunities. Partially meets the objective.	May not be permitted by the state. Partially meets objective.	Unlikely for cost to outweigh benefits. Does not meet objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Could affect the nearshore resources. May affect turtle nesting lanes. Could create nearshore habitat. May have a negative effect on adjacent shorelines. Does not meet objective.	May not be aesthetically pleasing. Could be a navigational hazard for boaters and may pose a safety risk for swimmers. Not favored by the public or the sponsor. Does not meet objectives.	Does not meet this objective.		No
		1	1	1	1	0	0	0	0	4	
S-9	Dunes and Vegetation	This measure could provide a significant degree of storm damage reduction as a stand alone measure. However, dunes may not reduce all damages. Partially meets the objective.	Dune habitat would be enhanced and expanded. Not likely to have negative impcts on existing resources. Fully meets objective.	Existing recreational opportunities would not be affected. Partially meets the objective.	Not likely to conflict with any State or Federal regulations. Fully meets objective.	This measure is most likely to contribute to NED based on the low relative cost and potential for effective storm damage reduction, but there are little to no structures to protect. Does not meet objective. Sea Level Rise (SLR): Could be affected and could require modifications.	Dune habitat would be enhanced and expanded. Not likely to have any negative impacts. Aesthetically appealing. Partially meets objective.	This measure is currently supported by the community. Stable dunes maintain beach and nearshore recreation without negatively affecting environmental resources. Several local dune rehabilitation projects have been completed successfully in the past. Partially meets the objective.	Does not meet this objective.		No
		1	2	1	2	0	1	1	0	8	

Carried Forward | Eliminated | 2 Fully Meets Objective | 1 Partially Meets Objective | 0 Does Not Meet Objective

St. Lucie County - Non-Structural Management Measures for North, Power Plant, and Narrows

	Management Measures	Planning Objectives			Constraints	Federal Objectives - (4 Accounts)					
		Reduce Storm Damages	Maintain Environmental Qulity	Maintain Recreation Opportunities	Avoid conflict with Federal and State Regulations	**National Economic Development (NED)** (potential to max. HSDR)	**Environmental Quality (EQ)** (maintain beach quality dune interaction)	**Other Social Effects (OSE)** (maintain beach and nearshore recreation consistent w/ laws)	**Regional Economic Development (RED)**	Rank	Carried Forward
	Nonstructural Measures (NS)										
NS-1	**No-Action**	This measure makes no attempt to reduce storm damages to coastal infrastructure. Does not meet the objective.	The beach berm and dunes will continue to function naturally through time. There is a potential for loss of habitat for shorebirds, sea turtles, etc. Nearshore hardbottoms will remain undisturbed. Existing conditions remain Fully meets the objective.	Existing conditions would continue into the future, not affecting current recreation opportunities. Fully meets objective.	Does not conflict with any laws. Fully meets objective.	No NED benefits are realized through this measure. No damages are prevented. No project costs. Makes no attempt to keep infrastructure from being damaged. No change in economic outputs. Does not contribute to this account/objective.	The beach berm and dunes will continue to erode naturally through time, causing a potential loss of habitat for shorebirds, sea turtles, etc, this may be offset by private dune restoration measures which could benefit dune habitat and storm damage protection. Nearshore hardbottoms will remain undisturbed. Partially	Coastal residents may experience loss of property and land, small scale protection measures may be implemented by home/condo owners, no storm damage reduction is provided, property values may decrease, public facilities likely unaffected. Partial OSE result.	Does not contribute to RED.		yes*
		0	2	2	2	0	1	1	0	8	
NS-2	**Coastal Construction Control Line**	Relocating the CCCL or increasing construction setbacks will not meet this objective. A majority of the study area is undeveloped and protected by CBRA, southern shorelines are fully developed mostlly with large, permanent structures. Does not meet objective	Rezoning in the northern study area could provide additional protection for existing environmental resources which are already protected by CBRA. The southern-most areas are already fully developed. Partially meets objective	Existing conditions would continue into the future, not affecting current recreation opportunities. Public recreation could be partially limited by decreased beach width. Partially meets objective.	Would require changes to State law. Partially meets objective.	Would only provide damage reduction benefits for potential future structures, which is unlikely due to area in CBRA zone. This line already exisits, no NED benefits to be gained. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	Setbacks are already in place.	This already exists. Near shore recreation will not be affected. Does not contribute possitively to OSE objectives.	Does not contribute to RED.		No
		0	1	1	1	0	0	0	0	3	
NS-3	**Moratorium on Construction**	This would have little impact on storm damage reduction to existing infrastructure. Does not meet objective	The majority of the northern study area already has permanent status as public land, and is protected by CBRA. The southern study is already fully developed.Does not meet objective.	Existing conditions would continue into the future, not affecting current recreation opportunities. Public recreation could be partially limited by decreased beach width. Partially meets objective.	Attempts to implement moratoriums on construction have resulted in lawsuits in the past. Changes to local laws would be needed. This measure does not avoid conflict with existing laws and regulations.	Would only provide damage reduction benefits for potential future structures, which is unlikely due to area in CBRA zone. NED benefits would be minimal. Makes no attempt to keep existing infrastructure from being damaged, but would reduce damages in the future. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	Quality of the existing coastal habitat could be preserved but this is already being done passively through CBRA zone.	This is already pasivley being done through CBRA. Property and tax revenue may decrease. May have an unfavorable public perception. Attempts to change local laws may result in lawsuits. OSE contribution is mostly negative.	Does not contribute to RED.		No
		0	0	1	0	0	0	0	0	1	
NS-4	**Establish a No-Growth Program**	This would have no impact on storm damage reduction to existing infrastructure. Does not meet objective	The majority of the northern study area already has permanent status as public land, and is protected by CBRA. This measure would preserve existing coastal habitat. Partially meets objective.	Existing conditions would continue into the future, preserving current recreation opportunities. This measure may limit future private property restrictions. Partially meets objective.	Changes to local laws would be needed. This measure may conflict with existing laws and regulations.	Makes no attempt to keep prevent damages to existing infrastructure but may reduce potential damage in the future, which is unlikely due to area in CBRA zone. May partially contribute to NED benefits. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory.	The quality of existing coastal habitats would be maintained but they would also be at risk to future increased erosion. Already being done through CBRA. Partially contributes to EQ.	Property and tax revenue may decrease. Existing conditions will continue in regard to the environment and recreation. Already being done through CBRA. This may require changes to local law. Partial OSE result.	Potential for loss of property value and tax revenue.		No
		0	1	1	0	1	1	1	0	5	
NS-5	**Relocation of Structures**	If feasible this measure could reduce storm damages to infrastructure however, most vulnerable structures are too large to be relocated. Partially meets the storm damage reduction objective.	This measure has minimal potential to affect shorelines in the northern study areas and is impractical in the southern areas. If most vulnerable structures were relocated, natural environmental quality may be partially preserved.	This measure would have no impact on existing recreation unless the structures to be moved were related to existing public facilities. Partially meets objective.	There would likely be no conflict with laws unless trying to relocate a historic structure. Partially meets objective.	Benefits not likely to out weigh costs in this study area. The structures in the most vulnerable areas are mostly large condos which are to big to reasonably relocate. Sea Level Rise (SLR) rates: Does not impact storm damages to	Moving buildings back from the coast would provide more area for natural beach and dune habitat. If feasible, this measure could produce positive EQ benefits.	This measure would displace large amounts of people during imlementation. Not likely to be feasible or cost-effective, public likely to dissent. Does not result in favorable OSE.	Does not contribute to RED.		No
		1	1	1	1	0	0	0	0	4	
NS-6	**Flood Proofing of Structures**	Various forms of flood proofing could provide significant storm damage reduction benefits. Fully meets objective.	This measure will have no impact on existing envornmental quality. Existing environmental conditions will continue into the future. Fully meets objective.	This measure will have no impact on recreation. Existing recreation opportunities will continue into the future. Fully meets objective.	The dry flood proofing does not comply with Section 2.1.7 of ASCE 24 (per FEMA), where dry flood proofing is not permitted in Coastal High Hazard Areas (Zone V)	There are few to zero structures to protect in this area. Does not meet objective to contribute to NED. Sea Level Rise (SLR) rates: Does not impact storm damages to existing inventory unless structural upgrades to existing	No adverse effects would be created by this measure, nor would any positive benefits be realized. Partially meets objective.	There are few to zero structures to protect in this area. No OSE result .	Does not contribute to RED.		No
		2	2	2	0	0	1	0	0	7	
NS-7	**Acquisition of Land and Structures**	This would not reduce storm damages, rather allow them to take their course. Does not meet objective.	Aquired land could be used to create public environmental and recreational preserves. Erosional conditions will continue at natural rates. Partially meets objective.	Aquired land could be used to create public environmental and recreational preserves. Erosional conditions will continue at natural rates. Partially meets objective.	By law, a government could, in the public interest, condemn land or structures. This alternative is most reasonable in undeveloped areas. Public agencies are very unlikely to receive authority to condemn private structures in developed areas. Partially meets objective.	There are few to zero structures in this area. Does not meets objective. Sea Level Rise (SLR) rates: Would not impact.	There are few to zero structures in this area. Does not meet objective.	There are few to zero structures in this area. Does not meet objective. No OSE result.	Does not contribute to RED.		No
		0	1	1	1	0	0	0	0	3	

Carried Forward | Eliminated | 2 Fully Meets Objective | 1 Partially Meets Objective | 0 Does Not Meet Objective

*The no-action plan is always carried forward.

The measures in North Hutchinson Island, Power Plant, and Narrows of Hutchinson Island reaches were jointly screened due to their similarities and proximity to one another. For these reaches, structural management measures were not carried forward, due to the cost of construction as well minimal damageable structures in the area, other than the Florida Power and Light (FPL) Power Plant in the Power Plant reach. Further, all three reaches are almost entirely within the CBRS unit, with the exception of the shoreline immediately in front of the FPL Power Plant which has revetment, indicating that FPL Plant has already taken measures to protect the plant (including its existing elevation of 20 feet above sea level). For these reaches, there are little to no structures to protect, with the exception of A1A. This highway is a major evacuation route, but is set back from the immediate project area in the upper reaches, with the exception of the Narrows of Hutchinson Island reach. In the Narrows of Hutchinson Island reach where A1A is most potentially vulnerable to storm damage, USACE contacted Florida Department of Transportation (FDOT) to discuss potential needs for a Federal project to protect A1A. According to discussions with FDOT, needs have been met for A1A and will continue to be met by FDOT in specific locations, with no need for a Federal project at this time. Additionally, the CBRS unit effectively rules out any Federal participation. Most non-structural measures are already in place or are being accomplished passively through the CBRA unit. After careful consideration and evaluation of all measures, and discussion with the Sponsor, all non-structural and structural measures were screened out, except for the no-action measure. For all the reasons described above, it was assumed there would be no-action for these reaches.

The South Hutchinson Island reach was screened as a stand-alone reach, with a length of approximately 3.4 miles. The CBRS unit is present in this reach from R98 to R98 +200 feet and from R101.5 to R103.5. The non-CBRS shoreline is the southernmost part of St. Lucie County and stretches 2.6 miles from approximately R103 to the St. Lucie/Martin County line at R115+1000 feet. The following structural measures were carried forward: S-4 Beach Nourishment, S-5 Groins, S-6 Submerged Artificial Reefs, and S-9 Dunes and Vegetation. Most non-structural measures are already being pursued by the local sponsor, or were not feasibly implementable. Acquisition of land and structures was cost prohibitive due to the high cost to buy condominiums (estimated during the Value Engineering Study process), the main damageable structures in the study area, in addition to the likely unpopularity among residents and owners. Flood proofing of structures (dry), such as flood shields, does not comply with Section 1,2,7 of ASCE 24 (per FEMA) where dry floodproofing in not permitted in Coastal High Hazard Areas (Zone V). The following non-structural measures were carried forward: NS-1 No-action.

