FINAL ENVIRONMENTAL IMPACT STATEMENT

PORT EVERGLADES HARBOR NAVIGATION STUDY

BROWARD COUNTY, FLORIDA

U.S. Army Corps of Engineers
Jacksonville District
701 San Marco Boulevard
Jacksonville, FL 32207

Cooperating Agencies:
U.S. Environmental Protection Agency
National Marine Fisheries Service
Florida Department of Environmental Protection
Florida Fish and Wildlife Conservation Commission
Broward County Commission

6 March 2015

U.S. Army Corps of Engineers, Jacksonville District

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Abstract: The Port Everglades Feasibility Study is authorized through House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 1st Session and by a resolution of the House Committee on Transportation dated May 9, 1996. The feasibility study was initiated in 2001 with the non-federal sponsor, Broward County Department of Port Everglades. The existing federal channel project depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and container ships currently visiting the harbor. Furthermore, the next generation of container ships and oil tankers requires significantly more channel depth to operate efficiently. Finally, a wider and deeper outer entrance channel will greatly improve the safety of navigation. The primary objectives for the project considered in the Port Everglades Feasibility Study are to (1) decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies at Port Everglades, (2) decrease transportation costs through increasing economies of scale for cargo and petroleum vessels at Port Everglades, and (3) increase channel safety and maneuverability at Port Everglades for existing vessel use as well as for larger vessels, through the year 2073. USACE proposes to deepen the Outer Entrance Channel (OEC) to an authorized depth of -48 feet MLLW (resulting in an *actual* depth of 57 feet, which includes overdredge and safety requirements), widen it to 800 feet on the seaward end, and extend it 2,200 feet seaward; deepen the Inner Entrance Channel (IEC) to 48 feet (50-foot actual); deepen the Main Turning Basin (MTB) to 48 feet (50-foot actual); widen the rectangular shoal region to the southeast of the MTB by about 300 feet and deepen to 48 feet (50-foot actual); widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26 by about 250 feet and reconfigure the USCG facility to the east; shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back to the existing federal channel limits; deepen the SAC from about berth 23 to the south end of berth 32 to 48 feet (50-foot actual); deepen the Turning Notch (TN) (following local-sponsor-dredging of same area to 42 feet) to 48 feet (50-foot actual) with an additional 100-foot north-south widening parallel to the SAC on the eastern edge of the SAC over a length of about 1,845 feet; widen the western edge of the SAC for access to the TN from the existing federal channel edge near the south end of berth 29 to a width of about 130 feet at the north edge of the TN; and provide compensatory mitigation for unavoidable impacted to certain resources. “Pre-treatment” (breaking, prior to removal) of rock substrates may be necessary. Appropriate measures to safeguard protected species during this process will be undertaken. Dredge disposal will occur at the existing ODMDS and within the expanded ODMDS, if the site is designated by the U.S. Environmental Protection Agency. To compensate for the effects of the action on various habitat types, USACE has proposed to mitigate for the removal of approximately 4.21 acres of vegetated seagrass habitat and the loss of approximately 1.16 acres of mangroves in the project footprint through use of mitigation “functional units” at an on-going habitat improvement project at adjacent West Lake Park, a Broward-County-operated, state-owned, natural area. In addition, USACE will mitigate for the direct removal of approximately 14.62 acres and the potential indirect damage to 0.71 acre of hardbottom and reef habitats through the creation of approximately five acres of boulder-reefs, on approximately two acres of which corals transplanted from the impact area will be installed. In addition, approximately 18 acres of hardbottom and reef habitats will be enhanced using over 103,000 coral colonies outplanted from nurseries. Additional mitigation will be provided due to any incidental direct or indirect impacts of dredging equipment and indirect impacts on hardbottom habitats due to any discernable effects of sedimentation.

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EXECUTIVE SUMMARY

Background.

Authorization: The Port Everglades Feasibility Study is authorized through House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 1st Session and by a resolution of the House Committee on Transportation dated May 9, 1996. In response to the study authority, the feasibility study was initiated in 2001. The non-federal sponsor for the feasibility study is Broward County.

Need: The existing federal channel project depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and container ships currently visiting the harbor. Furthermore, the next generation of container ships and oil tankers requires significantly more channel depth to operate efficiently. Finally, a wider and deeper entrance channel will greatly improve the safety of navigation.

Purpose: The primary objectives for the project considered in the Port Everglades Feasibility Study are the following: (1) decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies at Port Everglades through the 50-year period of analysis; (2) decrease transportation costs through increasing economies of scale for cargo and petroleum vessels at Port Everglades through the 50-year period of analysis; (3) increase channel safety and maneuverability at Port Everglades for existing vessel use as well as for larger vessels through the 50-year period of analysis; (4) present opportunities for national economic development and (5) present opportunities for port expansion that will avoid and minimize environmental impacts and comply with USACE environmental operating principles.

Alternatives.

USACE analyzed 22 alternatives (including multiple depths for various components) for the Port Everglades Feasibility Study. This Environmental Impact Statement (EIS) analyzes the environmental effects of (1) the Recommended Plan, i.e., the Locally Preferred Plan, which involves dredging channels to an *authorized* depth of 48 feet (up to an *actual* depth of 57 feet), (2) four other alternative dredge depths (including one depth selected as the National Economic Development, or "NED" Plan), and (3) the No-Action Alternative. Elements of the LPP include the following:

a increase the authorized depth of the OEC from 45 feet (actual existing depths vary) to 48 feet (-48 feet MLLW) (i.e., an *actual* depth of up to 57 feet due to engineering and safety requirements), widen the seaward end of it from 500 feet to 800 feet, and extend the channel 2,200 feet seaward;

b. increase the authorized depth of the Inner Entrance Channel (IEC) from 42 feet to 48 feet (resulting in an actual depth of 50 feet);

c. increase the authorized depth of the Main Turning Basin (MTB) from 42 feet to 48 feet (resulting in an actual depth of 50 feet);

d. widen the rectangular shoal region (the Widener, or "WID") by approximately 300 feet to the southeast of the MTB and deepen it to a new authorized depth of 48 feet (resulting in an actual depth of 50 feet);

e. widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and reconfigure the United State Coast Guard (USCG) facility, a General Navigation Feature (GNF), easterly on USCG property;

f. shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back from the expanded Widener area in the north to the existing federal channel limits to the south;

g. increase the authorized depth of the SAC from 42 feet to 48 feet (from the area adjacent to berth 23 to the south end of berth 32), resulting in an actual depth of 50 feet;

h. deepen the Turning Notch (TN), including an area currently being expanded and incorporated into the TN by the local sponsor, from 42 feet to 48 feet (resulting in an actual depth of 50 feet); widen the SAC to the east (across from the TN) by an additional 100 feet over a length of about 1,845 feet; and widen the western edge of the SAC from near the south end of berth 29 to a width of up to approximately 130 feet at the north edge of the TN;

i. conduct environmental mitigation (see below);

j. pre-treat rock substrates as necessary and take appropriate measures to safeguard protected species during that process;

k. dispose of dredged material east of the Port at the Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS), which is currently proposed for expansion by USEPA (under Section 102 of the Marine, Research, Protection, and Sanctuaries Act, or "MPRSA"). If it is not expanded under Section 201, the maximum amount of material that can be placed within the existing site will be deposited, and USACE will pursue designation under Section 102 of MPRSA.

The NED plan was identical to the above LPP, but the proposed, new authorized depth noted in items *a, b, c, d, g*, and *h* above would be 47 feet rather than 48.

Several other construction (and non-structural) alternatives that could have avoided or minimized impacts to offshore reefs and hardbottom habitats were also examined. However, none of them could be executed due to their inconsistency with project objectives, their impracticability, their locations, their implementation being outside the missions of USACE, or other factors.

Environmental Consequences of the Recommended Plan.

Avoidance and minimization of impacts was a major consideration during plan formulation. Two components, dredging in the Dania Cutoff Canal (DCC) and dredging wetlands in the Turning Notch (TN) were removed from consideration for implementation, decreasing impacts to seagrasses and mangroves. Furthermore, the proposed width of the eastern terminus of the OEC was decreased from 1,000 feet to 800 feet, decreasing impacts to sensitive hardbottom and reef habitats. The Recommended Plan involves dredging approximately 400 acres of substrates. This includes previously dredged areas as well as areas to widen and extend federal basins and channels. Notable unavoidable impacts include removal of approximately 4.21 acres of seagrasses (including 3.57 acres across which at least some protected Johnson's seagrass was observed), removal of approximately 1.16 acres of jurisdictional mangrove wetlands (adjacent to the Southport Access Channel), and removal of approximately 14.62 acres and assumed indirect impacts to 0.71 acre of hardbottom and reef habitats (due to widening and extending the Outer Entrance Channel). Project effects on listed species are not expected to result in either jeopardy to the various species or adverse modification of designated critical habitat. No long-term impacts to water quality are anticipated due to turbidity-limiting regulations, monitoring, and stringent

dredge shut-down protocols. USACE acknowledges that the possibility of temporary, uncontrolled, incidental resuspension of material during dredging operations that may result in temporary (up to two years) affect on corals. To monitor and accommodate for any potential effects of turbidity and sedimentation, USACE established a potential indirect impact zone around the proposed, expanded channel limits. The zone extends to the north, east, and south from the proposed channel limits 150 meters and comprises approximately 109 acres. Any permanent adverse effects on corals in this area will be compensated through mitigation, as appropriate.

Mitigation.

To compensate for the unavoidable adverse effects of the action on the significant habitat types noted above, several mitigation measures will be carried out. For the removal of seagrass and mangrove habitat, USACE will purchase ecosystem benefits provided by a previously permitted restoration project at West Lake Park (Broward County, FL), which is currently under construction. Mitigation for impacts is expected to involve use of approximately 2.5 seagrass functional units and one (1) mangrove functional unit, from that project, located in a county-operated, state-owned, natural area immediately to the south of the project area. USACE in collaboration with NMFS has also proposed the following mitigation for losses of hardbottom and reef habitats: (a) creation of approximately three acres of boulder reef left to be naturally recruited by benthic species; (b) creation of approximately two acres of boulder reef on which corals transplanted from the proposed OEC impact area will be installed; and (c) approximately 18 acres of hardbottom and reef habitats (locations to be determined) will be enhanced using over 103,000 coral colonies outplanted from nurseries. Additional mitigation will be provided, as appropriate, due to any detectable, incidental, direct impacts of dredging equipment and indirect impacts on hardbottom habitats due to sedimentation, as determined through pre- and post-construction monitoring.

Public Comments and Areas of Controversy.

Following publication of the Draft EIS, 578 comments were received from among 254 parties (including regulatory and resource agencies) during the public notice period. Issues for which multiple comments were received involved such issues as longshore sediment transport, impacts to reefs and protected coral species, and quantity of available seagrass mitigation at West Lake Park. Many commenters were in favor of the project. Areas of anticipated controversy include adequacy of mitigation for impacts to reefs and control of water quality and sedimentation during project construction.