Management measures that were carried forward after initial screening include:

<u>North Hutchinson Island, Power Plant, Narrows of Hutchinson Island reaches</u>
NS-1: No-Action

<u>South Hutchinson Island reaches</u>
NS-1: No-action
S-4: Beach Nourishment
S-5: Groins (low-profile)
S-6: Submerged Artificial Reefs
S-9: Dunes and Vegetation

3.7.2 FORMULATION STRATEGY

Measures, used singularly or in combination with others, create alternatives; and varying scales of each create additional alternatives. An alternative may be implementable for a portion of a reach but not for an entire reach. The combination of management measures results in alternatives that merit further analysis.

The CBRS (Coastal Barrier Resource System) unit is present from R98 to R98 + 180 feet, which is part of a privately owned undeveloped parcel and from R101.5 to R103.5, which is part of St. Lucie owned land for a public park. At this point, the alternatives with structural measures were avoided in the CBRS unit, with the exception of S-4 Beach Nourishment and S-9 Dunes and Vegetation (which are considered non-structural by USFWS). The length of R98 to R98 + 200 feet is a very small part of study area and has a remaining additional 70 feet of non-CBRA on the same private undeveloped parcel. In this case, it assumed that any alternatives which are not beach or dunes would begin at R98 + 270 feet where a new parcel begins which is owned by St. Lucie County and a public park, rather than R98 to avoid the CBRS unit in that area, as well as the small remaining distance on the private undeveloped parcel.

Avoidance of impacts to hardbottom was a prevalent part of the rationale, both from an environmental standpoint and cost standpoint, and played a large part in determination of feasible alternative combinations.

Non-Structural – Combinability Discussion

NS-1: No-action. This measure is a stand-alone alternative. However, it could be used in a sub-reach and recommend other measures in other sub-reaches.

Throughout the study area nonstructural risk reduction measures including education efforts, maintenance of evacuation route signage, zoning codes, and setback requirements were carried forward as elements of any complete systematic package of risk reduction measures. Many of these additional nonstructural efforts are currently being pursued by St. Lucie County would be performed locally.

Structural Measures– Combinability Discussion

S-4: Beach Nourishment: This measure could be a stand-alone alternative or could be combined with S-5, S-6, or S-9.

S-5: Groins: This measure would need to be combined with S-4, in order to avoid starving downdrift areas of sand.

S-6: Submerged Artificial Reefs: This measure could be a stand-alone alternative or could be combined with S-4.

S-9: Dunes and Vegetation: This measure could be a stand-alone alternative or could be combined with S-4.

Those measures were combined into alternatives, based on the combinability rationale discussed above, and using engineering judgment to assess the most effective combinations given the conditions in the

study area. This included minimum and maximum nourishment templates, which would mimic a smaller beach berm versus a larger beach berm (which would trigger hardbottom mitigation), as well as a much smaller beach nourishment fill, where the purpose would be to fill in low lying areas which potentially act as a conduit for water flow and flooding. A truck option with upland borrow source versus offshore borrow was also detailed in the alternatives.

The resulting alternatives are listed below:

- Alternative 1 – NO-ACTION
- Alternative 2 – Dunes with Vegetation
- Alternative 3 – Beach Nourishment (smaller template)
- Alternative 4 – Beach Nourishment (smaller template) with trucking
- Alternative 5 – Beach Nourishment (smaller template) AND Dunes with Vegetation
- Alternative 6 – Beach Nourishment (larger template) with Hardbottom Mitigation
- Alternative 7 – Beach Nourishment (larger template) with Hardbottom Mitigation AND Dunes with Vegetation
- Alternative 8 – Submerged Artificial Reefs
- Alternative 9 – Submerged Artificial Reefs AND beach nourishment (one-time event)
- Alternative 10 – Groins (low-profile) AND Beach Nourishment (smaller template)

3.8 ALTERNATIVE MILESTONE

With the advent of SMART and 3x3x3 Planning (Water Resources Reform and Development Act (WRRDA) 2014), the study received funding and was realigned in 2014 to meet the 3x3x3 Planning milestones, the first of which is the Alternatives Milestone which was held in June 2015. The alternatives outlined above were approved to be feasible for the study area. **With non-federal sponsor concurrence, the decision was made at the Alternatives Milestone or shortly thereafter with follow up meeting to de-scope the project by eliminating the Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island reaches from further analysis based on the following:**

- All three reaches are almost entirely within the CBRS unit, with the exception of the shoreline immediately in front FPL Power Plant which has revetment, indicating that FPL has already taken measures to protect the plant (including its existing elevation of 20 feet above sea level). The CBRS unit effectively rules out any Federal participation.
- For these reaches, there are little to no structures to protect, with the exception of A1A.
- A1A is a major evacuation route, but is set back from the immediate project area in the upper reaches, with the exception of the Narrows of Hutchinson Island reach. In the Narrows of Hutchinson Island reach where A1A is most potentially vulnerable to storm damage, USACE contacted Florida Department of Transportation (FDOT) to discuss potential needs for a Federal project to protect A1A. According to discussions with FDOT, needs have been met for A1A and will continue to be met by FDOT in specific locations, with no need for a Federal project at this time.

3.9 SECONDARY SCREENING: SCREENING WITH PRELIMINARY COSTS PRIOR TO BEACH-FX

During the process of developing screening level costs, the alternatives which are beach nourishment, or include it, were expanded to minimum and maximum berms for both the smaller and larger templates. This offers a range for the alternatives to better focus on the efficiency of varying berm widths with regard to reducing storm damages. Additionally, the alternatives which are dunes with vegetation, or include it, were expanded to minimum and maximum dune extensions. This exercise created variations within the alternatives, the full list which is listed below:

- Alternative 1 – NO-ACTION
- Alternative 2 – Dunes with Vegetation
    - 2A: Minimum dune extension 10 feet
    - 2B: Maximum dune extension 20 feet
- Alternative 3 - Beach Nourishment (smaller template)
    - 3A: Minimum Berm 20 feet
    - 3B: Maximum Berm 40 feet
- Alternative 4 – Beach Nourishment (smaller template) with trucking
    - 4A: Minimum Berm 20 feet
    - 4B: Maximum Berm 40 feet
- Alternative 5 - Beach Nourishment (smaller template) AND Dunes with Vegetation
    - 5A: Minimum dune extension 10 feet + Minimum Berm 20 feet
    - 5B: Maximum dune extension 20 feet + Maximum Berm 40 feet
- Alternative 6 – Beach Nourishment (larger template) with Hardbottom Mitigation
    - 6A: Minimum Berm 60 feet
    - 6B: Maximum Berm 100 feet
- Alternative 7 – Beach Nourishment (larger template) with Hardbottom Mitigation AND Dunes with Vegetation
    - 7A: Minimum dune extension 10 feet + Minimum Berm 60 feet
    - 7B: Maximum dune extension 20 feet + Maximum Berm 100 feet
- Alternative 8 – Submerged Artificial Reefs
- Alternative 9 – Submerged Artificial Reefs AND beach nourishment (one-time event)
    - 9A: Minimum Berm 20 feet
    - 9B: Maximum Berm 40 feet
- Alternative 10 – Groins (low-profile) AND Beach Nourishment (smaller template)
    - 10A: Minimum Berm 20 feet
    - 10B: Maximum Berm 40 feet

Screening with Screening Level Costs Prior to Beach-Fx

In order to screen the alternatives prior to Beach-fx modeling, preliminary costs were developed for each of the alternatives. The preliminary costs were developed using information from historical projects. These costs were brought to present value (PV) based on maintenance assumptions over 50 years.

Beach-fx, Future without-project Condition, and Sea-Level Change (SLC)

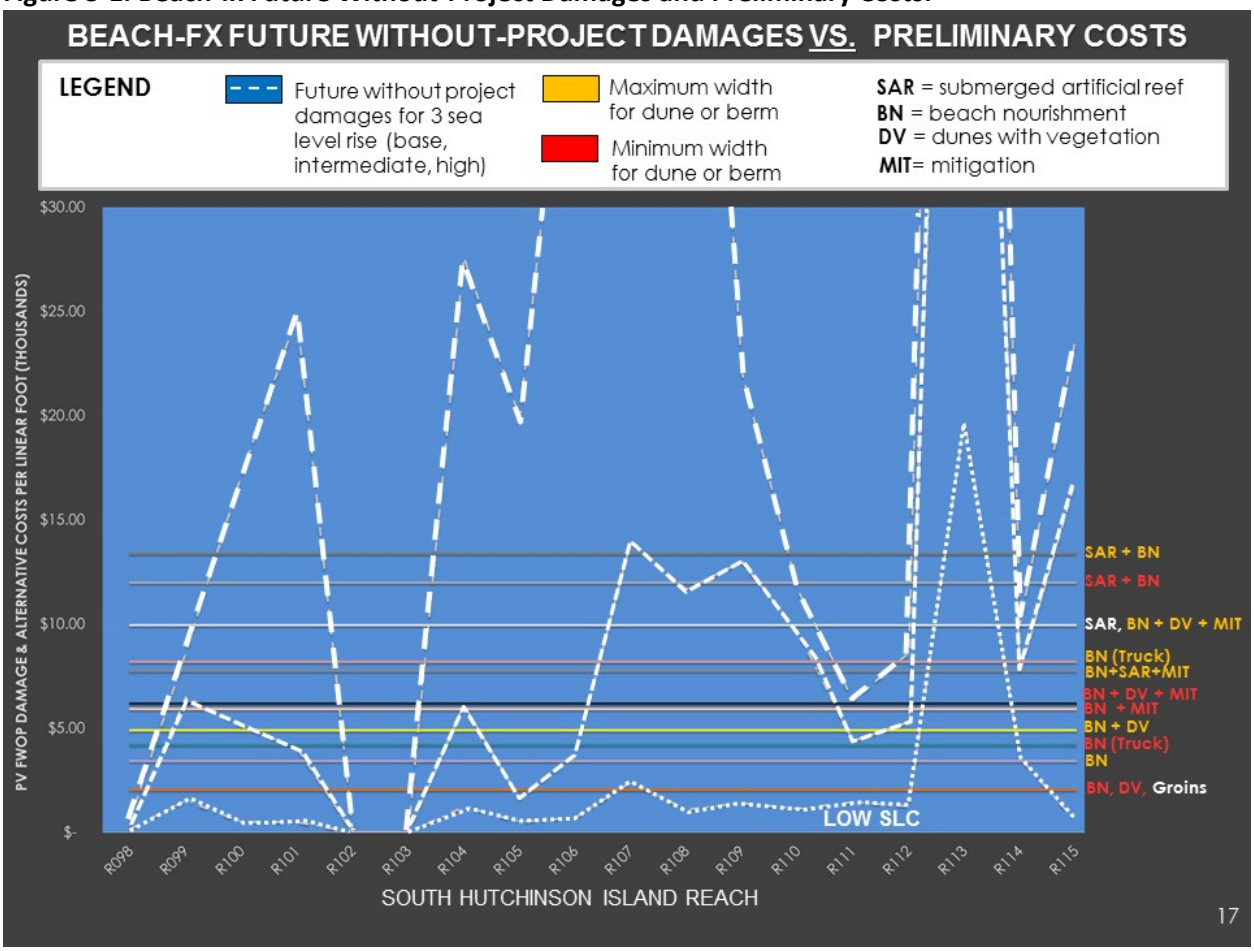
Beach-fx was run for the future without-project (FWOP) condition using each of the three Sea Level Change (SLC) scenarios prescribed by ER 1100-2-8162.

A project's benefit-to-cost ratio (B/C ratio) must be greater than 1.0 in order for an alternative to be justified and implementable; in short, the benefits must be greater than the costs. Benefits equal damages prevented, or the difference between without-project damages and damages resulting after implementation of an alternative.

In the future without-project model runs, damages are used as a proxy for benefits. Using the value of without-project damages as a substitute for the benefits will overestimate the benefit provided by any measure since this assumes that 100 percent of damages have been averted. Therefore if the cost of implementing an alternative is equal to, or less than the without-project damages, the B/C ratio can be assumed to approximate 1.

Figure 3-1 displays the costs in addition to damages along the shoreline for each of the three SLC scenarios. Wherever damages were far below an alternative's implementation costs, it was assumed that the alternative would not be justified along that shoreline length and the alternative was screened out.

Figure 3-1. Beach-fx Future Without-Project Damages and Preliminary Costs.



Where damages are near or above preliminary costs it was assumed that the alternative was justified and was carried forward. This comparison not only helps in screening, but it also serves to scope alternatives that are carried forward.

The cost of an alternative's implementation may vary depending on the SLC scenario used for design. Because of this it is important to note that there is uncertainty regarding future costs, and alternatives with costs just above projected damages should not be screened out prematurely. Other measures may have the same implementation cost for any scenario.

In **Figure 3-1**, damages are shown for each preliminary Beach-fx sub-reach within the main South Hutchinson Island reach. Straight horizontal lines are the preliminary costs for the alternatives. The damages typically include both damages to infrastructure (roads, houses, condos, dune walkovers, etc), as well as costs for replacing and constructing armor as it is damaged or triggered in the model. In this case, there is no armor in St. Lucie County, and therefore damages only include infrastructure.

Many combinations had preliminary costs that far exceed the expected damages along lengths of shoreline of sufficient length to realistically implement an alternative and were screened out.

This step was helpful to discern the alternatives which were too costly to provide BCRs above 1 in any of the sub-reaches. The alternatives screened out from this effort and reasons are listed below:

- All artificial reef alternatives, as the highest cost alternatives, were screened out (Alternatives 10 and 11).
- Alternative 7: All of the options for nourishment, dunes with vegetation, and hardbottom mitigation are screened out.
- Alternative 4: Although this alternative shows a different method of achieving the same goal as the other beach nourishment alternatives, it shows that at this time the trucking option is not viable for the maximum berm option. Trucking in general is more costly than the currently proposed offshore borrow area, and will be screened out at this time, but can be considered later if needed and viable.

The FWOP damages in the sub-reaches vary and the costs alone did not necessarily help to screen out alternatives. For additional screening, all alternatives were evaluated against planning objectives, constraints, P&G accounts, and criteria of completeness, effectiveness, efficiency, and acceptability. As a result, the following additional alternatives were screened out: Alternative 12 – Groins and Alternative 6 – Beach nourishment (large template) with hardbottom mitigation. The no-action alternative does not meet any of the planning objectives because it does not address any specific problems; however, it provides a comparison for all other alternatives.

A summary of the reasons for screening out the above alternatives are described below:

- Alternative 6 – Beach nourishment (large template) with hardbottom mitigation: Hardbottom mitigation is to be avoided within the study area, as stated in formulation strategy rationale, and would be environmentally unfavorable and as well costly.

- Alternative 12 – Groins: Groins could be unfavorable to the community, which currently does not have any structures along the beach, as well as potentially negative impacts to sea turtle habitat. The erosion rate in this area is fairly uniform, and applying structures in a specific area could negatively alter the natural forces and erosion rates in adjacent areas.

This resulted in the following alternatives carried forward to final screening:

- Alternative 1 – NO-ACTION
- Alternative 2 – Dunes with Vegetation
    - 2A: Minimum dune extension 10 feet
    - 2B: Maximum dune extension 20 feet
- Alternative 3 - Beach Nourishment (smaller template)
    - 3A: Minimum Berm 20 feet
    - 3B: Maximum Berm 40 feet
- Alternative 5 - Beach Nourishment (smaller template) AND Dunes with Vegetation
    - 5A: Minimum dune extension 10 feet + Minimum Berm 20 feet
    - 5B: Maximum dune extension 20 feet + Maximum Berm 40 feet

3.10 FINAL SCREENING: FUTURE WITH-PROJECT MODELING IN BEACH-FX

The 3 remaining alternatives, with minimum and maximum variations, were then modeled in Beach-fx, to evaluate future with-project (FWP) damages. Comparing "future without" to "future with" project damages results in the damage prevention provided by the alternative, where damage prevention is equivalent to storm damage reduction benefits.

The broad alternatives of 1,2, 3, and 5 listed above in the previous section were then expanded to show possible berms widths, dune widths, and combinations of both berms and dunes. The alternatives were designated as follows:

- **A**BERMxDuneEx represents a zero foot design berm, and maintaining the 2008 berm("existing condition") with a x foot extension, and also maintaining the 2008 dune("existing condition").

- **B**BERMxDuneEx represents an x foot design berm, and maintaining the 2008 berm("existing condition") with a 10 foot design berm with a (10 + x foot) extension, and also maintaining the 2008 dune("existing condition").

- **C**BERMxDuneEx represents an x foot design berm, and maintaining the 2008 berm("existing condition") with a 10 foot design berm with a (10 + x foot) extension, and also maintaining the 2008 dune("existing condition").

- DuneEx: represents maintenance of the 2008 dune only

- DuneX: represents maintenance of the 2008 dune with an additional x foot extension

The array shown in **Table 3-2** presents the results of the alternatives after running the Beach-fx model for 25 iterations (compared to 100 iterations). This allowed a preliminary output in a shorter timeframe, rather than running 100 iterations which would be more time consuming and would give similar outputs. The results give storm damage reduction benefits, and are organized by highest net benefits to lowest net benefits, and show that only nine alternatives have the highest net benefits which would then translate to benefit to cost ratios which are over 0.5. Selecting the alternatives with a BCR over 0.5 gives reasonable assurance that an alternative could then be justified {BCR over 1} after adding recreation and land loss benefits.

Table 3-2. Expanded Array of Alternatives.

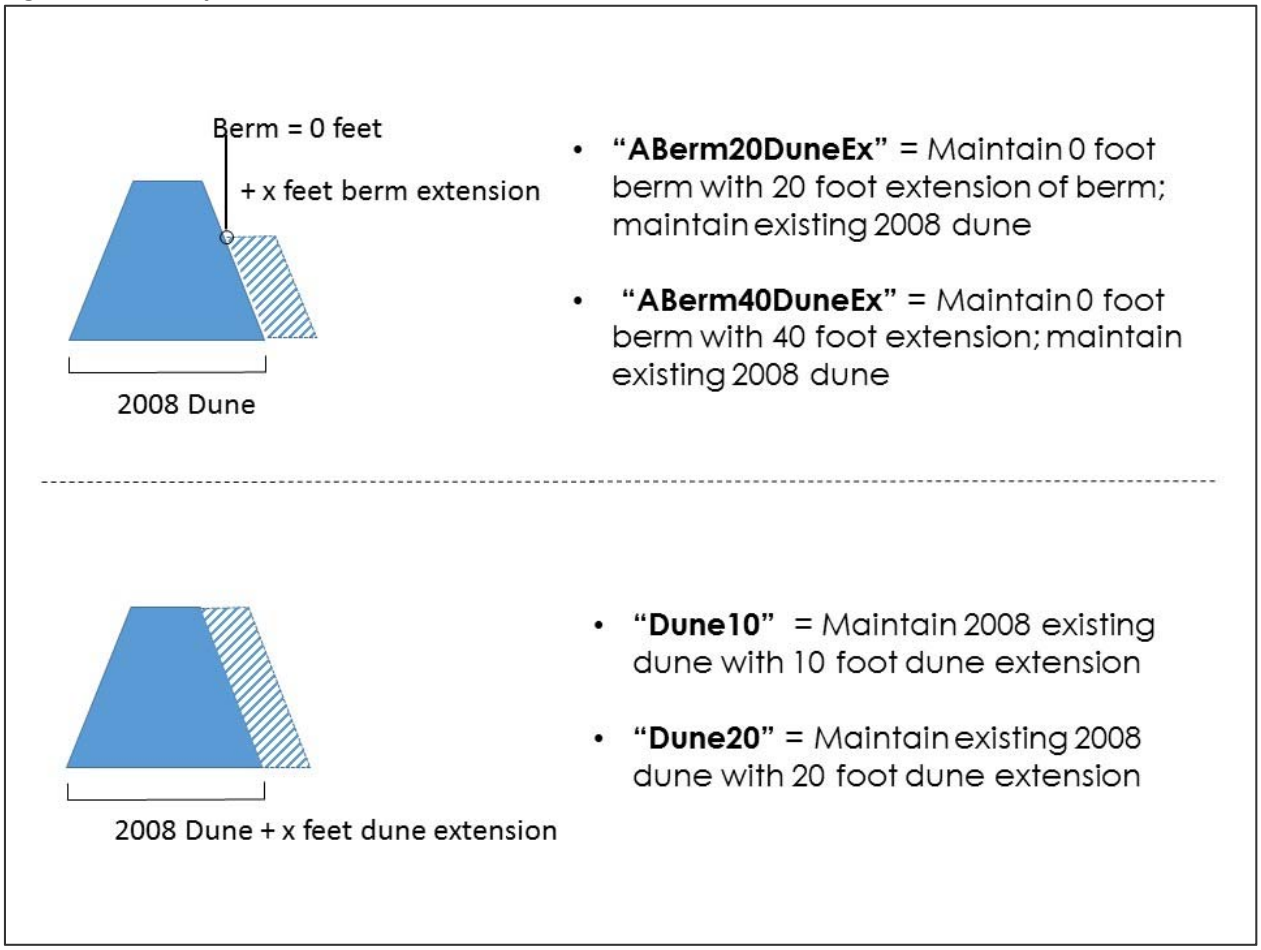
Alternative Name	Avg Total Project Vol (CY)	Avg Renourishment Interval (Years	Mob, PED, S&A Cost ($)	Additional Initial Costs ($)	Alternative iteration.csv Avg PV Place Costs ($)	Total PV Costs	FWOP iteration.csv Avg PV Damages ($)	FWP iteration.csv Avg PV Damages ($)	Avg PV Total Project Benefits ($)	Net Benefi	BC
ABERM10DuneEx	6,006,856	12	$ 8,069,737	$ 231,656	$13,426,270	$21,727,663	$24,579,504	$2,198,127	$22,381,377	$ 653,714	1.03
ABerm20DuneEx	10,649,836	16	$ 5,948,519	$1,174,900	$17,468,395	$24,591,814	$24,579,504	$2,271,977	$22,307,528	$ (2,284,286)	0.91
Dune10	6,626,298	12	$ 8,092,826	$2,817,200	$14,685,861	$25,595,887	$24,579,504	$2,364,452	$22,215,052	$ (3,380,835)	0.87
ABerm30DuneEx	15,688,521	19	$ 5,099,081	$ 694,968	$21,585,818	$27,379,867	$24,579,504	$2,430,245	$22,149,259	$ (5,230,608)	0.81
ABerm10Dune10	10,089,763	15	$ 6,917,051	$2,939,439	$19,349,184	$29,205,673	$24,579,504	$2,206,159	$22,373,345	$ (6,832,328)	0.77
ABerm40DuneEx	20,003,186	20	$ 4,857,220	$1,734,600	$26,040,978	$32,632,798	$24,579,504	$2,394,011	$22,185,493	$ (10,447,304)	0.68
Dune20	10,575,649	14	$ 7,183,314	$5,517,500	$20,959,864	$33,660,678	$24,579,504	$2,373,871	$22,205,633	$ (11,455,045)	0.66
BBerm30DuneEx	7,424,509	9	$10,788,174	$ 694,968	$24,736,108	$36,219,249	$24,579,504	$2,068,343	$22,511,162	$ (13,708,088)	0.62
ABerm60DuneEx	28,788,703	22	$ 4,617,313	$1,389,935	$34,914,330	$40,921,578	$24,579,504	$2,350,820	$22,228,684	$ (18,692,894)	0.54
ABerm40Dune10	21,780,431	17	$ 6,032,256	$3,634,406	$35,823,237	$45,489,900	$24,579,504	$2,225,228	$22,354,276	$ (23,135,624)	0.49
ABerm20Dune20	12,840,428	12	$ 8,247,126	$5,878,877	$31,453,613	$45,579,617	$24,579,504	$2,055,793	$22,523,711	$ (23,055,905)	0.49
ABerm80DuneEx	37,709,339	23	$ 4,357,867	$1,853,247	$42,763,082	$48,974,196	$24,579,504	$2,545,014	$22,034,491	$ (26,939,705)	0.45
BBerm60DuneEx	22,527,784	16	$ 6,578,239	$1,389,935	$41,332,957	$49,301,132	$24,579,504	$2,176,761	$22,402,743	$ (26,898,389)	0.45
BBerm40Dune10	13,591,156	11	$ 8,999,191	$3,634,406	$36,922,749	$49,556,346	$24,579,504	$2,055,292	$22,524,212	$ (27,032,134)	0.45
CBerm60DuneEx	16,982,751	12	$ 8,451,985	$1,389,935	$42,498,214	$52,340,135	$24,579,504	$2,072,222	$22,507,283	$ (29,832,853)	0.43
ABerm40Dune20	23,019,924	16	$ 6,462,148	$6,504,200	$41,933,456	$54,899,804	$24,579,504	$2,222,596	$22,356,908	$ (32,542,896)	0.41
ABerm60Dune10	30,872,571	18	$ 5,751,198	$4,097,718	$47,263,865	$57,112,781	$24,579,504	$2,321,841	$22,257,663	$ (34,855,117)	0.39
BBerm40Dune20	14,388,859	10	$ 9,735,740	$6,342,189	$42,975,632	$59,053,561	$24,579,504	$2,067,716	$22,511,789	$ (36,541,773)	0.38
BBerm60Dune10	23,736,751	15	$ 7,113,010	$4,097,718	$48,271,076	$59,481,804	$24,579,504	$2,142,101	$22,437,403	$ (37,044,402)	0.38
BBerm80DuneEx	32,070,152	17	$ 6,066,042	$1,853,247	$52,651,109	$60,570,398	$24,579,504	$2,232,877	$22,346,627	$ (38,223,771)	0.37
CBerm60Dune10	17,689,214	11	$ 9,249,140	$4,097,718	$49,577,954	$62,924,812	$24,579,504	$2,075,770	$22,503,734	$ (40,421,078)	0.36
CBerm80DuneEx	21,354,281	12	$ 8,496,894	$1,853,247	$53,852,486	$64,202,627	$24,579,504	$2,109,545	$22,469,959	$ (41,732,668)	0.35
ABerm60Dune20	32,351,472	17	$ 6,045,541	$6,805,501	$53,704,561	$66,555,603	$24,579,504	$2,282,760	$22,296,744	$ (44,258,859)	0.34
ABerm80Dune10	39,240,918	20	$ 5,524,683	$4,561,030	$57,040,870	$67,126,584	$24,579,504	$2,194,311	$22,385,193	$ (44,741,390)	0.33
BBerm60Dune20	24,912,910	13	$ 7,505,123	$6,805,501	$54,544,567	$68,855,191	$24,579,504	$2,131,279	$22,448,225	$ (46,406,966)	0.33
BBerm80Dune10	33,976,671	17	$ 6,248,461	$4,561,030	$58,530,821	$69,340,312	$24,579,504	$2,123,809	$22,455,695	$ (46,884,616)	0.32
Cberm60Dune20	18,631,403	10	$ 9,572,697	$6,805,501	$54,819,248	$71,197,445	$24,579,504	$2,095,625	$22,483,880	$ (48,713,566)	0.32
CBerm80Dune10	21,905,423	11	$ 8,968,334	$4,561,030	$60,118,048	$73,647,412	$24,579,504	$2,100,353	$22,479,151	$ (51,168,261)	0.31
ABerm80Dune20	41,391,623	18	$ 5,758,371	$7,268,813	$64,167,811	$77,194,995	$24,579,504	$2,240,276	$22,339,228	$ (54,855,767)	0.29
BBerm80Dune20	34,933,321	16	$ 6,529,808	$7,268,813	$64,443,775	$78,242,396	$24,579,504	$2,130,226	$22,449,279	$ (55,793,117)	0.29
CBerm80Dune20	22,729,709	11	$ 9,478,230	$7,268,813	$66,567,350	$83,314,393	$24,579,504	$2,131,583	$22,447,921	$ (60,866,472)	0.27