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ACRONYMS/ ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
AOML	Atlantic Oceanographic and Meteorological Laboratory
AQCR	Air Quality Control Region
BCEPD	Broward County Environmental Protection and Growth Management Dept
BCNRPMD	Broward County Natural Resources Planning & Management Division
BCSPP	Broward County Shore Protection Plan
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BSEE	BOEMRE's Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CAAA	Clean Air Act Amendment
CAR	Coordination Act Report
CBRA	Coastal Barrier Resources Act
CBRIA	Coastal Barrier Resources Improvement Act
CERCLA	Comprehensive Environmental Response Compensation Liability Act
CIBA	Coastal Barrier Improvement Act
CU	Confined Underwater
CWA	Clean Water Act
DARM	Division of Air Resource Management
DCC	Dania Cutoff Canal
DCH	Designated Critical Habitat
EEZ	Exclusive Economic Zone
EFB	Environmentally Friendly Bulkhead
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EOP	Environmental Operating Principles
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EWRAP	Estuarine Wetlands Rapid Assessment Procedure
FDEP	Florida Department of Environmental Protection
FEC	Florida East Coast (Railway)
FLL	Fort Lauderdale/Hollywood Airport
FLUCCS	Florida Land Use Cover Classification System
FMC	Fishery Management Council
FMSF	Florida Master Site File
FP&L	Florida Power and Light
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
FWS	U.S. Fish and Wildlife Service
FY	Fiscal Year
GOM	Gulf of Mexico
GNF	General Navigation Feature
GRBO	Gulf Regional Biological Opinion
HAPC	Habitat Areas of Particular Concern
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
ICTF	Intermodal Container Transfer Facility
I&EM	Impingement and Entrainment Mortality

IEC	Inner Entrance Channel
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IWR	Institute of Water Resources
IWW	Intracoastal Waterway
JUL	John U. Lloyd Beach State Park
LNG	Liquid Natural gas
LOOP	Louisiana Offshore Oil Port
LPP	Locally Preferred Plan
MHW	Mean High Water
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MMPA	Marine Mammal Protection Act
MPRSA	Marine Protection Research and Sanctuaries Act
MTB	Main Turning Basin
NAAQS	National Ambient Air Quality Standards
NARW	North Atlantic Right Whale
NCRI	National Coral Reef Institute
NEA	New England Aquarium
NED	National Economic Development
NEPA	National Environmental Policy Act
NGO	Non-government Organization
NMFS	U.S. National Marine Fisheries Service
NOS	National Ocean Service
NRPMD	Broward County Natural Resources Planning & Management Division
NSU	Nova Southeastern University
NSUOC	Nova Southeastern University Oceanic Center
NTB	North Turning Basin
O&M	Operations and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
OEC	Outer Entrance Channel
OPA	Otherwise protected area
OPR	Office of Protected Resources
OSE	Other social effects of a project (safety, quality of life, etc)
Panamax	Vessels that can navigate the Panama Canal
PBR	Potential Biological Removal
PCE	Primary Constituent Element
PED	Preconstruction Engineering and Design
PEPA	Port Everglades Pilots Association
PERG	Port Everglades Reef Group
PIB	Balances public interest regarding State Trust Land
Port	Broward County Port Everglades Department (government entity)
Port	Port Everglades Harbor (site/location)
Post-Panamax	Vessels too large to navigate the existing Panama Canal
PPV	Peak Particle Velocity
PSD	Prevention of Significant Deterioration
PTS	Permanent threshold shift
PVS	Peak Vector Sum
RIM	Regional Implementation Manual
RED	Changes in distribution of regional economic activity

RFP	Request for Proposal
RO/RO	Roll on/Roll off
RSCR	Relative Sea Level Rise
SAC	Port Everglades Southport Access Channel
SAFMC	South Atlantic Fisheries Management Council
SARBO	South Atlantic Regional Biological Opinion
SECRMP	Southeast Florida Coral Reef Evaluation and Monitoring Project
SEFSC	Southeast Fisheries Science Center
SFTF	South Florida Testing Facility
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SOSUS	U.S. Navy Sound Surveillance System
SST	Sea-Surface Temperature
STAR	Simulation Training and Research Center
STB	South Turning Basin
System	Coastal Barrier Resources System
TEU	Twenty-foot equivalent units
TN	Turning Notch
TTS	Temporary Threshold Shift
U.S. EEZ	U.S. Atlantic Exclusive Economic Zone
UMAM	Uniform Mitigation Assessment Methodology
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USN	U.S. Navy
VOC	Volatile organic compound
WBD	White Band Disease
WHOI	Woods Hole Oceanographic Institute
WID	Port Everglades Widener
WLPMMP	West Lake Park Master Mitigation Plan
YBP	Years Before Present

1.0 PROJECT PURPOSE

1.1 Project Objective

The primary federal objective is to provide for increased navigational safety, efficiency, and improved economic conditions while limiting impacts to the environment to the maximum extent practicable, in accordance with environmental statutes, applicable executive orders, and other federal planning requirements. In Section 1.3 of the Port Everglades Feasibility Study, the U.S. Army Corps of Engineers (USACE) specifically identifies that the purpose of conducting the study is to:

Objective 1	**Decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies at the Port through the 50-year period of analysis.**
Objective 2	**Decrease transportation costs through increasing economies of scale for cargo and petroleum vessels at the Port through the 50-year period of analysis.**
Objective 3	**Increase channel safety and maneuverability at the Port for existing vessel use, as well as for larger vessels through the 50-year period of analysis**
Objective 4	**Present opportunities for national economic development**
Objective 5	**Present opportunities for port expansion that will avoid and minimize environmental impacts**

The study process was initiated in response to a number of problems and issues identified by Broward County (the non-federal project sponsor) and the Port Everglades Pilots Association and are described in detail in Section 4.2 ("Problems and Opportunities") in the Port Everglades Feasibility Study.

While meeting the objectives above, USACE also strives to protect the environment to the maximum extent practicable. As with any USACE civil works project, the study process included incorporation of USACE's Seven Environmental Operating Principles (EOP). These are the following:

1. Foster sustainability as a way of life throughout the organization.

2. Proactively consider environmental consequences of all Corps activities and act accordingly.

3. Create mutually supporting economic and environmentally sustainable solutions.

4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments.

5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.

6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.

7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

1.2 Project Location

Port Everglades Harbor (the "Port") is a major seaport located on the southeast coast of Florida (Figure 1). It is located within the cities of Hollywood, Dania Beach, and Fort Lauderdale, with immediate access to the Atlantic Ocean. The entrance of the Port is approximately 27 nautical miles north of Miami Harbor, Florida and 301 nautical miles south of Jacksonville Harbor, Florida.

To the east of the Port is a barrier island that contains a U.S. Navy (USN) facility, the Nova Southeastern University (NSU) Oceanographic Center, a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park (JUL) and its adjacent beaches. South of the Dania Cutoff Canal (DCC) is the West Lake Park area. West of the Port is Federal Highway (US Highway 1) which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.

1.3 Project Need

According to the *U.S. Port and Inland Waterways Modernization Report: Preparing for Post-Panamax Vessels* (IWR 2012), as international trade expands, the overall trade and deployment of post-Panamax vessels to U.S. ports for multiple trade routes is anticipated to increase. The expansion of the Panama Canal, scheduled to be completed in 2016, will double its existing capacity, and its new locks will be able to pass vessels large enough to carry three times the volume carried by vessels today (typically for Asian trade and round the world trade services). For the current feasibility study concerning Port improvements, the future-condition assumption presumes commodity growth rates, and on larger sized, post-Panamax vessels for conveyance for parties engaged in international trade (thus the need for additional channel depth). Furthermore, the study's economic analysis assumes the same vessel traffic for with- and without-project conditions, since the larger post-Panamax vessels are more cost-effective for large volume trade across multiple trade routes that are expected to call along the east coast US.

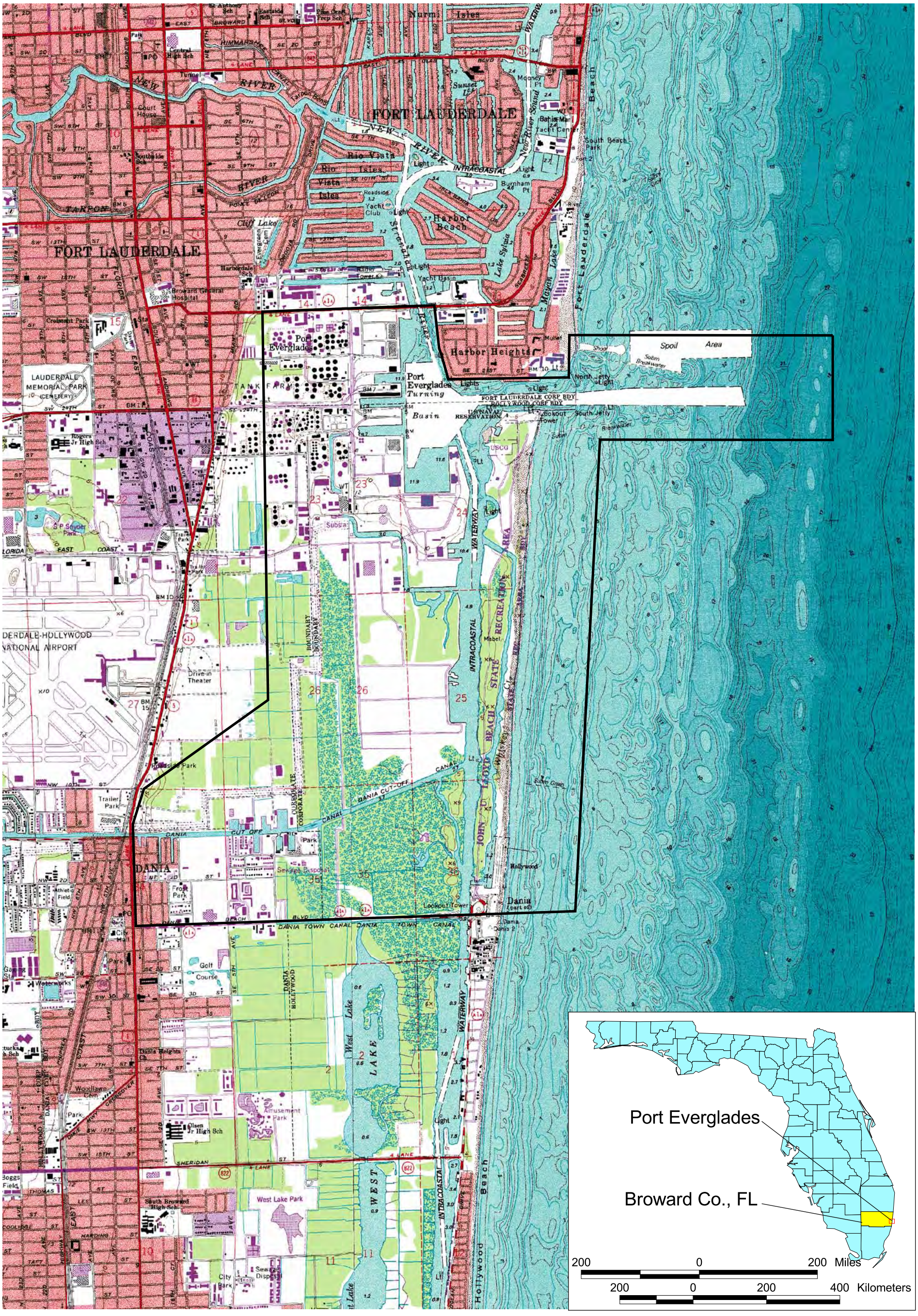
The existing authorized Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide (Figure 2), an Inner Entrance Channel (IEC) that is 450 feet wide and 42 feet deep, a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (NTB) that is 31 feet deep, a South Turning Basin (STB) that is 31 to 36 feet deep, a Southport Access Channel (SAC) that is 390 to 400 feet wide and 42 feet deep, and a Turning Notch (TN) that is 42 feet deep. Figure 3 shows Port-associated facilities and berths.

The existing federal channel project depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and container ships currently visiting the harbor (Section 4.2 of the Port Everglades Feasibility Study). Those ships must be light-loaded or wait on tides to enter the harbor resulting in transportation inefficiencies and additional expenses. These vessel calls are expected to be more efficiently utilized when ports in the itinerary have channels with greater depths. The Institute of Water Resources (IWR) report defines a port "post-Panamax ready" if it has channel depth of about 50 feet with allowances for tide, as well as sufficient

channel width, turning basin size, and dock and crane capacity. Port Everglades is expected to make the necessary dock and crane infrastructure improvements. These improvements will create efficiencies for movement of containerized cargo. For example, major capital projects include the development of an Intermodal Container Transfer Facility (ICTF) at Port Everglades which will provide the Port with direct access to the Florida East Coast (FEC) Railway rail network and its intermodal terminals. The FEC, a 351-mile freight rail system located along the east coast of Florida, provides an efficient north/south option for transporting freight and has a competitive advantage for long distance hauls due to the highly congested roadways in South Florida. This investment is occurring regardless of federal project construction. The ICTF will eliminate the need for trucks to haul containers to and from off-port rail terminals and opened in 2014. Once completed, the ICTF is expected to reduce congestion on interstate highways and local roadways and reduce harmful air emissions by diverting an estimated 180,000 trucks by 2027.