These nine alternatives are highlighted in blue on Table 3-3, and graphic examples are shown in **Figure 3-2**. They are also listed below, in order of highest net benefits to lowest:

- **2008 Dune + 10 ft Berm Extension (ABerm10DuneEx):** 0 foot design berm, Maintain existing berm with 10 foot extension; maintain existing dune
- **2008 Dune + 20 ft Berm Extension (ABerm20DuneEx):** Maintain existing berm with 20 foot extension; maintain existing dune
- **2008 Dune + 10 ft Dune Extension (Dune10):** Maintain existing dune with 10 foot extension
- **2008 Dune + 30 ft Berm Extension (ABerm30DuneEx):** 0 foot design berm, Maintain existing berm with 30 foot extension; maintain existing dune
- **2008 Dune + 40 ft Berm Extension (ABerm40DuneEx):** 0 foot design berm , Maintain existing berm with 40 foot extension; maintain existing dune
- **2008 Dune + 20 ft Dune Extension (Dune20):** Maintain existing dune with 20 foot extension

- **2008 Dune + 20 ft Design Berm+ 10 foot Berm Extension (BBerm30DuneEx):** 20 foot design berm, 10 foot extension; maintain existing dune
- **2008 Dune + 60 ft Berm Extension (ABerm60DuneEx):** 0 foot design berm, Maintain existing berm with 60 foot extension; maintain existing dune

Figure 3-2. Examples of Dune and Berm Alternatives.



After the preliminary results were obtained as discussed in the previous section, the top five[13] alternatives were chosen to be carried forward. Five was deemed to be a reasonable number of alternatives that could be modeled within the given timeframe, and had the best chance at being economically justified, as well as reasonably maximizing net benefits within the study area.
The top five alternatives were:

- **2008 Dune + 10 ft Berm Extension (ABerm10DuneEx)** = Maintain existing berm with 10 foot extension; maintain existing dune

[13] ABerm10Dune10 was removed from the list since it was thought to be not realistic from a constructability standpoint.

- **2008 Dune + 20 ft Berm Extension (ABerm20DuneEx)** = Maintain existing berm with 20 foot extension; maintain existing dune
- **2008 Dune + 10 ft Dune Extension (Dune10)** = Maintain existing dune with 10 foot extension
- **2008 Dune + 30 ft Berm Extension (ABerm30DuneEx)** = Maintain existing berm with 30 foot extension; maintain existing dune
- **2008 Dune + 40 ft Berm Extension (ABerm40DuneEx)** = Maintain existing berm with 40 foot extension; maintain existing dune

It should be noted for the numbers shown in **Table 3-2**, a preliminary cost was used for all alternatives which included dredging from the ocean borrow site and placement for all alternatives. At this point, benefits were influenced by three main factors. First, the rebuild assumption in the Beach-fx model was set at a very conservative numbers at this stage, which capped potential FWOP and FWP benefits. Second, benefits from R115 to the Martin County line had not yet been incorporated. Third, the model runs were performed for 25 iterations only. For this table, only storm damage reduction benefits were included.

After more discussions, the 10 foot alternatives (both ABerm10DuneEx and Dune10) were considered to be too small to be reasonably constructed through a dredging operation. Therefore, at this level of consideration and screening, a revised preliminary cost was used for both 10 foot alternatives to show truck haul from an upland borrow site.

For the final round of screening, the 5 alternatives carried forward as described above were then modeled in Beach-fx using full (100 iterations) life-cycle simulations, with updated benefits for the portion from R115 to Martin County line, and with rebuild assumptions that were more likely to occur, and with the truck haul estimates for ABerm10DuneEx and Dune10. The results of these simulations were used to select the NED Plan, presented in **Table 3-4**. The benefits shown reflect storm damage reduction benefits only, since land loss benefits and recreation benefits are determined external to the model. The combination of storm damages reduction benefits and land loss are typically relied on for plan formulation and plan selection; recreation benefits are considered to be incidental and therefore are added later once the Tentatively Selected Plan is determined. Additional level of detail is provided in the **Economics Appendix**.

ABERM20DuneEx was determined to be the NED plan, as the alternative with the highest net benefits, and meets the planning objectives, constraints, and P&G accounts and criteria as described above. It meets the Federal criteria of being economically justified, with a BCR equal to or more than 1.0.

Table 3-4. AAEQ Benefits and Costs for Final Array of Alternatives.[14]

Alternative Name	Brief Description	Total Costs (AAEQ)	Net Benefits (AAEQ)	BCR
ABerm20DuneEx	Existing Dune and 20' sacrificial berm	$ 1,327,721	$ 767,852	1.58
ABerm30DuneEx	Existing Dune and 30' sacrificial berm	$ 1,358,477	$ 733,004	1.54
ABerm40DuneEx	Existing Dune and 40' sacrificial berm	$ 1,356,253	$ 735,194	1.54
ABERM10DuneEx	Existing Dune and 10' sacrificial berm	$ 1,691,824	$ 401,904	1.24
Dune10	10' Dune Extension	$ 1,926,323	$ 161,395	1.08

[14] Costs were developed by SAJ District Cost Engineering personnel in FY16 dollars. Benefits are in FY16 discount rate.

3.11 TENTATIVELY SELECTED PLAN

Typically, the NED plan becomes the Tentatively Selected Plan (TSP) unless the non-federal sponsor chooses to pursue a Locally Preferred Plan (LPP) which differs from the NED plan. An LPP is subject to requirements described in ER 1105-2-100. There is no LPP for this study at this time, although the non-federal sponsor still has the option to pursue one. Therefore, the NED plan is chosen as the Tentatively Selected Plan (TSP).

3.11.1 DESCRIPTION OF THE NED/TSP PLAN

The TSP Plan for St. Lucie County is a protective berm that extends the entire (2008) beach profile (7 ft-NAVD88) 20 feet seaward from the toe of the existing dune. The project construction reference line was established based on the 2008 "existing" dune and profile survey. The elevation of the construction reference line is a consistent +7 ft-NAVD88 (the nourishment template berm elevation). This will include restoration and/or leveling of the 2008 dune behind the construction reference line as well as extension of the berm.

The average initial construction volume over 100 iterations is 530,400 cubic yards (cy). The average volume of each future renourishment over 100 iterations is 380,000 cubic yards (cy).

The average time interval between nourishment events over 100 iterations is 18 years. Assuming that renourishment events occurred at this average interval, the initial construction would occur in 2020 and the nourishment years would be 2038 and 2056.

Traditionally, in CSRM studies, a fixed renourishment interval is defined and optimized for 50 year period of Federal participation. In Beach-fx, rather than having a fixed renourishment interval, renourishment events are triggered when specific criteria are met. The triggers were set up to simulate a point at which the berm extension erodes to at least half its equilibrated width. Based on these parameters, the average time interval between nourishment events over all 100 iterations is 18 years. In reality, this interval could vary significantly depending on erosion and storm events. More information about the renourishment triggers is provided in the Engineering Appendix. Ultimately, planning based on life-cycle modeling results in plans that are more resilient and adaptable. Life-cycle modeling allows planners to design projects while recognizing the inherent uncertainty that exists when future events are simulated.

Beach-fx reaches correspond, approximately, with FDEP range monuments (R-monuments). The shoreline extent of the TSP, ABERM20DuneEx from Beach-fx corresponds to a shoreline length spanning from R-monument R98 to the Martin County line (approximately R001). A description of the TSP is shown in **Table 3-5.**

Table 3-5. Description of the TSP.