The next generation of container ships and oil tankers requires significantly more channel depth to operate efficiently. Specifically, such container ships comprise *post*-Panamax vessels (i.e., those too large to transit the current Panama Canal lock system) such as S-Class vessels like the *M/V Susan Maersk* that have an overall length of 1,138 feet, an extreme breadth of 141 feet, and a maximum draft of 47.6 feet. In contrast, the current largest Panamax (e.g., the Panama Canal-going *Maersk Pristine*) container ships have overall lengths of 965 feet, an extreme breadth of 106 feet, and a maximum draft of 44.3 feet. Figure 4 shows how such vessels, and Voyager-class vessels (*Enchantment of the Seas*), compare in size to the *Queen Mary II* and such notable structures as the Empire State Building and the Seattle Space Needle. Post-Panamax vessels currently comprise 16% of the world's container fleet, but account for 45% of the fleet's capacity. The efficiencies of scale they provide drive the deployment of more and more of these vessels. By 2030, they are expected to make up 27% of the world's container fleet, accounting for 62% of its capacity (IWR 2012).

In addition to channel depth limitations, the existing federal project has channel width constraints. Ships that currently call at the Port frequently must pass and maneuver within unsafe distances of each other. Furthermore, the present channel configuration prevents the next generation of container ships from transiting the channel. Finally, docking Voyager-class vessels (1,021 feet long) used as the design vessel for this study) in the harbor would create transit problems for any post-Panamax container ships as they would attempt to dock at berths on the Southport Access Channel. Fleet composition and analysis of the next generation of ships expected to call at Port Everglades are found in Section 4.2 of the Economic Appendix to the Feasibility Study.

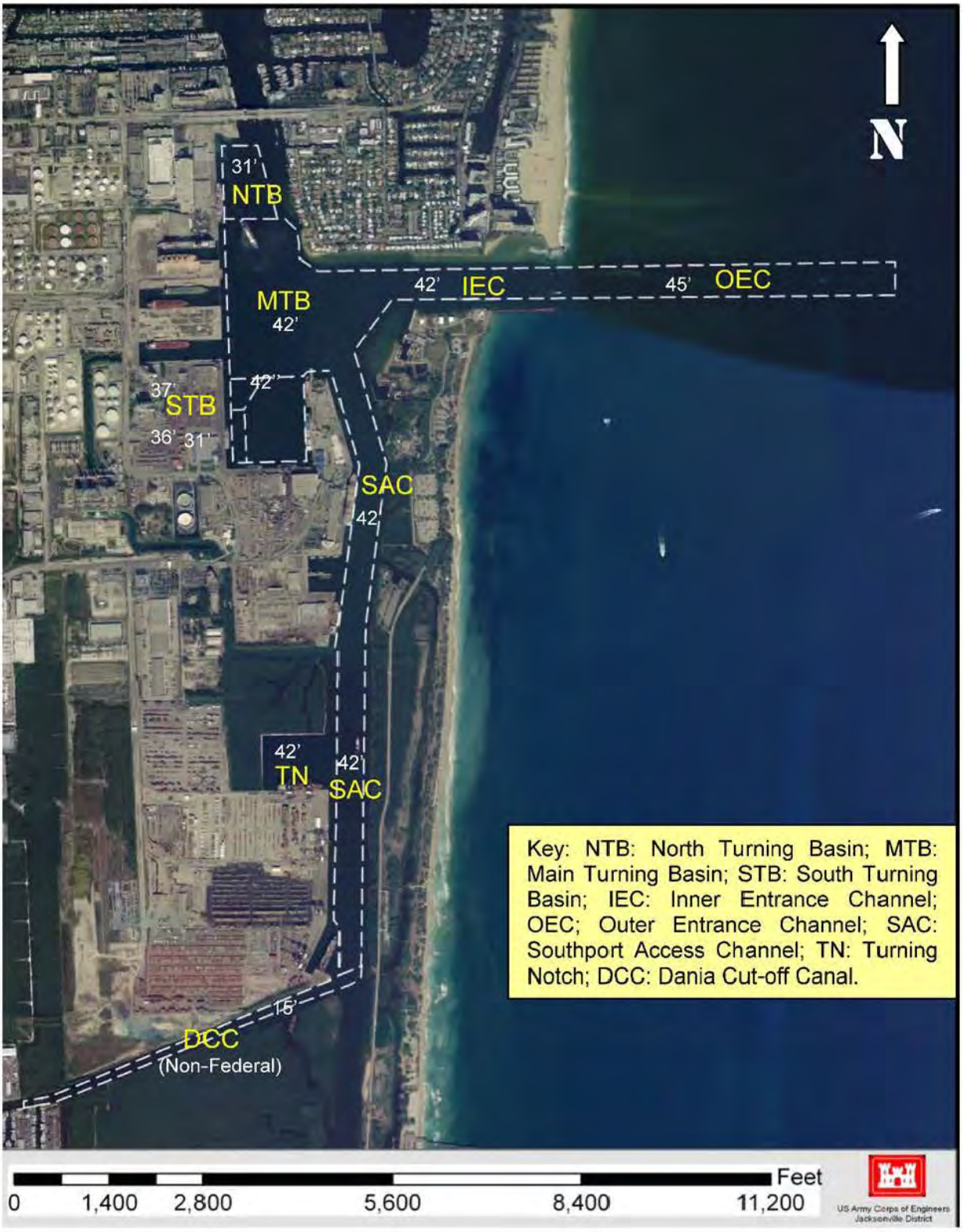


Approximate Extent of Study Area

0.25 0 0.25 0.5 0.75 1 Miles

0.5 0 0.5 1 1.5 2 Kilometers

Port Everglades Location	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: inch = 0.5 mile	rawn By: MR
Date: September 2014	Approved By: E
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J 2
	Figure 1



Port Everglades Existing Channel Components and Authorized Depths	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: as shown	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 2

Source: Port Everglades/Broward County FL, 2009.

Port Everglades Berths and Facilities	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: NTS	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 3

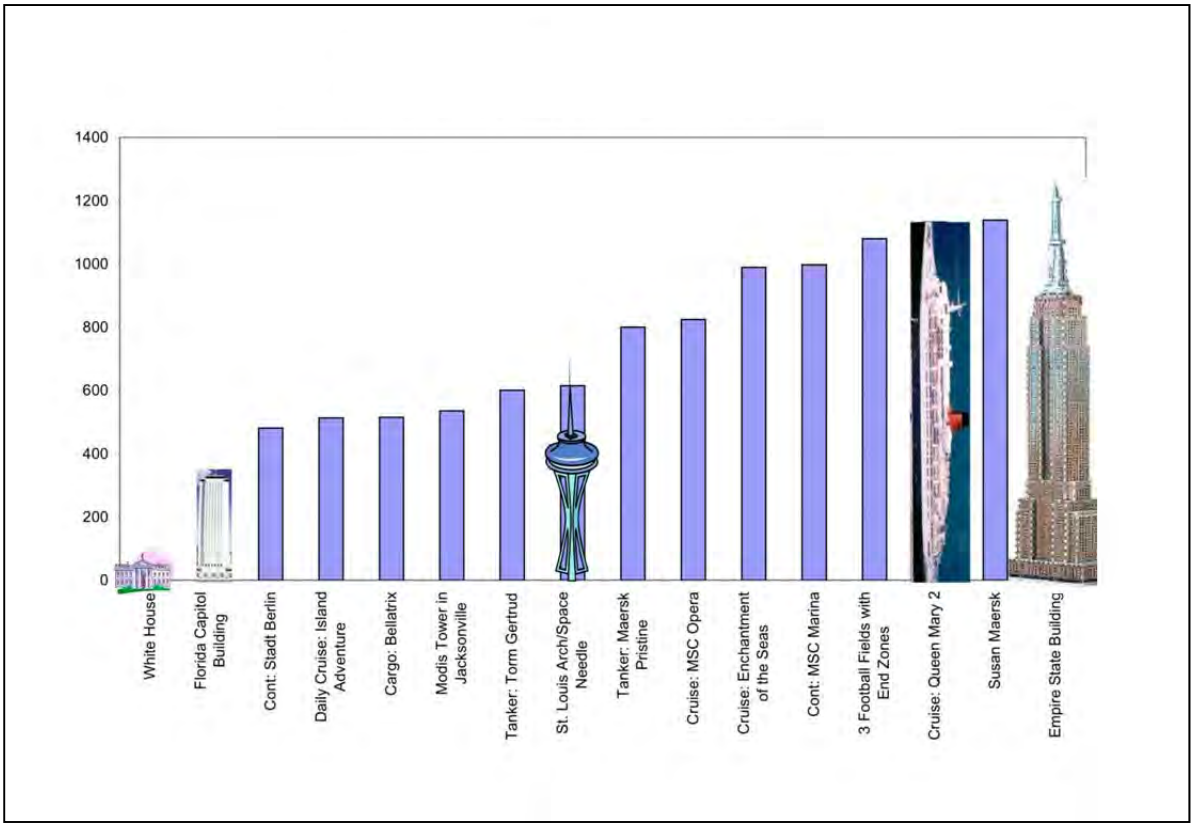


Figure 4 Comparison of Port Everglades Ship Lengths to Notable Structures and Vessels

Economic analyses have shown that improvements to most of the major federal and non-federal channels and basins are required to achieve efficient transit of the existing fleet and to accommodate the future fleet. Methods to improve efficiency of Port operations and mitigate costs of consumer products being brought into the country through the Port include the following:

- avoiding light-loading of ships,
- allowing for Port calls at all tides, and
- promoting fewer calls of larger vessels (rather than more calls of smaller vessels).

Also pertinent to the economic analyses is the cost of in-harbor congestion, due both to influxes of vessels that enter the harbor on beneficial tides and to pilot operating restrictions within the harbor and channels. Ultimately, traffic and restrictions result in time delays that affect cost to port users and therefore consumers (See discussion of Port Simulation/Waterway Analysis Model in Sections 1.0 and 2.0 of Sub-Appendix C of the Economics Appendix of the Feasibility Study for additional details).

With respect to safety issues, the Port Everglades Pilots Association (PEPA) has expressed significant concern regarding the safety of navigation to and within the existing channel (see their letter dated March 22, 2007 in Appendix A). Additionally, the annual NOAA publication for mariners, “The Coast Pilot”, has recognized the unpredictable currents and resultant safety issues at the Port Everglades entrance channel” (NOS 2010):

> "The entrance channel has dangerously strong cross currents, which vary in strength and are unpredictable in direction. These currents generally run at right angles to the direction of the narrow entrance channel making transit hazardous, without local knowledge, for deep draft vessels. These currents have been reported to be as much as 5 knots" (NOS 2010).

Based on the conditions noted above and subsequent results of vessel movement simulations, a wider and deeper entrance channel and deeper inner entrance channel will greatly improve the safety of navigation.

The proposed project (discussed in later sections) resulted from a comprehensive analysis of all the existing and future commercial vessel transit needs within the Port. The Port Everglades Feasibility Study addresses the existing economic conditions as well as forecasts of future conditions both with and without the proposed improvements (see Section 2.4 and the Economic Appendix for more detail).

The National Environmental Policy Act (NEPA) requires Federal agencies to examine the impacts of their proposed actions before decisions are made. This Environmental Impact Statement (EIS) has been prepared in accordance with NEPA, as amended (42 U.S.C. 4321, et seq.), as well as the Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act" (40 CFR, Parts 1500-1508) and The U.S. Army Corps of Engineers (USACE) ER 1105-2-100 Planning Guidance Notebook. The scope of this EIS includes analyses of activities, associated with the No-Action Alternative and the Proposed Action that could impact the natural or human environment. The scope was determined, in part, through the public involvement process.

In accordance with NEPA regulations, this EIS evaluates a No-Action Alternative, in which the proposed improvements in the Port Everglades Harbor would *not* be implemented, as well as the Recommended Plan (the LPP) and the National Economic Development (NED) Plan. This EIS also provides USACE with environmental information that could be used, if the Recommended Plan is built and operated, to avoid or minimize resource impacts, or to develop and implement any necessary mitigation actions to minimize unavoidable adverse effects to the quality of the human environment and natural ecosystems potentially resulting from the project.