Tentatively Selected Plan (TSP) Description	The TSP includes
Average # Nourishment Events	1 initial construction event, approximately 2 periodic nourishment events
Average Volume of Initial Construction	530,400 cubic yards
Average Volume of Each Periodic Nourishment	380,000 cubic yards
Average Periodic Nourishment Interval	approximately 18 years
Initial Construction Duration	approximately 4 months
TSP total project cost (including contingency)	$72,289,000 (October 1, 2015 (FY16) Price Level)
Cost sharing	Initial construction: 26% Federal / 74% non-federal Periodic nourishments: 21.5% Federal / 78.5% non-federal
Benefit-to-Cost Ratio (BCR)	2.1 (October 1, 2015 (FY16) Price Level and FY16 3.375% discount rate).

3.11.2 TSP SAND SOURCE

The TSP will require approximately 1,290,400 cubic yards of sand over a 50 year period. The initial construction volume of 530,400[15] cubic yards and the periodic nourishment volume is 380,000 cubic yards every 18 years on average.

As detailed in the **Geotechnical Appendix**, there is adequate beach quality sand (meeting FDEP permitting requirements for beach placement) to meet the estimated sand needs of the TSP. Currently, there is approximately 10.6 million cubic yards of compatible sand available within the St. Lucie Shoals, which is composed of the north and south shoals (8.3 million in the north and 2.3 million in the south). This volume is more than adequate to meet the average total forecasted project volume.

3.11.3 BENEFITS OF THE TSP

St. Lucie County is highly susceptible to hurricane and storm damage. This is particularly true for the large and high-value commercial structures and more pronounced in the southern section of the project area. Beach-fx modeling has demonstrated that, in the absence of a federal project, significant economic damage from coastal forces can be expected to occur over the next 50 years. When factoring in the potential for sea levels to rise in excess of baseline projections those economic damages could average almost half of a billion dollars in present-value terms.

The model results suggest that the TSP is highly effective at reducing nearly all damages, with primary economic benefits of the plan generated by reductions in erosion, wave, and inundation damages. The TSP is effective in the following ways:

[15] Note that these volumes are from Beach-fx and are approximate averages, due to the probabilistic nature of the model (randomly generated storm seasons over the life of the project). Volumes needed could me slightly more or less over the life cycle of the project. The Engineering Appendix, Table 6-2, provides a discussion of the project volume breakdown and confidence interval information.

Amount of Damages: The FWP condition under the TSP protects St. Lucie County from 94% of all damages in the project life. In R113 and R115, where damages in the FWOP were the most dramatic due to high-value structures on slab foundation, 99% and 95% of damages are avoided.

Types of Damages: Additionally, the project will reduce the number of structure types that are receiving damage. In the FWOP, 21 different structure types were being damaged whereas under the TSP only six different structure types receive damage. It is important to note the complete absence of residential property, roads, and all high-rise structure damage.

Effective over time: The TSP is also effective over time and requires only two renourishment events throughout the 50 year life of the project. Benefits begin to accrue immediately after initial construction and peak in 2026 when the project provides $2.38M (PV) in benefits. After 2026 benefits begin to gradually decline until reaching a relative low in 2036, triggering a projected nourishment event. Again, the benefits are immediately realized by the nourishment and provide $2.4M (PV) worth in 2038 alone, the project's overall largest year for benefits. Despite the impact of discounting, the NED provides substantial benefits in later years leading up to a second projected re-nourishment event around 2055.

Conclusion: The TSP prevents 94% of economic damages across 50 years with only two re-nourishments and nets $2,114,809 AAEQ worth of benefits. The project yields $2.10 in benefits for every $1.00 spent (i.e. BCR is 2.10). The plan is efficient, acceptable and complete. It is also robust and increasingly efficient under sea level change scenarios. Though the recommended plan is relatively small in scope and scale, it represents the most prudent investment of Federal and sponsor dollars. The economic summary is shown in **Table 3-6.**

Table 3-6. Economic Summary of the TSP.

Economic Summary	**Storm Damage Reduction Benefits**	**Storm Damage Reduction + Land Loss Benefits**	**Storm Damage Reduction + Land Loss + Recreation**
Price Level	FY16	FY16	FY16
FY Water Resources Discount Rate	3.125%	3.125%	3.125%
Average Annual Structure & contents Damage Costs Benefits	$3,179,950	$3,179,950	$3,179,950
Average Land Loss Benefits	$0	$276,819	$276,819
Average Annual Incidental Recreation Benefits	$0	$0	$584,018
Average Annual Total Benefits	$3,179,950	$3,456,769	$4,040,787
Average Annual Costs	$1,925,977	$1,925,977	$1,925,977
Average Annual Net Benefits	$1,253,973	$1,530,792	$2,114,810
Benefit Cost Ratio	1.65	1.79	2.10

BENEFITS OF THE NED ON EVACUATION ROUTE INUNDATION

The TSP was modeled to obtain how effective it would be at preventing flooding of both one foot or more and two feet or more to Florida State Route A1A. The TSP was incredibly effective in achieving both of these goals since 0% of the iterations experienced flooding of either one or two feet. Thus, the TSP performs satisfactorily in keeping A1A accessible as an evacuation route.

LAND LOSS BENEFITS

In outlining the process and procedures to be used in the evaluation of coastal storm risk management projects, ER-1105-2-100 mentions the inclusion of land loss due to erosion, stating that such damages should be computed as the market value of the average annual area expected to be lost. Prevention of land loss is a component of primary storm damage reduction benefits but is not computed within the Beach-fx model. Thus, calculation of land loss benefits must be completed external to the model and added to the structure and contents damage benefits to obtain the total storm damage reduction benefits of the project.

Following the guidance provided, two key pieces of information are needed to calculate land loss benefits of a storm damage reduction project: (1) the square footage of the land lost each year and (2) the market value of land in the project footprint. The Economics Appendix provides detail on how the square footage of land loss each year was calculated. As the second component of the land loss benefits calculation, ER 1105-2-100 instructs that nearshore land values be used to estimate the value of land lost. The Jacksonville District Real Estate Department estimated a nearshore land value of $14.00 per square foot for the St. Lucie study area.

Using the analysis technique described, the total present value of land loss benefits over the 50 year project life is estimated at $6,956,475 or $276,819 in average annual equivalent (AAEQ) terms.

RECREATION BENEFITS

According to ER-1105-2-100, incidental recreation benefits can be calculated for Coastal Storm Risk Management (CSRM) projects. Recreation benefits are not to be used in plan formulation, but they can constitute up to 50% of total project benefits.

Additionally, ER-1105-2-100 specifies that benefits arising from recreation opportunities created by a project be measured in terms of willingness to pay. As described in the Economics Appendix, the unit day value (UVD) method was used to calculate the incidental recreation benefit provided by the TSP resulting in an estimated total present value of recreation benefits of $14,676,408 in present value (PV), or $584,018 in average annual equivalent (AAEQ) terms.

3.11.4 SEA LEVEL RISE CONSIDERATIONS

An important aspect about the TSP is its performance under different Sea Level Change scenarios. As discussed earlier in this report, the study area is experiencing Sea Level Rise (SLR). Each of the SLR scenarios described earlier are considered equally likely to occur. Therefore, if the project does not

perform, then it cannot be considered a completely effective plan. Table 3-7 shows the average BCRs and net benefits of the NED TSP under the three SLR scenarios. As shown below, the TSP performs satisfactorily in each SLR scenario

Table 3-7. Average PV Benefits and Costs for the TSP in different SLR scenarios.

SLR Scenario	AAEQ Benefits	AAEQ Costs	BCR	Net Benefits
ABERM20DuneEx - TSP				
Baseline	$ 3,179,950	$ 1,925,977	1.65	$ 1,253,973
Intermediate	$ 9,990,903	$ 4,020,469	2.49	$ 3,589,239
High	$ 19,075,671	$ 6,674,833	2.86	$ 12,400,838

*Values based on 100 iterations, final cost estimates, and only include structure and content damage.

3.11.5 TSP COST SHARING

The current cost share estimates are based on policy guidance provided by ER 1105-2-100 Appendix E and ER 1165-2-130. The Water Resources Development Act (WRDA) of 1999 changed the cost sharing policy previously provided by WRDA 1986 by setting a maximum federal share of periodic nourishment carried out after 1 January 2003 to 50% for projects authorized for construction after 31 December 1999.

Table 3-8 shows the Federal and non-federal cost sharing for the TSP. Changes to shoreline ownership and use prior to construction could change the stated cost sharing percentages. Cost sharing for initial construction is 26% Federal / 74% non-federal. Cost sharing for periodic nourishments is 21.5% Federal / 78.5% non-federal.

CBRS unit P-11 (described further in the Key Social and Environmental Factors section, as well as coordination with USFWS to support this discussion) has been taken into account for cost sharing purposes. There are three portions of P-11 in the TSP area. The first is a portion of P-11 for a length of approximately 500 feet at the northern boundary of the project, and it is on a privately developed parcel – this portion has been allocated as 100% non-federal sponsor due to the a. CBRS unit and b. privately developed parcel. The second portion of P-11 is just north of Dollman Park for a length of approximately 150 feet. This portion allocated will not be 100% non-federal for that portion due to the presence of the CBRS unit. The third portion of P-11 is within Dollman Park (for a length of approximately 2000 feet), which is publically owned by St. Lucie County. Coordination with USFWS indicates that this portion is "exempt" from the CBRA under Section 6, and therefore Federal cost-sharing in this portion could occur. Therefore, this length has been allocated 50% Federal cost sharing and 50% non-federal cost sharing, according to Appendix E from ER 1105-2-100 and ER 1165-2-130. More information on cost sharing can be found in **APPENDIX F**.

Table 3-8. TSP cost sharing.

	INITIAL CONSTRUCTION				PERIODIC NOURISHMENT		
Shore Ownership and Project Purpose (as defined in EC 1105-2-100)	Maximum Level of Federal Participation in Construction Costs	Shoreline Length (feet)	Length of Federal Participation (feet)	Length of non-Federal Participation (feet)	% of Federal Participation for Periodic Nourishment	Length of Federal Participation (feet)	Length of non-Federal Participation (feet)
I. Federally Owned	100%	0	0	0	100%	0	0
II. Publically and Privately							
A. Coastal Storm Risk	65%	5,362	3,486	1,877	50%	2,681	2,681
B. CSRM on Undeveloped Public Lands	50%	2235	1,118	1,118	50%	1,118	1,118
III. Privately Owned, Use	0%	9,169	0	9,169	0%	0	9,169
IV. Privately owned, undeveloped	0%	912	0	912	0%	0	912
	Total Distance:	17,679	4,603	13,076	Total Distance:	3,799	13,880
	Cost Shares:		26.0%	74.0%	Cost Shares:	21.5%	78.5%

3.11.6 TSP COSTS

The TSP total project cost including contingency is$72,289,000 (1 Oct 15 effective price level date, FY19 Program Year), with cost breakouts and allocations as shown in **Table 3-9**. The **Cost Appendix** provides additional detail.

Table 3-9. TSP Total Project Costs (FY16).