1.4 Project Authority

The Rivers and Harbors Act of 1930, as amended, authorized the federal navigation project at Port Everglades. The Port Everglades Feasibility Study is authorized through House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 1st Session and by a resolution of the House Committee on Transportation dated May 9, 1996. In response to the study authority, the feasibility study was initiated in 2001. The non-federal sponsor for the feasibility study is Broward County Port Everglades Department. Congress added funding in the appropriations for fiscal year (FY) 1997 to begin the Feasibility Study. Details pertaining to study authorizations, and pertinent documentation and correspondence, can be reviewed in the Feasibility Study.

The purpose of this Environmental Impact Statement (EIS) is to "provide full and fair discussions of significant environmental impacts and shall inform decision-makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment" (NEPA regulations 40 CFR 1502.1).

1.5 Related Environmental Documents

Related environmental documents include the following:

U.S. Army Corps of Engineers (USACE) and National Marine Fisheries Service (NMFS). 2014. Mitigation Requirements Analysis for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements (Final). USACE Jacksonville District, Jacksonville, FL.

Dial Cordy and Associates Inc. (DC&A). 2013. Seagrass Mapping and Assessment Between the Nearshore Hardbottom and Middle Reef on the South Side of Port Everglades Entrance Channel. Broward County Port Everglades Department. Ft. Lauderdale, FL. 12 pp.

Dial Cordy and Associates Inc. (DC&A). 2013. Port Everglades Navigation Project Draft Comprehensive Mitigation Plan. Prepared for Jacksonville District USACE. Jacksonville Beach, FL. 45 pp. This document detailed the mitigation alternatives for hardbottom/reef, wetland, and seagrass impacts and described the selected alternative.

National Marine Fisheries Service (NMFS). 2011. Characterization of Essential Fish Habitats in the Port Everglades Expansion Area. St. Petersburg, FL. 45 pgs.

AECOM. 2011. Port Everglades Master/Vision Plan Executive Summary. Prepared for Broward County Board of County Commissioners. 53 pgs.

Dial Cordy and Associates Inc. (DC&A). 2010. Port Everglades Feasibility Study *Acropora* Coral Survey Navigation Project Draft Comprehensive Mitigation Plan. Prepared for Jacksonville District USACE. Jacksonville Beach, FL. 10 pp. This document resulted from surveys investigating the presence of protected corals in the proposed impact area.

Dial Cordy and Associates Inc. (DC&A). 2009. Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel. Jacksonville Beach, Florida. 65 pp. Prepared for Jacksonville District USACE. Jacksonville Beach, FL. This effort documented field efforts to characterize the hardbottom communities within and near the proposed navigation channel.

Dial Cordy and Associates Inc. (DC&A). 2009. Seagrass Mapping and Assessment, Port Everglades Harbor. Prepared for Jacksonville District USACE. Jacksonville Beach, FL. 21 pp. This document summarized and detailed findings regarding seagrass community field investigations within the project area.

Coastal Eco-Group. 2008. Biological Assessment, Port Everglades Inlet Sand Bypass Project. Prepared for Olsen Associates. Jacksonville, FL. 100 pgs.

Coastal Eco-Group. 2008. Environmental Assessment, Port Everglades Inlet Sand Bypass Project. Prepared for Olsen Associates. Jacksonville, FL. 196 pgs.

Olsen Associates, Inc. 2007. Port Everglades Inlet Sand Management Phase II: Sand Bypassing Feasibility Study Addendum. Prepared for Broward County Board of Commissioners. Jacksonville, FL. 136 pgs.

U.S. Army Corps of Engineers (USACE). 2005. Maintenance Dredging, Port Everglades, Broward County, Florida, Final Environmental Assessment and Finding of No Significant

Impact. 46 pp. This Environmental Assessment evaluates the environmental effects of maintenance dredging the currently authorized Port project and available disposal options.

Olsen Associates, Inc. 2004. Port Everglades Inlet Sand Management Phase I: Sand Bypassing Feasibility Study. Prepared for Broward County Board of Commissioners. Jacksonville, FL. 222 pgs.

U.S. Environmental Protection Agency (USEPA). 2004. Final Environmental Impact Statement (EIS) for Designation of the Palm Beach Harbor Ocean Dredged Material Disposal Site and the Port Everglades Harbor Ocean Dredged Material Disposal Site, July 2004, Palm Beach and Broward Counties, Florida. This study addressed the designation of ocean dredged material disposal sites (ODMDS) to accommodate Palm Beach Harbor and Port Everglades Harbor. The FEIS evaluated the potential environmental impacts of alternative sites as designation for ocean disposal of sediments associated harbor maintenance.

USACE 2003, Maintenance Dredging Port Everglades Entrance Channel. Broward County, Florida. Environmental Assessment. November 2003.

Dial Cordy and Associates Inc. 2001. Environmental Baseline Study and Impact Assessment for Port Everglades. Prepared for Jacksonville District USACE. Jacksonville, FL.15 pp. This document was initiated in support of the current EIS. This report documents the environmental resources within the study area and potential impacts to these resources as results of various proposed alternatives.

Florida Department of Environmental Protection (FDEP). 2000. John U. Lloyd State Recreation Area Unit Management Plan. The plan was completed to serve as the basic statement of policy and direction for the management of JUL State Recreation Area.

USACE, 1990. Navigation Study for Port Everglades Harbor, Florida, 10207 Feasibility Report and Environmental Assessment. This EA explored the feasibility of deepening and widening an 8,000-foot segment of the SAC and creation of a 750-foot by 900-foot TN.

Broward County Department of Port Everglades. 1987. Final Environmental Impact Statement, Proposed Expansion Port Everglades, Broward County, Florida. This EIS was performed for the deepening and widening the SAC, bulkheading Port lands, and creation of the TN.

USACE. 1977. Phase I General Design Memorandum on Port Everglades Harbor, Florida. Jacksonville District, U.S. Army Corps of Engineers. Jacksonville, Florida. February 1977.

U.S. House of Representatives. 1972. House Document No 93-144. Letter from the Secretary of the Army transmitting A letter from the Chief of Engineers, Department of the Army, Dated August 31, 1972. *Submitting a Report, Together with Accompanying Papers and Illustrations, on Port Everglades Harbor, Florida, Requested by a Resolution of the Committee on Public Works, House of Representatives*, Adopted September 30, 1964. 93rd Congress (1972); 1st Session.

Many of the above and other relevant National Environmental Policy Act (NEPA) documents can be viewed on the internet at the following address:
http://www.saj.usace.army.mil/About/DivisionsOffices/Planning/EnvironmentalBranch/EnvironmentalDocuments.aspx.

Other NEPA documents that cover additional activities taking place in Broward County outside of the Federal Navigation Project boundaries include the following:

USEPA 2013. Draft Environmental Assessment on the Expansion of the Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS), Broward County, Florida.

USEPA 2004 Final Environmental Impact Statement (FEIS) for Designation of the Palm Beach Harbor Ocean Dredged Material Disposal Site and the Port Everglades Harbor Ocean Dredged Material Disposal Site

FERC. 2004. Tractebel Calypso Pipeline Project. Final Environmental Impact Statement. Docket #CP01-409-000

FERC. 2003. Ocean Express Pipeline Project. Final Environmental Impact Statement. AES Ocean Express LLC. Docket #CP02-090-001

USACE. 2003. Broward County Shore Protection Project, Segments II and III. Final Environmental Impact Statement, Jacksonville District. June 2003.

USACE. 1996. Coast of Florida Erosion and Storm Effects Study, Region III: Feasibility Report with Draft Environmental Impact Statement.

1.6 Scoping

USACE initiated scoping under NEPA in April 2000. The public was invited to the March 28, 2001 public scoping meeting, there was a Notice of Intent to Prepare an EIS published in the Federal Register (Vol. 66, No 57 page 16191), mailings (USACE mailing March 5, 2001), and advertisement in local papers (Miami Herald March 16, 2001 and Sun Sentinel March 17, 2001). Correspondence received from commenting stakeholders as well as scoping documents and information is included in Appendix A.

The following agencies and organizations were involved in the study and are collectively hereafter referred to as the "study team". All members of the study team provided input at various levels throughout the history of the project, dating back to initial scoping efforts in 1998. Federal agencies involved included USACE, the USCG, the United States Navy (USN), the U.S. Environmental Protection Agency (USEPA), the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). State agencies include the Florida Department of Environmental Protection (FDEP) and the Florida Fish and Wildlife Conservation Commission (FWC). Local agencies include the Broward County Port Everglades Department (Port), Broward County Environmental Protection and Growth Management Department (BCEPD), Broward County Aviation Department (Fort Lauderdale/ Hollywood Airport), and the Broward County Department of Safety and Emergency Services. Non-government organizations/institutions include Nova Southeastern University (NSU), and the Port Everglades Pilots Association (PEPA). Private interests include Hvide Marine, Maersk-Sealand, Coastal Fuels Marketing, and the Simulation Training and Research Center (STAR).

USEPA, USFWS, and BCEPD personnel contributed to the project by suggesting adjustments to project components and mitigation elements and providing information regarding resources, particularly from 1999 through 2007. NMFS Habitat Conservation Division provided suggestions for improvement of the project and mitigation early in the project, but with a change in staff in 2002, its role shifted to project review and impact assessment. In addition to participation in the

study team, FDEP, FWC, NMFS, USEPA, USFWS and BCEPD were invited to participate as cooperating agencies under NEPA by letter dated September 11, 2007. All agencies, except USFWS, replied that they would serve as cooperating agencies for the EIS. All agencies participated in preliminary draft EIS review, and comments from that review helped to shape the EIS. Additionally, NMFS drafted a companion document detailing the Essential Fish Habitat (EFH) in the project area that assisted with analysis of impacts to EFH. Table 1 summarizes agency and public meetings.

Table 1 Scoping and Coordination Meetings
(Continued on next two pages)

Reconnaissance Phase Meetings

Meeting Date	Location	Meeting Purpose
Apr 26, 2000	Port Everglades, FL	Introduce the study to agencies, institutions. Initiate agency/institution EIS scoping.
Jun 28, 2000	Port Everglades, FL	Port, USACE, PEPA mariners: formulation of preliminary alternatives
Jul 25, 2000	Jacksonville, FL	Feasibility Scoping Meeting. USACE, Port, agencies, institutions. Overview of the study, preliminary plan formulation, discuss any issues.
Sep 21, 2000	Port Everglades, FL	Alternative screening meeting. USACE, Port, agencies, institutions, defined study objectives, did first alternative screening.
Nov 16, 2000	Tallahassee, FL	Environmental issue/scoping meeting. USACE, Port, agencies, institutions, updated on impacts, discussed environmental issues.

Feasibility Phase Meetings

Meeting Date	Location	Meeting Purpose
Mar 28, 2001	Fort Lauderdale, FL	Public scoping for EIS.
Mar 29, 2001	Port Everglades, FL	Agency scoping and field trip for EIS
July 26, 2001	Port Everglades, FL	Meeting with State park Staff
Aug 22,2001	Port Everglades, FL	State Parks/JUL impacts meeting
Aug 28, 2001	Port Everglades, FL	Alternative Formulation Briefing meeting USACE, Port, agencies, institutions. Overview of study results, comments received prior to release of DEIS

Meeting Date	Location	Meeting Purpose
Sept 12-13, 2001	Port Everglades, FL	Field investigation for resource agency staff
Oct 22, 2001	Fort Lauderdale, FL	West Lake Park Mitigation planning meeting
Feb 19, 2002	Vero Beach, FL	CAR discussion meeting. USACE, Port, FWS, NMFS
March 19, 2002	Port Everglades, FL	West Lake Park mitigation presentation to agencies
June 12, 2002	Fort Lauderdale, FL	1st team meeting of the "Port Everglades Reef Group" (PERG).
Aug 26, 2002	Fort Lauderdale, FL	2nd meeting of PERG
Nov 21, 2002	Fort Lauderdale, FL	3rd meeting of PERG
Apr 30, 2003	Fort Lauderdale, FL	4th meeting of PERG
May 4, 2005	Fort Lauderdale, FL Airport	Alternative Formulation Briefing
May 31, 2005	Fort Lauderdale, FL	Review data requirements for reef HEA/UMAM with DEP, FWC, NSU, and local sponsor
June 16, 2005	EPA offices – West Palm Beach, FL	Conduct UMAM assessment on seagrass and mangrove impact areas
July 26, 2006	Port Everglades, FL	Draft Reef Assessment Review meeting
Oct 19, 2006	Port Everglades, FL	Hardbottom UMAM assessment meeting
Nov 28, 2006	Fort Lauderdale, FL	1st hardbottom HEA meeting
Mar 8, 2007	Jacksonville, FL	Alternatives Review meeting
May 8-9, 2007	Port Everglades, FL	PEPA mariners' perspective, plan formulation and agency field trip meeting
Aug 7, 2007	Port Everglades, FL	West Lake park mitigation meeting – Port, Airport, West Lake park
Sept 25 & 26, 2007	Port Everglades, FL	2nd project HEA meeting
Nov 27, 2007	Port Everglades, FL	3rd project HEA meeting
March 2008	Port Everglades, FL	NMFS-led UMAM Mangrove assessment field investigation
March 2008	Port Everglades, FL	Alternatives Review Meeting & Site Visit
April 2008	St. Petersburg, FL	Meeting with NMFS, *Acropora* survey protocol and regulatory considerations for project
April 2008	Various Locations	Cooperating Agency Preliminary Draft EIS review
June 17-18, 2008	Port Everglades, FL	NMFS-led UMAM Seagrass assessment field investigation
September 2008	Tallahassee, FL	Executive Coordination Meeting

Meeting Date	Location	Meeting Purpose
October 2010	Online	Acropora Survey Review Webinar with NMFS
March 2011	Ft. Lauderdale, FL	PE ODMDS Public Scoping Meeting
May 2011	Online	PE ODMDS Agency Webinar
June 2011	Various Locations	Cooperating Agency Preliminary Draft EIS review
Aug-Sept 2012	Various Locations	Agency leadership project review meetings
July 22, 2013	Port Everglades, FL	Public Meeting – Draft EIS
August 2013	Jacksonville, FL	Interagency Meeting
October 2013	Jacksonville, FL	Interagency Meeting
November 2013	St. Petersburg, FL	NMFS/USACE Working Meeting
April 2014	St. Petersburg, FL	NMFS/USACE Working Meeting

During and subsequent to the above, the local sponsor (Broward County) was involved in the Port master planning meetings and workshops listed below. These effectively supplemented USACE's public outreach and coordination efforts, and included discussions regarding feasibility study alternatives.

- October 6, 2006 - Port Everglades Association Meeting
- December 6, 2006 - 2006 Port Everglades Master Plan Update 2nd Public Meeting
- February 20, 2007 - Phase I Workshop
- March 9, 2007 - Port Everglades Association Presentation
- July 12, 2007 - Tenant Workshop
- August 3, 2007 - Port Everglades Mangrove Wetland Assessment
- August 24, 2007 - Tenant Workshop
- August 28, 2007 - Phase II Workshop
- September 6, 2007 - Public Participation Program - 3rd Workshop
- November 13, 2007 - Port Everglades Preliminary Discussions of the Broward County Commission as Relative to the Master/Vision Plan
- February 11, 2008 - Port Everglades Turning Notch Conservation Easement
- March 11, 2008 - Port Everglades Master Plan Workshop Turning Notch Issue
- March 27, 2009 - Port Everglades Master/Vision Plan Update, Stakeholder Meeting Presentation
- June 15, 2009 - Port Everglades Master/Vision Plan Update, Environmental Stakeholder Meeting

- June 18, 2009 - Port Everglades Master/Vision Plan Update, Container and Non-Containerized Cargo Charrette Meeting
- June 19, 2009 - Port Everglades Master/Vision Plan Update, Charrette Summary Meeting
- January 28, 2010 - Port Everglades Master/Vision Plan Update, Stakeholder Meeting Presentation
- May 4, 2010 – Presentation to the Board of County Commissioners
- June 24, 2010 - Port Everglades Focus Group Meeting
- July 9, 2010 - Port Everglades Association Meeting
- July 29, 2010 - Port Everglades Master/Vision Plan Update, Stakeholder Meeting Presentation
- August 31, 2010 - Port Everglades 2009 Master/Vision Plan Update
- January 11, 2011- Master Plan workshop

Comments from the meetings noted above and those from Port users and resource agencies were used to formulate the objectives and goals for the project that resulted in the recommended plan. In short, users were most concerned about safety issues and keeping the Port efficient and economically viable in future decades, while resource agencies were concerned about avoiding and minimizing the impacts of dredging (particularly sensitive habitats such as seagrasses, mangroves, and especially reefs/hardbottoms; see Section 1.7 below). USACE and the local sponsor used this input during plan formulation; Sections 2.5, 2.6, and 2.7 specifically address responses to resource agency concerns.

1.7 Issues

The following general issues were identified during scoping, and by the preparers of this EIS, as relevant to the proposed action and appropriate for detailed evaluation:

- Impacts to mangrove wetlands
- Impacts to marine resources including
    - Seagrasses
    - Hardbottom and reefs
    - Unvegetated benthic habitat
- Impacts to Essential Fish Habitat (EFH) including habitat areas of particular concern (HAPC)
- Potential direct or indirect impacts to species protected under the Endangered Species Act of 1973 and/or the Marine Mammal Protection Act of 1972, including
    - Sea turtles
    - Manatees (*Trichechus manatus*)
    - Johnson's seagrass (*Halophila johnsonii*)
    - Dolphins and whales
    - Smalltooth sawfish (*Pristis pectinata*)
    - Elkhorn and staghorn (*Acropora* sp.) corals and designated critical habitat
- Potential effects to marine species due to confined underwater blasting and evaluation of alternatives for avoiding and minimizing unavoidable impacts

- Beneficial uses of dredged material and marine habitat creation
- Testing and evaluation of sediments for contamination
- Impacts to adjacent lands, such as those owned/operated by John U. Lloyd Beach State Park, USCG, Nova Southeastern University Oceanographic Center (NSUOC), and the Department of the Navy
- Impacts to potential historic resources or properties
- Analysis of potential air quality impacts
- Seagrass and mangrove wetland habitat improvements at West Lake Park

During the development of this Final Environmental Impact Statement (FEIS) extensive efforts were made concerning information-sharing and coordination with resource agency staff and interested parties. Table 1 presents a summary of the major meetings held between USACE staff and resource agency staff.

1.8 Permits, Licenses, and Entitlements

The Recommended Plan affects waters of the United States (including jurisdictional wetlands) subject to Section 404 of the Clean Water Act (CWA). USACE has determined that an evaluation under Section 404(b)1 of Section 404(b) of the CWA is required for this project and is included in Appendix B. Upon completion of this DEIS, under the Interagency Coordination Agreement for Civil Works Projects dated Feb 28, 2006 between FDEP and USACE, this DEIS will serve as part of the application for a State of Florida Water Quality Certificate under Section 401 of the CWA.

A majority of the dredged materials from the proposed project will be placed in an ODMDS, which is currently proposed for expansion as described in USEPA and USACE (2013). NEPA documents exploring the feasibility for expansion are lead by USEPA, not USACE, although the latter is frequently a cooperating agency. USEPA and USACE concurred not to incorporate the ODMDS NEPA analysis into the Port Everglades EIS. ODMDS expansion is not driven by the proposed navigation improvements; the expanded site is also needed for non-federal projects; see Section 1.3 entitled “Project Need or Opportunity” of USEPA and USACE 2013. The Final Environmental Assessment (EA) for the ODMDS should be completed prior to the finalization of the Port Everglades feasibility study (site monitoring was conducted during September 2014 and EPA is finalizing the evaluation of the data collected during that monitoring effort). In the event that ODMDS expansion and use is necessary and practicable, USACE and USEPA have initiated NEPA coordination. If USEPA does not designate a disposal site with capacity for proposed material from the Port Everglades Harbor deepening under Section 102 of the Marine, Protection, Research, and Sanctuaries Act (MPRSA), then USACE would select the proposed site in the Site expansion EA as authorized under Section 103(b) of MPRSA. Section 103(b) authorizes USACE, with USEPA concurrence, to select a site for one time disposal of dredged material in ocean waters. The No Action Alternative in the EA for the expansion of the Port Everglades ODMDS includes the possible emergency, one-time designation of an ODMDS by USACE under Section 103(b) of MPRSA for the dredged material generated by the proposed Port Everglades Harbor deepening.

Effects to fish and wildlife and their habitats are important considerations in the study. USACE initiated consultation with the USFWS and NMFS regarding effects of the project on listed/protected species under the Endangered Species Act (ESA). Apart from ESA considerations, an Incidental Harassment Authorization (IHA) for take of non-listed marine mammals under the Marine Mammal Protection Act (MMPA) will be required for potential effects

due to blasting activities that may occur with the project. Due to authorization timelines of IHA's (they are only good for one calendar year from issuance), USACE will submit the official application for take under the MMPA during the Preconstruction, Engineering and Design (PED) phase of the project, after the feasibility phase (which includes this NEPA evaluation) to ensure the document is valid during the blasting phase of construction. Although the application has not yet been submitted to NMFS Office of Protected Resources (Permits, Conservation and Education Division, or NMFS-OPR-PR1), USACE has had ongoing coordination for all port construction projects in Florida that will require blasting, including Port Everglades with OPR-PR1.

USACE has prepared a Coastal Zone Management Consistency Determination (Appendix C) for review and concurrence by the State of Florida; it concludes that the alternative recommendedfor construction (See Section 2.0) is consistent, to the maximum extent practicable, with the state's coastal management program. USACE has obtained Coastal Zone Management consistency concurrence from the State of Florida.

2.0 ALTERNATIVES

2.1 Objectives

The three main planning objectives for the federal project at Port Everglades are the following (they are referenced by number in subsequent sections):

1. Decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies at Port Everglades through the 50-year life of the project.
2. Decrease transportation costs through increasing economies of scale for cargo and petroleum vessels at Port Everglades through the 50-year life of the project.
3. Increase channel safety and maneuverability at Port Everglades for existing vessel use as well as for larger vessels through the 50-year life of the project.

Additionally, any plan for improvements must comply with USACE's Environmental Operating Principles (See Section 1.1 above). A complete history of the Feasibility Planning process for the Port Everglades project can be found in Section 1.0 of the Feasibility Study.

2.2 Initial Planning Concepts

2.2.1 Alignment of Plan Elements with Objectives

Since initiation of the feasibility study, numerous navigation improvements and plans (combinations of measures) have been suggested in support of one or more of these objectives. An earlier (feasibility study) report version completed in 2004 included a recommended plan. However, the 2004 recommendations and measures were reevaluated and expanded in 2007 based on the interim technical and policy review of the document, new engineering and environmental information, and stakeholder input. The reevaluation that began in 2007 eliminated measures that did not have the potential to meet at least one of the three planning objectives listed above.

Beginning in 2007, a number of measures were initially developed and evaluated to determine their ability to meet at least one of the objectives listed above. A detailed description of this screening process is presented in Section 4.0 of the Feasibility Study and is incorporated here by reference. An initial list of the potential non-structural measures is presented in Table 2 and a list of potential structural measures is included in Table 3.

Per 40 CFR 1502.14, USACE will "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives eliminated from detailed study, briefly discuss the reasons for their having been eliminated." For this EIS, a reasonable alternative is defined as an alternative that meets all three objectives of the feasibility study detailed in Section 1.0 of this EIS and is under USACE's mission. If an alternative does not successfully meet all three objectives in the Feasibility Study (see left), and the USACE is unable to implement the alternative under our existing Congressionally authorized missions, then it is unable to be considered reasonable under the feasibility study, and will not undergo a detailed analysis.

Table 2 Non-Structural Measures

Measure	General Description
1. No-Action/Future Without-Project Condition	Port will continue to develop; selected portions of the port's Master/Vision Plan will be implemented by Broward County
2. Additional Tugs	Add more "Ship Docking Module" tugs
3. Clear Berthed Vessels	Transit large vessels when no vessels are berthed at 24-29
4. Bypass Port using Trucks	Commodities would be imported to another port and trucked as needed
5. Off-loading Cargo	Off-load cargo before entering the port to a smaller vessel from vessels with greater than allowable drafts.
6. Light-loading Vessels	Larger vessels would light-load and have lesser drafts that allow a port entry
7. Lightering	Larger vessels would offload offshore onto smaller vessel to allow port entry at existing channel depths
8. Off-Shore Petroleum*	Construct an offshore petroleum facility to unload tankers with deeper drafts prior to entering the port. Use pipelines to transport products to shore for processing and distribution.
9. Bypass Port using Rail	Commodities would be imported to another port and transferred via rail as needed
10. NOAA PORTS®	Use the NOAA *Physical Oceanographic Real-Time* System to predict current direction and magnitude instead of deepening and widening.