INITIAL CONSTRUCTION				
Item	**Total Item Cost**	**Federal Share**	**Federal Cost**	**Non-federal Cost**
Mob/Demob	$3,389,132.22	26%	$881,174.38	$2,507,957.84
Beach Fill	$14,783,735.50	26%	$3,843,771.23	$10,939,964.27
Associated General Item	$784,495.28	26%	$203,968.77	$580,526.51
Subtotal	$18,957,363.00		$4,928,914.38	$14,028,448.62
Lands and Damages				
- lands and damages	$1,300,000.00	26%	$338,000.00	$962,000.00
- administrative	$30,000.00	26%	$7,800.00	$22,200.00
PED	$1,155,000.00	26%	$300,300.00	$854,700.00
Construction Manageme	$1,517,421.49	26%	$394,529.59	$1,122,891.90
Post-Project Monitoring	$930,000.00	26%	$241,800.00	$688,200.00
Dune Planting	$1,008,709.21	26%	$262,264.40	$746,444.82
Subtotal	$5,941,130.70		$1,544,693.98	$4,396,436.72
Contingency (20%)	$4,979,698.74	26%	$1,294,721.67	$3,684,977.07
Credit for non-federal LERR			$984,200.00	-$984,200.00
Total Project Cost (Initial Construction)	**$29,878,192.44**		**$8,752,530.03**	**$21,125,662.41**

PERIODIC NOURISHMENT				
Item	**Total Item Cost**	**Federal Share**	**Federal Cost**	**Non-federal Cost**
Mob/Demob	$3,389,132.22	21.5%	$728,663.43	$2,660,468.79
Beach Fill	$10,559,784.79	21.5%	$2,270,353.73	$8,289,431.06
Associated General Ite	$592,110.32	21.5%	$127,303.72	$464,806.60
Subtotal	$14,541,027.33		$3,126,320.88	$11,414,706.46
Lands and Damages		21.5%		
- lands and damages	$0.00	21.5%	$0.00	$0.00
- administrative	$30,000.00	21.5%	$6,450.00	$23,550.00
PED	$1,155,000.00	21.5%	$248,325.00	$906,675.00
Construction Managen	$1,105,118.08	21.5%	$237,600.39	$867,517.69
Post-Project Monitoring	$930,000.00	21.5%	$199,950.00	$730,050.00
Dune Planting	$0.00	21.5%	$0.00	$0.00
Subtotal	$3,220,118.08		$692,325.39	$2,527,792.69
Contingency (20%)	$3,552,229.08	21.5%	$763,729.25	$2,788,499.83
Credit for non-federal LERR			$23,550.00	-$23,550.00
Total Project Cost (Periodic Nourishment)	**$21,313,374.49**		**$4,605,925.52**	**$16,707,448.98**

3.12 OPERATION AND MAINTENANCE CONSIDERATIONS

PROJECT MONITORING

Physical monitoring of the project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year project life. The monitoring plan will be directed primarily toward accomplishing systematic measurements of the beach profile shape. Profile surveys should provide accurate assessments of dune and beach fill volumes and a basis for assessing post-construction dune and beach fill adjustments, as well as variation in the profile shape due to seasonal changes and storms. Monitoring will play a vital role in determining if project renourishment is necessary. Post construction monitoring activities include topographic and bathymetric surveys of the placement area on an annual basis for 3 years following construction and then biannually until the next construction event. The cost for this post construction monitoring is included in the cost shared total project cost. Other monitoring efforts include bathymetric mapping of the borrow site, which will be done as part of the pre-construction engineering and design (PED) phase prior to each nourishment. Measured wind, wave, and water level information will be obtained from the best available existing data sources. This data will be applied in support of previously discussed monitoring efforts. It will also be used to periodically assess the state of sea level rise and to determine if reassessment of the project volumes and/or renourishment intervals based on an intermediate of high SLR case is required.

RENOURISHMENT EVENTS

Traditionally, renourishment events take place based on both an economically optimized renourishment interval and the physical performance of the project. Project performance, in the past, has been determined by assessing the condition of the design template. Should the design template be breached, the project is no longer providing the required level of protection and is considered for renourishment. Part of this consideration is how close the project may be to the designated renourishment interval.

While the basic principles of renourishment still apply, due to the probabilistic nature of Beach-*fx* and the way in which the model assesses renourishment requirements, a new means of assessing project performance must be employed. The former concepts of “design template” and “advance fill” are only loosely applicable. The entire 20-foot berm and beach profile extension template acts as the “advance fill”, while the existing beach profile is the minimum acceptable profile (making it akin to what was formerly the “design template”).

Assessing the performance of the project fill now has two stages. First, a survey of the project area (such as a monitoring or post-storm survey) will be assessed to determine if the shoreline at any of the R-monument locations within the project have receded past the pre-project (2008) condition. If recession beyond the pre-project condition has occurred at one or more of the R-monuments, then a summation of the volume required to restore those profiles to the initial construction template will be made. If the total volume required to restore the receded profiles exceeds the threshold volume (430,000 cubic yards), then a renourishment event is recommended. The decision to renourish may then be made based on traditional concerns, including such factors as budget cycle and available funding.

For this project, it is assumed that dune vegetation for periodic nourishment will occur by natural recruitment, and therefore no cost is associated with periodic dune vegetation.

4 Effects of the Tentatively Selected Plan

4 EFFECTS OF THE TENTATIVELY SELECTED PLAN*

This section is the scientific and analytic evaluation of effects that would result from implementing the Tentatively Selected Plan. Section 2 includes the effects resulting from the "No-action alternative," or the "Future Without-Project Conditions." The following section includes anticipated changes to the existing environment including direct, indirect, and cumulative effects as a result of the Tentatively Selected Plan, or the "Future With-Project Conditions."

4.1 NATURAL (GENERAL) ENVIRONMENT

4.1.1 GENERAL ENVIRONMENTAL EFFECTS

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

In accordance with permits issued by the State of Florida and the USACE, the non-federal sponsor has previously placed beach quality material from the designated offshore borrow site along this shoreline. The Tentatively Selected Plan proposes to continue use the same borrow site and construct a smaller berm along a shorter reach of this same placement area. Impacts to hardbottom resources within this area have been previously mitigated by the sponsor.

The beneficial effects of continued 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 habitat for beach flora and fauna as well as more space for recreational activities.

The proposed project would likely produce more favorable environmental conditions than exist at present, although construction operations would produce some temporary adverse effects. These effects would be primarily temporary in nature, and most affected resources would return to pre-construction conditions either immediately after dredging (with respect to resources such as aesthetics and noise) or within one or two years (with respect to sea turtle nesting and benthic resources).

4.1.2 VEGETATION

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The plan 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 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.

If needed, the plant community could be reestablished by planting a mix of native dune species that, depending on nursery availability, may include sea oats (*Uniola paniculata*), beach sunflower (*Helianthus debilis*), railroad vine (*Ipomoea pes-caprae*), and dune panic grass (*Panicum amarum*).

4.1.3 FISH AND WILDLIFE RESOURCES (OTHER THAN THREATENED AND ENDANGERED SPECIES)

FUTURE WITH-PROJECT (TENATIVELY SELECTED PLAN)

Effects that could potentially affect fish and wildlife resources 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.

Alteration (Burial) of Exposed Nearshore Hardbottom

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-federal sponsor provided mitigation to offset these impacts. The Tentatively Selected Plan, with its smaller placement area, would not exceed previous impacts and, therefore, would not be mitigated.

Disturbance of Sand Bottom Habitats

Dredging activities within the shoal borrow area and beach fill sites would continue to 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) 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. 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). 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.

Modification of the St. Lucie Shoal Feature

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 a depth of 10 feet 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 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 proposed design. The Hammer et al. design removed almost 25 times the amount of sand proposed for removal. 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 non-federal sponsor 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. 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. 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 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 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.

4.1.4 THREATENED AND ENDANGERED SPECIES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The USACE has determined that the Tentatively Selected Plan may affect nesting sea turtles. Also, the plan may affect, but is not likely to adversely affect sea turtles in the water, manatees, whales, smalltooth sawfish, piping plover, or the rufa red knot. The terms and conditions of the 1997 NMFS South Atlantic Division Regional Biological Opinion (SARBO), 2015 USFWS Statewide Programmatic Biological Opinion, and 2013 Programmatic Piping Plover Biological Opinion will be followed for these species. Additional consultation between the USACE and USFWS will be performed on the rufa red knot. In addition, USACE has determined that the proposed dredging and beach placement could temporarily impact the physical or biological features (PBF) and primary constituent elements (PCE) of loggerhead critical habitat unit LOGG-T-FL-09 and LOGG-N-18 during construction. Hatchling egress from the water's edge to open water and nesting female transit back and forth between the open water and the nesting beach during nesting season could be hindered by the presence of the dredge and pipeline. However, the construction phase would typically last 3-5 months approximately every 18 years (erosion due to storms could require more frequent events) and the daily construction activity would occur within only a small area at a time. In addition, the SARBO includes conditions that minimize incidental take of turtles. Finally, the placement of sand may increase sea turtle nesting habitat if the placed sand is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project (i.e. the project complies with the terms and conditions of the SPBO). Therefore, the Corps has determined that the project will not destroy or adversely modify loggerhead critical habitat. The USACE final determination relative to project impacts as well as the need for protective and mitigation measures is subject to review by and coordination with the USFWS and NMFS.

4.1.4.1 SEA TURTLE 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, 2015). 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 2015).

The non-federal sponsor 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 (Ecological Associates, Inc. [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 4-1** 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 4-1**). 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 4-2**: 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 4-1. 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 4-2. 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 4-1** 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 4-2** 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 4-2**, 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 2015). State 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 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 Tentatively Selected Plan 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.

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).

4.1.4.2 INNER SHELF SEA TURTLE HABITAT

Effects associated with the plan 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. 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 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. 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 be stationed on hopper dredges, 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

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-federal sponsor provided mitigation to offset these impacts. The Tentatively Selected Plan, with its smaller placement area, would not exceed previous impacts and, therefore, would not be mitigated. The mitigation reef was completed in July 2015. Monitoring of the reef immediately after construction indicated that permit requirements have been met. Specifically, the percent of net boulder cover within the mitigation site exceeds permit requirements. The non-federal sponsor will continue to monitor the mitigation reef during summer months for three years following construction.

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.

4.1.5 MARINE MAMMALS

Effects 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. 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 be stationed on dredges 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 an 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. Standard protective measures would be taken during placement activities to ensure the safety of manatees and other marine mammals.

4.1.6 SMALLTOOTH SAWFISH

Effects 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.

4.1.7 PIPING PLOVER AND RUFA RED KNOT

Wintering grounds and migration stopovers for piping plovers and red knots 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 and red knots, 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 plovers and knots 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 benthic organisms, would also occur in the project area. Recovery from this short-term reduction should occur within about one year after sand placement.

4.1.8 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.

4.1.9 HARDBOTTOM

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Effects 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

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-federal sponsor provided mitigation to offset these impacts. The Tentatively Selected Plan, with its smaller placement area, would not exceed previous impacts and, therefore, would not be mitigated.

Re-exposure of hardbottom likely occurs 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. Pipeline placement would use corridors previous used to the maximum extent practical.

4.1.10 ESSENTIAL FISH HABITAT (EFH)

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Effects associated with the plan 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

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-federal sponsor provided mitigation to offset these impacts. The Tentatively Selected Plan, with its smaller placement area, would not exceed previous impacts and, therefore, would not be mitigated.

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 plan would continue to 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 a small percent 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.

BMPs would include 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. 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. 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. 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). 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.

4.1.11 COASTAL BARRIER RESOURCES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The project area includes portions of CBRS (Coastal Barrier Resource System) Unit P11 (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 H**) 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. Dollman Park, a publicly owned parcel within the project area, does meet the Section 6 exception since development is prohibited in this location; therefore, Federal funds could be used to nourish the

beach adjacent to the park. 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 sand within the project area is anticipated to contribute to the sand-sharing system and provide feeder benefits to adjacent shorelines.

4.1.12 WATER QUALITY

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Implementing the plan 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 Documents); 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), 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.

4.1.13 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The plan is not 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.

4.1.14 AIR QUALITY

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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 non-federal sponsor'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.

An analysis was performed to estimate emissions from the project previously completed by the non-federal sponsor (Taylor 2012). 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 non-federal sponsor'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 4-3**). 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 4-3**). Prevailing winds would quickly disperse any pollutant released into the atmosphere from the project area. Since the Tentatively Selected Plan is smaller in size, the resulting emissions would be even less significant.

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 non-federal sponsor's project 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 4-3. Estimated Emissions of the Non-Federal sponsor'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/

4.1.15 NOISE

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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. Sound would likely dissipate significantly over the three-mile+ distance between the dredging area and shoreline.

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.

4.1.16 AESTHETIC RESOURCES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Effects associated with the plan 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.