*"Nonstructural" for USACE; other parties would install structures..

2.2.2 Measures Considered for Use in Plan Alternatives

Once the screening process was complete, ***only those measures that met at least one of the objectives were considered in the development of alternative plans***. The various plan components are presented in the paragraphs below, some of which are represented in Figure 5.

Light-loading Vessels. This measure would, in effect, limit the loads of vessels that could enter the Port. Larger vessels would still enter the Port and be *capable* of being fully loaded, but would *not* be due to the additional draft such loads would require. This would be the case under the No-Action Plan/future-without-project condition. Hence, large container vessels could enter the Port "light-loaded." This would increase transportation costs due to additional transits required to bring in the same amount of material as a fully loaded large container vessel and resulting congestion from addition transits. Large container vessels are difficult and dangerous to bring into the Port under current conditions. It would take additional time to turn and transit these vessels. Additionally, these vessels would create delays and block other vessels from passing.

Table 3 Structural Measures

Measures	General Description
1. Widen OEC	Widen the existing outer entrance channel
2. Deepen OEC, IEC	Deepen the Outer and Inner Entrance Channel, and associated berths
3. Widen MTB	Increase turning basin size
4. Deepen MTB	Deepen Main Turning Basin and associated berths
5. Deepen NTB	Deepen north extension of Main Turning Basin and berths
6. Deepen STB	Deepen the western portion of the south extension of Main Turning Basin and berths
7. Widener	Deepen and widen the channel where it connects the Inner Entrance to the Southport Access Channel
8. Widen SAC	Widen the Southport Access Channel
9. Deepen SAC	Deepen the Southport Access Channel and associated berths
10. Widen TN	Widen the Turning Notch and associated berths
11. Deepen TN	Increase depth to match Southport Access Channel deepening
12. DCC TB	Create a southern turning basin at the confluence Dania Cut-off Canal and Southport Access Channel
13. Widen and Deepen DCC	Widen and deepen the Dania Cut-off Canal
14. Extend North Jetty	Extend the north jetty

Widen Outer Entrance Channel (OEC). This measure would widen the existing OEC. Under conditions of strong, variable currents, the 500-foot existing OEC presents a hazard to the existing and future design fleet for large vessels. Presently, pilots are required to line up vessels with the channel (parallel to its north and south extents) farther offshore and transit into the Port at increased speeds to remain aligned within the channel (observed during ship simulation studies that USACE conducted with the Port Everglades Pilots Association). Rapid deceleration of the vessel is then required for safe negotiation of the entrance jetties. This rapid deceleration results in the bow of the ship plunging downward, a factor referred to as "squat" (see text box to the right). To alleviate the need for potentially dangerous maneuvering for the existing and future design fleet, the OEC should first be flared to a maximum width of 800 feet at its present seaward limit (based on vessel safety simulations) and then extended 2,200 feet offshore past the outer (easternmost) reef tract (to meet natural depths matching those selected for the OEC), which runs on a north-south axis. This measure should be combined with the Deepen OEC measure to accommodate the design vessel. The measure would increase safety and maneuverability for vessels so it satisfies Objective 3 (noted above). This measure only meets Objectives 1 and 2, if the Widen SAC and the Widener measure (which provides ample turning space for the "design vessel" to transit from the IEC to the SAC) are combined with the Widen OEC measure.

All channel depths indicated in this section of the EIS are "project depths" (vs. actual depths) unless otherwise specified. Project depth is the authorized depth to which the Federal government maintains channels and basins. For construction purposes on this project, the Federal government will dredge channels and basins to an additional one-foot of required overdepth and one-foot of allowable overdepth ("+1+1"); i.e., a maximum of two feet beyond the recommended plan project depth. The Outer Entrance Channel will require additional depth for squat and under-keel clearance: seven feet (i.e., "+7") beyond the two feet of required and allowable overdepth (pursuant to requirements, formulas and rationale provided in EM 1110-2-1613). These depth and other USACE engineering requirements can be found in the Engineering Appendix to the Feasibility Study, Appendix A, Section 3.4.11, and Sub-Appendix C "Squat Analysis" of the Engineering Appendix.

Deepen OEC. This measure would deepen the existing outer and inner channels further to allow deeper draft vessels to enter. Presently, the depths in the MTB restrict the size of bulk carriers and sufficient drafts of container ships for transit to berths in the Midport and Southport regions. Deeper draft vessels can carry more cargo (resulting in fewer vessel calls at port) than shallower draft vessels (which would require more transits to bring in the same amount of cargo as the larger vessels). This reduces harbor congestion delays, as well as reductions in transportation costs through economies of scale. However, this measure meets only Objectives 1 and 2, if combined with widening of the OEC (see above), deepening of the MTB (see below), deepening of the SAC (see below), and the Widener measure (see below). A deeper channel does reduce the risk of deeper vessels scraping the channel bottom (especially if squat is properly accounted for), which increases safety, Therefore, Objective 3 is met as well. Section 5.3 of the Feasibility Study discusses the incremental benefits of various project depths for the OEC.

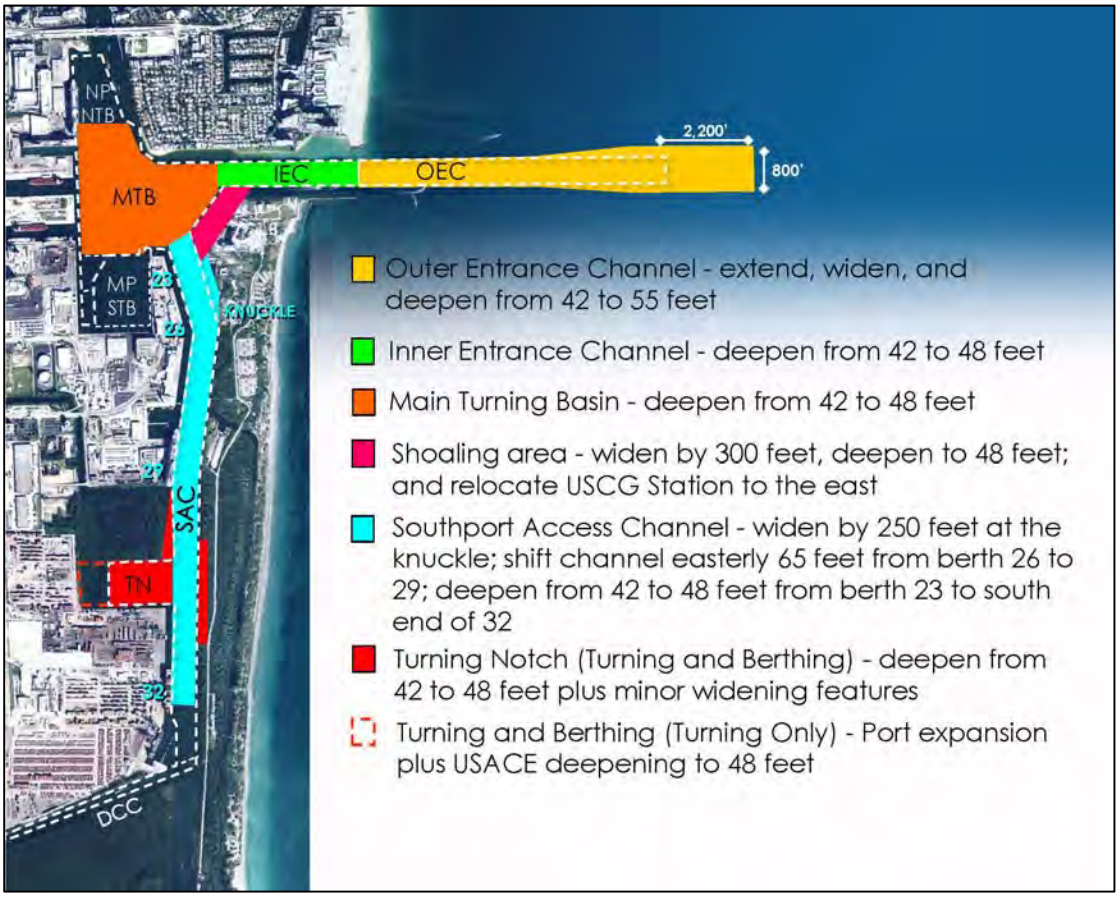


Figure 5 Proposed Components of the Various Plans, Including the Recommended Plan

Widen Main Turning Basin (MTB). This would eliminate some shoals adjacent to the existing turning basin. Smaller vessels would have sufficient depth in this area to avoid larger vessels and potential collisions. This would also clear up congestion because vessels could turn and pass more easily. Larger vessels could be brought into Port at the existing drafts to gain economies of scale if combined with other measures. This meets Objectives 1, 2, and 3.

Deepen MTB. This measure would deepen the MTB and associated berths. This measure would only improve safety independent of other measures. This measure would improve safety and economies of scale when combined with other measures to meet all objectives. Presently the depths in the MTB restrict the size of bulk carriers able to transit to berth in the main harbor.

Deepen North Turning Basin (NTB). The NTB, which is the north extension of the MTB, would be deepened for future cruise vessels. Previous surveys indicated an accumulation of sediment has reduced depths in some areas of the basin. To transit a cruise ship to Berths 1 and 2 on the west side of the basin, a cut would be made along the western side of the basin to provide a uniformly deepened area that is 250 feet wide from the northern wall to the south where the NTB and MTB merge. However, further research showed that the current depth of 31 feet MLLW was anticipated sufficient to accommodate future cruise ships. The present design depth of 31 feet in the NTB is adequate to accommodate the full draft of a Statendam ("S") Class cruise ship (average length 712 feet with an accepted safety clearance of 3 feet. Additionally, the existing fleet is not likely to rely on the NTB measure for additional safety or expansion due to Port traffic patterns and current configurations.

Deepen South Turning Basin (STB). The western portion of the STB, which is the south extension of the MTB, would be deepened. The Navy uses the eastern berths and does not require additional depth. The existing depth is less than the MTB and the future vessels are not likely to benefit from any depth greater than the existing depth. Therefore, the depth would be equal or less than 42 feet. Deepening would accommodate smaller containers vessels and reduce congestion in the SAC. This area may improve safety by adding additional turning room or maneuverability for some vessels. This measure would not induce any costs saving from economies of scale. This measure meets Objectives 1 and 3.

Widener (WID). This measure would remove the shoal located at the confluence of the SAC and the MTB and IEC. The shoal restricts the amount of maneuvering room a vessel has when turning into the MTB in preparation for backing down the SAC (a common method of transit) or turning into the channel. The shoal also prohibits other traffic from transiting and exiting the SAC while another vessel is in the MTB. This measure would eliminate the hazards in maneuvering around the shoal, berthed vessels, and the Knuckle at the same time. The Knuckle is the area just south of berth 25, within the SAC, which creates transit problems. This measure would create a straighter channel, which is more efficient and safer. Post-Panamax container vessels would also be able to safely turn into the SAC with this feature, which contributes to economies of scale. It would also allow for two-way traffic in the MTB. This measure meets all objectives.

Widen South Access Channel (SAC). This measure would widen the SAC to allow vessels to safely transit and pass berthed vessels along the channel. It would also allow for larger vessels to safely transit and pass, currently a risky to near impossible maneuver. Transportation costs would decrease from larger container vessels having economies of scale. Fewer vessels would also be necessary if larger vessels carried additional cargo. This measure requires that the Widener measure be in place in order to turn the large vessels into this section. The Widen TN measure should also be in place to allow safer and easier turning for these vessels. This measure meets all objectives when combined with another measure.

Deepen SAC. This measure would deepen the SAC. This would have the same general benefits and objectives as the Widen SAC measure; however, it would likely be more efficient in achieving the objectives. This measure requires that the Widener measure be in place in order to turn the large vessels into this section. The Widen TN measure should also be in place to allow safe and easier turning for these vessels. This measure (Deepen SAC) meets all objectives when combined with another measure. Section 5.3 of the Feasibility Study discusses the incremental benefits of various project depths for the SAC.

Deepen Turning Notch (TN). The TN would be deepened to match the SAC depth if it were combined with the Deepen SAC measure. This measure would allow for safer and easier turning for large container vessels. This would reduce congestion, and allow vessels with economies of scale to berth. This measure should be combined with the Widener measure, and the Widen or

Deepen SAC measures to more efficiently achieve objectives. This measure meets all objectives when combined with another measure.

Dania Cutoff Canal (DCC) Turning Basin. This measure would create a turning basin for smaller container vessels. The turning basin may improve safety and congestion by itself. This option would not improve the economies of scale. This measure would be more effective if it were combined with the DCC measure.

Widen and Deepen DCC. This measure would deepen and widen the DCC. This measure must be combined with the DCC TB measure to meet any of the three objectives. This expansion would redirect smaller container vessels to this area. This would improve berth availability and congestion in other parts of the port. Safety may be improved through less congestion. Transportation cost savings from economies of scales are not directly impacted. However, other berths could now be available for larger vessels if combined with other measures and this would improve transportation cost savings.

2.3 Project Alternatives

2.3.1 Plan Formulation

The above measures that were moved forward during the screening process were combined into six plans based on structural characteristics, environmental impacts, and economic units (Table 4). Each plan accomplishes at least one of the objectives of the proposed project.

Four of the plans were further expanded (in multiple ways) in order to address objectives in slightly different ways. The resulting 22 plans are shown in Table 5. These plans were passed on to the incremental screening process (Section 4.8 of the Feasibility Study).

Table 4 Preliminary Plan Components

Measures	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
Light-loading Vessels (widening at existing 42 ft project depths)						X
Widen OEC	X	X			X	X
Deepen OEC	X	X			X	
Deepen MTB	X	X			X	
Deepen STB	X			X	X	
Widener		X			X	X
Widen SAC		X			X	X
Deepen SAC		X			X	
Widen TN		X			X	X
Deepen TN		X			X	
DCC TB			X		X	X
Widen and Deepen DCC			X		X	X
Plan 6 does not comprise any deepening of the harbor to accommodate post-Panamax vessels. Deepening of the DCC was evaluated for depths ranging from 11-34 feet. Plans 1-5 examine the existing and greater depths incrementally.						

Table 5 Components of Each Alternative Plan

Plan 1A - OEC, IEC, MTB Plan 1B - OEC, IEC, MTB, STB Plan 2A- OEC, IEC, MTB Plan 2B- OEC, IEC, MTB, WID, SAC Plan 2C- OEC, IEC, MTB, WID, SAC, TN (berth & turn) Plan 2D- OEC, IEC, MTB, WID, SAC, TN (turn only) Plan 2E - OEC, IEC, MTB, WID, SAC, S_TN (deepening only) Plan 3A – DCC Plan 4A – STB Plan 5A- OEC, IEC, MTB Plan 5B - OEC, IEC, MTB, STB Plan 5C- OEC, IEC, MTB, WID, SAC, STB Plan 5D- OEC, IEC, MTB, WID, SAC, STB, TN (berth & turn) Plan 5E - OEC, IEC, MTB, WID, SAC, STB, TN (berth & turn), DCC Plan 5F - OEC, IEC, MTB, WID, SAC, STB, TN (turn only) Plan 5G- OEC, IEC, MTB, WID, SAC, STB, TN (turn only), DCC Plan 6A - WID Plan 6B - OEC, WID, SAC Plan 6C - OEC, WID, SAC, TN (berth & turn) Plan 6D - OEC, WID, SAC, TN (berth & turn), DCC Plan 6E - OEC, WID, SAC, TN (turn only) Plan 6F - OEC, WID, SAC, TN (turn only), DCC
Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB), South Turning Basin (STB), Widener (WID), Southport Access Channel (SAC), Turning Notch (TN), Sponsor's Turning Notch (S_TN), Dania Cutoff Canal (DCC)

The structural elements of each plan shown in Table 5 are detailed in the Feasibility Study, as are the specific differences among plans. Part of that discussion in the Feasibility Study is transcribed below, to illustrate the differences among plans within a single plan group. Plan 2 was selected for this illustration because it was from this Plan group that the recommended plan was ultimately chosen. The five "sister" plans from among the Plan 2 group are described as follows:

Plan 2: This plan would resolve problems and create opportunities for the petroleum vessels and the container vessels. This plan will allow deeper draft petroleum and container vessels to enter the Port while improving safety and vessel trafficking efficiency.

- **Plan 2A**: This combination of measures is the same as Plan 1A. This plan would analyze project/authorized depths incrementally from 42 to 50 feet (i.e., -42 to -50 feet MLLW) in the OEC (yielding actual depths up to 59 feet, accounting for required and allowable dredging and OEC squat requirements, i.e., +1' +1' +7', respectively; other reaches have no squat requirements), and from 42 to 50 feet in the IEC and MTB. Depth will be optimized. It is assumed that the Port will deepen the connecting berths to the optimized federal project depth.

  Structural Improvement:
  - **Widen and Deepen the Outer Entrance Channel**
  - **Deepen the Inner Entrance Channel**
  - **Deepen the Main Turning Basin**
  - **Deepen adjacent berths**

- **Plan 2B:** This plan expands on Plan 2A and would accommodate post-Panamax container vessels that could not safely enter without the additional deepening and widening of the WID and SAC measures. This plan analyzes incremental project/authorized depths in the SAC and the WID from 42 to 50 feet.

  Additional Structural Improvement:
  - **Widen and Deepen the Outer Entrance Channel**
  - **Deepen the Inner Entrance Channel**
  - **Deepen the Main Turning Basin**
  - **Deepen adjacent berths**
  - **Widen and Deepen the Widener measure**
  - **Widen and Deepen the Southport Access Channel**

- **Plan 2C:** This plan expands on Plan 2B with the widening and deepening of the TN. Plans 2A and 2B could create inefficiency and reduce safety without this additional measure. Post-Panamax container vessels would be required to turn in the MTB and use only one berth without the widening and deepening of the TN. This could cause congestion and delays. Plan 2C will analyze project/authorized depths incrementally from 42 to 50 feet in the TN. The TN is important to fully realize all potential benefits for container and petroleum vessels. This measure would allow post-Panamax container vessels to berth and turn in Southport.

Additional Structural Improvement:

- **Widen and Deepen the Outer Entrance Channel**
- **Deepen the Inner Entrance Channel**
- **Deepen the Main Turning Basin**
- **Deepen adjacent berths**
- **Widen and Deepen the Widener measure**
- **Widen and Deepen the Southport Access Channel**
- **Widen and Deepen the Turning Notch**
- **Additional Widening and Deepening of the Southport Access Channel to allow turning**

- **Plan 2D:** This plan actually takes an element away from Plan 2C. Plan 2D includes only deepening of the TN, analyzing project/authorized depths incrementally from 42 to 50 feet and not expanding the width of the TN.

  Additional Structural Improvement:

  - **Widen and Deepen the Outer Entrance Channel**
  - **Deepen the Inner Entrance Channel**
  - **Deepen the Main Turning Basin**
  - **Deepen adjacent berths**
  - **Widen and Deepen the Widener measure**
  - **Widen and Deepen the Southport Access Channel**
  - **Deepen the Turning Notch**
  - **Additional Widening and Deepening of the Southport Access Channel to allow turning**

- **Plan 2E:** This component was added as a result of the local sponsor's intent to expand the TN as a future without-project condition. Therefore this plan examines deepening the future widened portion of the TN and deepening the existing TN footprint, in addition to the widening increments in the SAC. Project/authorized depths will be analyzed incrementally from 42 to 50 feet.

  Additional Structural Improvement:

  - **Widen and Deepen the Outer Entrance Channel**
  - **Deepen the Inner Entrance Channel**
  - **Deepen the Main Turning Basin**
  - **Deepen adjacent berths**
  - **Widen and Deepen the Widener measure**
  - **Widen and Deepen the Southport Access Channel**
  - **Deepen existing and sponsor-expanded portion of the TN**
  - **Additional Widening and Deepening of the Southport Access Channel to allow turning**

After the evaluation conducted during the final screening process, it was determined that Plan 2 (specifically Plan 2E) was the only alternative plan that would be implemented by USACE, and therefore, is the only action alternative to be evaluated in this EIS. The other potential plans

(Alternative sets 1, 3, 4, 5, and 6) have been fully evaluated through USACE's six-step planning process and all other potential alternatives have been eliminated from further consideration.

To further screen potential options, five "sub-alternatives" for Plan 2E were evaluated; the only difference among these being the authorized (and related, actual) depths of the channels. The OEC is currently authorized to 45-feet-deep (+1+1+5 for required overdepth, allowable overdredge, and squat/underkeel clearance, respectively), which results in maximum actual depths up to 52 feet (i.e., -52 feet MLLW). Evaluated *authorized* depths of all channels, including the OEC, for the proposed project ranged from 46 to 50 feet. For the OEC, these authorized depths could result in *actual* depths of 55 to 59 feet, respectively, given its required overdepth of +1', allowable overdredge of +1', and *an increase in squat/underkeel clearance from +5' to +7'.* Depths in interior harbor channels resulted in shallower *actual* depths due to the lack of need for a squat allowance there, although *authorized* depths among all channels, including the OEC, for each sub-alternative were the same.

2.3.2 Recommended Plan (Locally Preferred Plan)

The Recommended Plan (which is also the Locally Preferred Plan, i.e., the *authorized* 48-foot depth option for Alternative 2E; refer to Figure 5 above) comprises the following:

- removal of approximately 5.47 million cubic yards of material from channels and basins;
- deepen the OEC from an existing, authorized, project depth of 45 feet (i.e., -45 feet MLLW) to a proposed, authorized, project depth of 48 feet (i.e., up to an actual depth of 57 feet, due to an additional 1-foot required overdepth and 1-foot of allowable overdepth and 7 feet additional for squat/underkeel clearance, i.e., +1'+1'+7');
- widen the OEC from an existing width of 500 feet to a proposed width of 800 feet (maximum width including flare);
- extend the OEC 2,200 feet seaward;
- deepen the IEC from (authorized depth of) 42 feet to 48 feet (+1+1);
- deepen the MTB from (authorized depth of) 42 feet to 48 feet (+1+1);
- widen the rectangular shoal region (Widener, or "WID") to the southeast of the MTB by about 300 feet and deepen to (authorized depth of) 48 feet (+1+1);
- widen the SAC in the proximity of berths 23 to 26 (referred to as the knuckle", by about 250 feet and reconfigure the USCG facility, a General Navigation Feature (GNF), easterly on USCG property;
- shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition from the knuckle to the existing federal channel limits farther south of the knuckle;
- deepen the SAC from about berth 23 to the south end of berth 32 from (authorized depth of) 42 feet to 48 feet (+1+1);
- deepen the TN, including the expanded portion from (authorized depth of) 42 feet to 48 feet (+1+1) (following local sponsor dredging of the same area to 42 feet); widening by an additional 100 feet the eastern edge of the SAC over a length of about 1,845 feet (across from the TN); and widen by approximately 130 feet the western edge of the SAC north of the TN from the south end of berth 29 to the TN.

- provision of compensatory mitigation for unavoidable impacts to certain resource types (see Section 5.0).

2.3.3 National Economic Development Plan

The National Economic Development (NED) objective is a policy that guides federal water resource planners in their choice of solutions to problems. The objective of NED is to maximize increases in the net value of the national output of goods and services. Within USACE, this is done by comparing the difference in the value (benefits) produced by the project to the value of the resources (costs) required to produce those goods and services or construct the project (USACE 2009). The authorized channel depth that resulted in formulation of the NED plan for Port Everglades was the 47-foot-depth for Alternative 2E. This alternative was evaluated for environmental effects and comparison to the LPP and the No Action Alternative.

2.4 No-Action Alternative

This alternative represents the future without-project condition, and assumes that USACE would not implement any project to achieve planning objectives. However, the Port will likely implement portions of its Master/Vision Plan. The depth and width of the OEC would continue to create hazardous and unreliable conditions for vessels, which would be affected by strong and unpredictable cross currents (Shefter and Grose 1996). Maneuverability and passing operations would continue to be restricted. Channel and basin depths would restrict future vessel sizes, and the amount of goods that some vessels can carry. Vessels would be increasingly inefficiently distributed throughout Port areas and berths. All of the above will result in potentially higher costs for regional and national consumers.