4.1.17 RECREATION RESOURCES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Effects associated with the plan 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 R77 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.

4.1.18 CULTURAL RESOURCES AND HISTORIC PROPERTIES

As discussed in the Section 2: Existing Conditions and Future Without-Project Conditions portion of this document, substantial cultural resources work and investigations have been conducted throughout various portions of the project area. Consultation is ongoing with the Florida SHPO and appropriate federally-recognized tribes. Prior to project implementation, consultation will be finalized in accordance with Section 106 of the NHPA.

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The Tentatively Selected Plan would see shoreline impacts occurring between FDEP Range Monuments R98 and the Martin County line. No cultural resources have been identified within this portion of the project area. As discussed in Section 2, this area was previously surveyed in 2007 and no cultural resources were identified as a result of this survey. The SHPO reviewed the survey record and concurred with the recommendation of no effect on cultural resources in a letter to the Corps dated 27 July 2010 (DHR File No. 2008-02141-B) (**Appendix H**).

Based on remote sensing surveys conducted between 2007 and 2010 of the proposed offshore borrow locations, one cluster of magnetic anomalies was identified in the southern borrow area and two historic wreck sites are located adjacent to the northern borrow area. No diver evaluations were performed on the magnetic targets, and a buffer of 200 feet was recommended to avoid effects on the potentially significant resource. In a letter dated 31 July 2008 the Corps determined that a 500-foot buffer of the anomalies would be utilized during dredging to avoid impacts (Appendix H). This letter also noted that the two previously recorded historic shipwrecks are located outside of the project area and determined that, contingent upon the preservation of the anomaly cluster with a 500-foot buffer zone, no historic properties would be affected by dredging. The SHPO concurred with the determination of effects in a letter dated 4 September 2008 (DHR File No. 2008-05091) (**Appendix H**).

During implementation of the Tentatively Selected Plan, the Corps will continue to protect these cultural resources by maintaining the 500-foot buffer previously implemented during dredging. Contingent upon maintaining the buffer, the Corps has determined that the Tentatively Selected Plan will have no effect on historic properties listed or eligible for listing in the NRHP. Consultation has been initiated and is ongoing with the Florida SHPO and appropriate federally-recognized tribes and will be updated upon further

coordination of this project (**Appendix H**). Once consultation is complete, additional updates may be needed.

4.1.19 NATIVE AMERICANS

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

As part of the development of this project, consultation is ongoing between the Corps and the appropriate federally-recognized tribes within the immediate area of potential effect. As discussed in Chapter 3, there are no known Native American properties within the project area and the project should not have any effects to Native Americans. However, consultation is ongoing and will be updated upon further coordination of this project (**Appendix H**). Once consultation is complete, additional updates may be needed.

4.1.20 PUBLIC SAFETY

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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.

4.1.21 NATURAL OR DEPLETABLE RESOURCES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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 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).

4.1.22 ENERGY REQUIREMENTS AND CONSERVATION

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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.

4.1.23 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

4.1.23.1 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 10.6 million cubic yards of beach-compatible sand, which is more than adequate for the sand required by the project.

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 recolonization 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 have been previously mitigated. These nearshore hardbottom areas are also 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.

4.1.23.2 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.

The loss hardbottom habitat has been previously mitigated through the implementation of a program to construct nearshore artificial reef. 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.

4.1.24 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The main unavoidable adverse impact of the plan would be impacts to nearshore hardbottom habitat; however, this impact has been previously offset by the non-federal sponsor. Re-exposure of hardbottom is also possible due to high-energy dynamics of the area and equilibration of beach fill. Recolonization of re-exposed hard substrates by worm rock and turf and macroalgae is probable as these organisms have high recruitment capability.

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.

4.1.25 LOCAL SHORT-TERM USES AND MAINTENANCE / ENHANCEMENT OF LONG-TERM PRODUCTIVITY

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

The plan is expected to produce localized, short-term impacts on nearshore benthic communities and water quality, but it is 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. The plan 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 creation of mitigation reefs.

4.1.26 INDIRECT EFFECTS

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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 non-federal sponsor 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.

4.1.27 COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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 non-federal sponsor commitment. The non-federal sponsor's main objective is to abate ongoing and historical beach erosion; specific non-federal sponsor 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.

4.1.28 CONFLICTS AND CONTROVERSY

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Conflicts and controversy will be identified, considered, and fully addressed within the EA after coordination with agencies and through the public comments.

4.1.29 UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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 plan considered in this EA.

4.1.30 REUSE AND CONSERVATION POTENTIAL

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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.

4.1.31 URBAN QUALITY

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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.

4.1.32 SOLID WASTE

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

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.

4.1.33 SCIENTIFIC RESOURCES

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Their no known scientific resources associated with the plan.

4.1.34 DRINKING WATER

FUTURE WITH-PROJECT (TENTATIVELY SELECTED PLAN)

Implementation of either the non-federal sponsor's preferred alternative or other build alternative and the associated effects were not evaluated and no comments were received.

4.2 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 4-4 summarizes cumulative impacts by identifying the past, present, and reasonably foreseeable future condition of the various resources with and without the project.

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 R96.5 in St. Lucie County to R1.5 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 R88 to R115 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.

4.2.1.1 PAST CONDITIONS AND ACTIVITIES

A Conditions Assessment Report (Coastal Tech 2009) summarizes historical shoreline changes from R77 through R115. Except for the segment from R103 to R109, the shoreline within the study area predominantly retreated from 1972 to 2006. A volumetric study conducted by 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 non-federal sponsor — including placement of about 162,000 cubic yards of sand along the dune from R98.4 to R101.5, and from R103.3 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 non-federal sponsor 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 4-4. 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.
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	Nearshore hardbottom areas would continue to exist in the area, subject to the natural dynamics of the nearshore	Impacts to the nearshore hardbottom from previous beach placement activities have been mitigated.

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with-project
	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.	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.	
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.
Water Quality	The project area consists of Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a	Project-specific impacts would be avoided, but turbidity would continue to occur	In addition to the ongoing natural and anthropogenic fluctuations in water quality,

Resource	Past and Present (Baseline/Existing Condition)	Future without Project	Future with-project
	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.	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.	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

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 18 years and 380,000 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 area 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 (R1 to R25). The authorized project was initially constructed in 1996 with a planned periodic renourishment interval of 11 years. Federal participation (costsharing) 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.

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 (380,000 cubic yards) than the initial nourishment on a 18-year renourishment cycle. This results in a requirement of about 1.3 million cy over the 50-year project planning horizon. This amount comprises approximately 12% of the sand resources in the St. Lucie Shoal. Additionally, based on recent beach nourishment projects, construction of a 380,000 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 non-federal sponsor 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 non-federal sponsor 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 non-federal sponsor 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 non-federal sponsor's Board of County Commissioners has recently directed non-federal sponsor 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.

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.

USACE Circular No. 1165-2-211 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 MidAtlantic 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 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.

4.27.3. 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. 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.

5 Environmental Compliance

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5 ENVIRONMENTAL COMPLIANCE

This chapter discusses the status of coordination and compliance of the Tentatively Selected Plan with environmental requirements. Additionally, it shows how the Tentatively Selected Plan meets USACE environmental operating principles.

5.1 SCOPING AND ISSUES – NEPA PUBLIC MEETINGS

An initial scoping period for the project was conducted from May 31 through June 30, 2006. NOAA responded to the scoping letter with concerns about the proposed dredging of the offshore shoals and that the EFH assessment and NEPA documents on this action should be prepared with sufficient detail. This assessment is included in Sections 2.3.4 and 4.1.10 of this report. The Florida Department of Environmental Protection (FDEP) coordinated a review of the scoping letter and the proposed project with the appropriate state agencies. FDEP stated that "based on the information contained in the public notice and the enclosed state agency comments, the state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program." Other stakeholders raised concerns regarding the use of St. Lucie Shoal as a borrow site, impacts to hardbottom resources, and cumulative impacts.

The non-federal sponsor was issued USACE and State permits for a larger beach nourishment project in this area in 2012. An Environmental Impact Statement (EIS) was prepared as part of the issuance of the USACE permit. This EIS was subsequently coordinated with the agencies and general public. This report tiers off of that EIS.

A public meeting is tentatively being scheduled for June 2016. The meeting will occur during the public review period of this document. The format of the meeting will include an overview of the Tentatively Selected Plan as well as a formal comment period.

All correspondence associated with this NEPA scoping process is included in Appendix H.

5.2 COOPERATING AGENCIES

This proposed project is being coordinated with the following agencies: U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Florida State Clearinghouse, Florida State Historic Preservation Officer (SHPO), Florida Department of Environmental Protection, and Florida Fish and Wildlife Conservation Commission. The Bureau of Ocean and Energy Management (BOEM) has accepted USACE's invitation to participate as a cooperating agency in this study. Correspondence with all Federal and state agencies is included in Appendix H.

5.3 LIST OF RECIPIENTS

A Notice of the Availability of the Draft EA and Draft FONSI will be mailed to those listed in Appendix H, NEPA Mailing List. The document will also be available on USACE's website at http://www.saj.usace.army.mil/About/DivisionsOffices/Planning/EnvironmentalBranch/EnvironmentalDocuments.

5.4 COMMENTS RECEIVED AND RESPONSE

Comments received as a result of the public review of the draft EA will be addressed in the final NEPA document.

5.5 ENVIRONMENTAL COMMITMENTS

The USACE shall comply with all terms and conditions of the biological opinions issued by the USFWS and NMFS, as well as the State permit, including but not limited to the following:

SEA TURTLES

- 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 (727824-5312) and the local authorized sea turtle stranding/rescue organization.

MANATEES

- 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 (1-904-7313336) 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.

SMALLTOOTH SAWFISH

- 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 50foot 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.

TURBIDITY

- 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.

In addition the USACE commits to the following:

- Migratory birds (adult birds, eggs and chicks) shall be protected during construction activities.

- Essential Fish Habitat conservation recommendations shall be implemented.

- In the event that cultural resources are discovered (i.e. at new or expanded upland quarries), then protective measures shall be utilized.

- Air emissions such as vehicular exhaust and dust shall be controlled.
- The contracting officer would notify the contractor in writing of any observed noncompliance with Federal, state, or local laws or regulations, permits and other elements of the contractor's Environmental Protection Plan.
- The contractor would train his personnel in all phases of environmental protection.
- The environmental resources within the project boundaries and those affected outside the limits of permanent work would be protected during the entire period of work.
- An oil spill prevention plan shall be required.

5.6 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) of 1969

Environmental information on the project has been compiled and this Environmental Assessment has been prepared. A scoping letter on the proposed work was mailed out to all Federal, State, and local agencies and public stakeholders on May 31, 2006. This draft document shall be coordinated with interested stakeholders for review and comment. A public scoping meeting is tentatively planned for June 2016. The project shall be in full compliance with the National Environmental Policy Act.

ENDANGERED SPECIES ACT of 1973

This project falls under the scope of the November 25, 1991 South Atlantic Regional Biological Opinion (as amended) for federally listed marine species. No additional coordination is required with NOAA Fisheries for these species. USACE has determined that the sand placement activities associated with this project fall within the scope of the USFWS SPBO (2011), as amended in 2015, and the P3BO (2013). USACE will coordinate with USFWS for project effects to species under their jurisdiction. USFWS generally responds within 30 days to confirm that USACE can utilize these programmatic biological opinions. This project shall be in full compliance with the Endangered Species Act.

FISH & WILDLIFE COORDINATION ACT of 1958

Coordination with the USFWS shall be conducted through the NEPA scoping process and the Endangered Species Act. This project shall be in full compliance with the Act.

NATIONAL HISTORIC PRESERVATION ACT of 1966 (*INTER ALIA*)

The Proposed Action shall be in compliance with Section 106 of the National Historic Preservation Act, as amended (PL89-665). As part of the requirements and consultation process contained within the National Historic Preservation Act implementing regulations of 36 CFR 800, this project is also in compliance through ongoing consultation with the Archaeological and Historic Preservation Act, as amended (PL93- 29), Archeological Resources Protection Act (PL96-95), American Indian Religious Freedom Act (PL 95- 341), Native American Graves Protection and Repatriation Act (NAGPRA), Executive Order 11593, 13007, and 13175, the Presidential Memo of 1994 on Government to Government Relations and appropriate Florida Statutes. Consultation with the Florida SHPO, appropriate federally recognized tribes, and other interested parties has been initiated and is ongoing. The Proposed Action shall be in compliance with the goals of this Act upon completion of coordination as stated above.

CLEAN WATER ACT of 1972

A Section 401 water quality certification (State permit) application will be submitted to the FDEP, and USACE will obtain this certification prior to construction. All state water quality requirements would be met. A Section 404(b) evaluation is included in this report as Appendix G-1. The project shall be in full compliance with this Act.

CLEAN AIR ACT of 1972

The short-term impacts from construction equipment associated with the project would not significantly impact air quality. No air quality permits would be required for this project. St. Lucie County is designated as an attainment area for Federal air quality standards under the Clean Air Act. Because the project is located within an attainment area, USEPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination is not required.

COASTAL ZONE MANAGEMENT ACT of 1972

The Florida State Clearinghouse coordinated a review of the project in response to USACE's scoping letter dated May 31, 2006. The state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program. A Federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as Appendix G-2. The USACE has determined that the project is consistent with the Florida Coastal Management Plan (FCMP). The Draft EA and Section 404 (b)(1) Evaluation will be submitted to the state in lieu of a summary of environmental impacts to show consistency with the FCMP. The state's final concurrence of the project's consistency with the FCMP will be determined during the environmental permitting process, in accordance with the 2006 Interagency Coordination Agreement. At this time, this project is in compliance with this Act.

FARMLAND PROTECTION POLICY ACT of 1981

No prime or unique farmland would be impacted by implementation of this project. This Act is not applicable to the project.

WILD AND SCENIC RIVER ACT of 1968

No designated Wild and Scenic river reaches would be affected by project related activities. This project is in compliance with this Act.

MARINE MAMMAL PROTECTION ACT of 1972

USACE does not anticipate the take of any marine mammal during any activities associated with the project. Should a hopper dredge be utilized, a trained, government-certified sea turtle and marine mammal observer will be stationed on the dredge during all water-related construction activities. Appropriate actions will be taken to avoid adverse effects to listed and protected marine mammal species during project construction. Therefore, this project shall be in compliance with this Act.

ESTUARY PROTECTION ACT of 1968

In the Estuary Protection Act of 1968, Congress declared that "many estuaries in the United States are rich in a variety of natural, commercial, and other resources, including environmental natural beauty, and are of immediate and potential value to the present and future generations of Americans." This Act is intended to protect, conserve, and restore estuaries in balance with developing them to further the growth and development of the Nation. There are no estuaries of national significance located in the study area; therefore, this project is consistent with the purposes of this Act.

FEDERAL WATER PROJECT RECREATION ACT

The principles of the Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1 (12), *et seq*. P.L. 89-72, do not apply to this project.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

Pursuant to the 1999 Finding between USACE and NMFS, USACE's Notice of Availability of this draft EA will initiate USACE's consultation under the Magnuson-Stevens Fishery Conservation and Management Act. NMFS provided initial comments in response to USACE's request for scoping comments (May 31, 2006). NMFS requested that any NEPA document associated with the project include an EFH assessment, and noted the importance of St. Lucie Shoal. The project shall be coordinated with NMFS, and shall be in full compliance with the Act.

SUBMERGED LANDS ACT of 1953

The project would occur on submerged lands of the State of Florida. The project is being coordinated with the State, and shall be in compliance with the Act.

COASTAL BARRIER RESOURCES ACT and COASTAL BARRIER IMPROVEMENT ACT of 1990

The Coastal Barrier Resources Act (CBRA) and the Coastal Barrier Improvement Act of 1990 (CBIA) limit Federally subsidized development within the CBRA Units to limit the loss of human life by discouraging development in high risk areas, to reduce wasteful expenditures of Federal resources, and to protect the natural resources associated with coastal barriers. CBIA provides development goals for undeveloped coastal property held in public ownership, including wildlife refuges, parks, and other lands set aside for conservation ("otherwise protected areas," or OPAs). These public lands are excluded from most of the CBRA restrictions, although they are prohibited from receiving Federal Flood Insurance for new structures.

Federal monies can be spent within the CBRA Units for certain activities, including (1) projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats; (2) establishment of navigation aids; (3) projects funded under the Land and Water Conservation Fund Act of 1965; (4) scientific research; (5) assistance for emergency actions essential to saving lives and the protection of property and the public health and safety, if preferred pursuant to the Disaster Relief Emergency Assistance Act and the National Flood Insurance Act and are necessary to alleviate the emergency; (6) maintenance, repair, or reconstruction, but not expansion, of publically owned or publically operated roads, structures, or facilities; (7) nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system; (8) any use or facility necessary for the exploration, extraction, or transportation of energy resources; (9) maintenance or construction of improvements of existing federal navigation channels, including the disposal of dredge materials related to such projects; and (10) military activities essential to national security. The USACE has coordinated with the USFWS concerning the CBRS and CBIA units in the project area to confirm that the project is in compliance with the Act (correspondence is provided in Appendix H).

RIVERS AND HARBORS ACT of 1899

The proposed work would temporarily obstruct navigable waters of the United States. The proposed action will be subject to the public notice, public hearing, and other evaluations normally conducted for activities subject to the Act. The project is in compliance with this Act.

ANADROMOUS FISH CONSERVATION ACT

This Act authorizes the Secretaries of the Interior and Commerce to enter into cooperative agreements with the States and other non-federal interests for conservation, development, and enhancement of anadromous fish and to contribute up to 50 percent as the Federal share of the cost of carrying out such agreements. As this project is not receiving funding for these purposes, this Act does not apply.

MIGRATORY BIRD TREATY ACT and MIGRATORY BIRD CONSERVATION ACT

Migratory birds would be minimally affected by dredging at the proposed sand source locations. The USACE will include our standard migratory bird protection requirements in the project plans and specifications and will require the Contractor to abide by those requirements. Renourishment activities at the beach placement site will be monitored at dawn or dusk daily during the nesting season to protect nesting migratory birds. If nesting activities occur within the construction area, appropriate buffers will be placed around nests to ensure their protection. The project shall be in compliance with these Acts.

MARINE PROTECTION, RESEARCH and SANCTUARIES ACT (OCEAN DUMPING ACT)

The term "dumping" as defined in the Act (3[33 U.S.C. 1402](f)) does not apply to the disposal of material for beach nourishment or to the placement of material for a purpose other than disposal (i.e. placement of rock material as an artificial reef or the construction of artificial reefs as mitigation). Therefore, the Marine Protection, Research, and Sanctuaries Act does not apply to this project. The disposal activities addressed in this EA have been evaluated under Section 404 of the Clean Water Act (see Appendix G-1).

UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION POLICIES ACT OF 1970.

The purpose of PL 91-646 is to ensure that owners of real property to be acquired for Federal and Federally assisted projects are treated fairly and consistently and that persons displaced as a direct result of such acquisition will not suffer disproportionate injuries as a result of projects designed for the benefit of the public as a whole.

While one of the alternatives considered during plan formulation included the acquisition of real property, this is not part of the Tentatively Selected Plan. Therefore, this project does not involve any real property acquisition or displacement of property owners or tenants. Therefore, this Act is not relevant to this project.

EXECUTIVE ORDER (EO) 11990, PROTECTION of WETLANDS

No wetlands would be affected by project activities. This project is in compliance with the goals of this Executive Order.

E.O 11988, FLOOD PLAIN MANAGEMENT

To comply with EO 11988, the policy of USACE is to formulate projects that, to the extent possible, avoid or minimize adverse effects associated with the use of the floodplain and avoid inducing development in the floodplain unless there is no practicable alternative. No activities associated with this project are located within a floodplain, which is defined by EO 11988 as an "area which has a one percent or greater chance of flooding in any given year." The project is located within the Coastal High Hazard Area (CHHA), as defined by EO 11988 as an "area subject to inundation by one-percent-annual chance of flood, extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms." The project shoreline is significantly developed, and further development is anticipated to be minimal.

CSRM projects are inherently located in coastal areas, and are often located in CHHAs based on the problems the project is seeking to alleviate. The primary objective of the St. Lucie County Coastal Storm Damage Reduction Project is to reduce infrastructure damage. There is no practicable alternative that could be located outside of the CHHA that would achieve this objective.

For the reasons stated above, the project shall be in compliance with EO 11988, Floodplain Management.

E.O. 12898, ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The Executive Order mandates that each federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Any potential adverse effects of the proposed action would be more likely to affect those of higher socioeconomic status, such as large watercraft owners or those living in the coastal area surrounding the project. The beneficial effect of a wider, more sustainable beach would benefit all members of the public who are able to obtain transportation to access the beach. The storm damage reduction benefits are primarily benefitting the landowners in this area. There are no disproportionate adverse impacts to minority or low income populations resulting from the implementation of the project.

E.O. 13045, DISPARATE RISKS INVOLVING CHILDREN

On April 21, 1997, the President of the United States issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. The Executive Order mandates that each Federal agency make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

As the proposed action does not affect children disproportionately from other members of the population, the proposed action would not increase any environmental health or safety risks to children.

E.O. 13089, CORAL REEF PROTECTION

The EO refers to "those species, habitats, and other natural resources associated with coral reefs." There are no coral reefs in the project area. This EO does not apply.

E.O. 13112, INVASIVE SPECIES

The proposed action will require the mobilization of dredge equipment from other geographical regions. Dredge equipment has the potential to transport species from one region to another, introducing them to new habitats where they are able to out-compete native species. The benefits of the proposed project outweigh the risks associated with the very slight potential for introducing non-native species to this region. The action takes place primarily in Atlantic Ocean waters, minimizing risk to more sheltered coastal habitats.

6 Recommendations

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6 RECOMMENDATIONS

The Recommended Plan has not yet been identified. This section will be completed for the final version of the report.

NOTE: This draft document is not yet complete. The current report describes existing conditions in the study area as well as future conditions if a project is not constructed, problems that a project would address and opportunities available to manage coastal risk. The current report also describes plan formulation, including environmental considerations, to reach a Tentatively Selected Plan (TSP). The document will be revised per comments received during concurrent review, and the TSP could be modified. There will be additional review prior to the report being made "final," and information will be added to the report as the TSP is developed into a Recommended Plan.

6.1.1 DRAFT ITEMS OF LOCAL COOPERATION

Recommendations for provision of Federal participation in the Recommended Plan described in this report would require the project sponsor to enter into a written Project Partnership Agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation satisfactory to the Secretary of the Army. Such local cooperation shall provide the following non-federal responsibilities:

a. Provide a minimum of 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits, and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do provide public benefits, and as further defined below:

(1) Provide all lands, easements, rights-of-way, including suitable borrow areas, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the initial construction, periodic nourishment or operation and maintenance of the project;

(2) Provide, during design, 35 percent of design costs allocated to hurricane and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(3) Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Inform affected interests, at least annually, of the extent of protection afforded by the project;

d. Participate in and comply with applicable floodplain management and flood insurance programs;

e. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12);

f. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent

unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

g. Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal government;

h. For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

i. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

j. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal government;

k. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;

l. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

m. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, periodic nourishment, operation and maintenance of the project;

n. Assume, as between the Federal government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, periodic nourishment, or operation and maintenance of the project;

o. Agree, as between the Federal government and the non-federal sponsor, that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the

maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

p. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

q. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

r. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)); and

s. Not use funds from other Federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-federal sponsor's obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

7 List of Preparers

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7 LIST OF PREPARERS

7.1 PREPARERS

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8.2 INDEX

Reference Maps