Regardless of the proposed federal project, the Port is pursuing widening of the Turning Notch to expand berthing options that are currently severely limited. The Port has initiated pre-application permitting efforts with both the USACE Jacksonville District - Regulatory Division and the FDEP to obtain the necessary permits for the expansion. Currently, construction of the TN expansion is scheduled for 2017 by the Port, and construction of the mitigation for the TN expansion is scheduled for 2015.

The economic analysis of the project's without-project condition for year 2073 indicates a minimum of 5,193 vessels calling annually at Port Everglades, an increase from the pre-2012 baseline of more than 1,163 vessels annually. This increase in vessel calls associated with the "future without-project" scenario/ No-Action Alternative will result in increased pressure on berth capacity as more ships arrive at the Port and the Port does not have more berthing capacity to absorb them. This will result in more ships waiting in the anchorage for berths to open and as a result may result in a greater likelihood of anchor damage or of a ship breaking free of the anchorage and grounding on the reefs shoreward of the anchorage. In a report about the usage of the Port Everglades Anchorage, Moffat and Nichol (2006) documented that 50% of the grounding and anchorage damage was linked to vessels awaiting berths to open in Port Everglades. Although this report was specific to the former anchorage that was reconfigured to reduce impacts to the inshore reefs, as more vessels are crowded into the new anchorage, the potential for adverse impacts increases.

The future without-project condition may affect use of the Port by cruise lines. The cruise industry has already launched two newer, larger classes of cruise ship since the economic and ship simulation analysis was completed by the USACE. When the USACE did the analysis for the project, the *Voyager of the Seas* (Voyager Class), launched in 1999, was the largest cruise ship in the world with a length of 1,020 feet, a beam (width) of 156 feet, a draft of 28 feet and a sail

area (area above the water line) of 207 feet. In 2006, The *Freedom of the Seas* (Freedom Class) became the largest cruise ship in the world, with a length of 1,111 feet, a beam of 126 feet, a draft of 28 feet and a sail area of 209 feet. Currently, the *Oasis* and *Allure of Seas*, launched in December 2010 and October 2010, respectively, have a length of 1,187 feet, a beam of 154 feet, a draft of 31 feet and a sail area of 236 feet and are the largest cruise ships in the world. Both of these ships sail from Port Everglades.

Finally, under the without-project condition, as larger ships call at Port Everglades, albeit light loaded and/or with higher sail area, they lack sufficient room in the OEC to respond to wind and varying current conditions in the channel, resulting in a higher risk of grounding on the reefs adjacent to the channel or scraping against the walls of the outer channel (allusion), impacting the resources that have colonized the walls since the channel was widened in 1980. This would also result in a higher likelihood of oil spills associated with vessels grounding (particularly petroleum vessels) and thus endanger human health and safety, in addition to the surrounding environment.

Evaluation of the no-action alternative (as well as all proposed alternatives involving dredging) includes accounting for two complete cycles of operations and maintenance (O&M) dredging through the entire existing federal project footprint. Based on historic O&M dredging, USACE estimates that O&M dredging of the complete footprint of the Port would be required twice over the 50-year life of the project at approximately 25-year intervals (USACE 2005). However, recent shoaling rates at the entrance channel appear to be increasing (C. Creed, Olson Engineering, personal communication, as cited in USACE 2005), and as a result, the frequency of dredging the entrance channel may increase.

2.5 Alternatives Considered and Eliminated from Detailed Review

2.5.1 Overview

During the 17-year feasibility phase of this study, dozens of specific, alternative plans were considered in addition to those listed in Table 5 above. Furthermore, several conceptual options were evaluated during feasibility investigations. Many of those are detailed below; they pertain to the entrance channel, other channels and basins, and disposal sites. Alternatives that would have affected the depth, width, and or channel position of the Outer Entrance Channel are discussed in the first two subsections below (configuration and logistical alternatives, respectively), followed by alternatives that would have affected depth, width, and or position of channels and/or basins in the inner harbor.

2.5.2 Entrance Channel Configuration Alternatives

Entrance channel alternatives, typically proposed to reduce reef impacts, were necessarily based on reef position and geometry as well as bottom depths. Therefore, a working knowledge of the county's reef system, including relevant nomenclature, is necessary to understand descriptions of each option.

Offshore of the Port Everglades inlet are the high-latitude reef tracts of southeast Florida (Miami-Dade, Broward, and Palm Beach counties). The reef complex comprises a nearshore hardbottom zone and a seaward succession of three shore-parallel reefs referred to as the "inner," "middle, and "outer" reefs, or the "first," "second", and "third" reefs, respectively (Goldberg 1973; Moyer *et al.* 2003; Gilliam *et al.* 2004, 2006; Banks *et al.* 2007). These terms may be used in reference to these reef tracts throughout this document and supporting appendices.

Although not accreting as it was 5,000 years ago (Banks *et al.* 2007), the reef complex provides storm protection, habitat for invertebrate and fish species, and recreational uses that result in economic benefits to South Florida (Johns *et al.* 2001). Given that, the maximally practicable protection and preservation of the reef system conforms to USACE's Seven Environmental Operating Principles (EOP), as outlined above, and minimizing impacts to the reef complex was a priority throughout the feasibility study (see Section 2.7 below). Nevertheless, several options designed to minimize reef impacts could *not* be incorporated into the project for various reasons. Among structural alternatives that were eliminated from further consideration were options called (1) the southern reef-gap approach; (2) the northern reef-gap approach; (3) the double dog-leg approach; and (4) the dog-leg approach. These plans are detailed below. However, other plans that were eliminated from further consideration *did* result in the project impacting fewer acres of important habitats. The removal of the use of a 1,000-foot-wide OEC flare from among project plans (see below) was one such case.

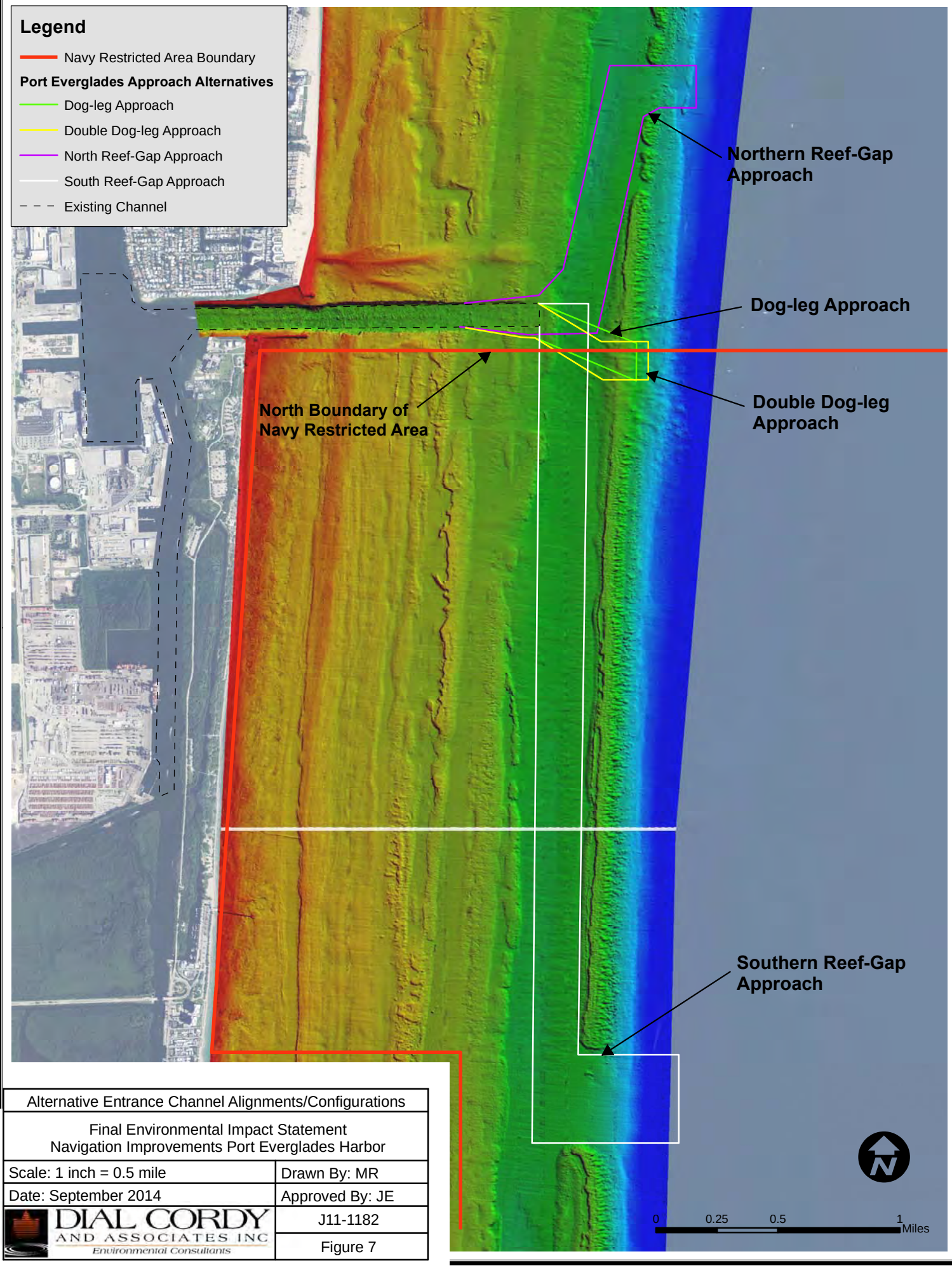
1,000-Foot-Wide OEC Flare with 3:1 Side Slopes. In 2000, during meetings with the Port Everglades Pilots Association regarding the need for a safe channel, analyses indicated that a channel with a 1,000-wide flare on the seaward (i.e., eastern) end was a required project component due to a need to simplify navigation in an area of unpredictable currents in the OEC (Figure 6). Additionally, geotechnical analysis available at the time suggested that a 3:1 side slope would be required for this channel alignment with the required depth. This proposal would have impacted 39.58 acres of hardbottom resources in the nearshore area, and in the inner, middle, and outer reefs. Subsequently, during the Feasibility Study process, the Port Everglades Pilots Association participated in several ship simulation exercises. Based on the results of those efforts, it was determined that an 800-foot-wide flare in the entrance channel was the minimum width required for vessel safety. This resulted in a reduction of impacts to only 25.71 acres (a net avoidance of 13.87 acres) of impact to hardbottom resources. Furthermore, an analysis of existing geotechnical data conducted between 2004 and 2008 indicated that the OEC's channel walls could remain vertical or near vertical and that stabilizing side slopes were not required for the project. This resulted in an additional reduction to the project footprint of 10.64 acres. Hence, due to these changes in the recommended plan, a total reduction in impacts of 24.51 (13.87+ 10.64) acres of hardbottom resources was achieved. This minimization of impacts is further discussed and summarized below in Section 2.7.

Plan Formulated in 2002 for Outer Entrance Channel Deepening/Widening and Resulting Impacts		
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor		
Date: Sept. 2014	Scale: 1 in = 750 ft	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants		J11-1182
		Figure 6

Southern Reef-Gap Approach. In the first plan (see Figure 7) suggested at one of the Port Everglades Reef Group (PERG) meetings, the outer reef tract that is perpendicular to the existing channel alignment would not be dredged. Ships would enter the Port through a natural break in the outer reef tract into a natural "channel" (running north/south) between the middle and outer reefs located approximately three miles south of the existing entrance channel. After passing through the cut, ships would make a 90-degree turn to the north, run parallel between the middle and outer reefs for three miles, come to a position directly perpendicular to the existing channel, turn another 90 degrees to the west to steer the bow to the north toward the entrance channel and enter the port. This plan was eliminated from further consideration because (1) it may be necessary to impact coral reefs in order to construct two offshore turning basins for the ships to complete the turns necessary to transit this channel alignment; (2) offshore currents would make such precise turning and safe handling of the vessel extremely difficult; (3) a review of this proposed alignment by the USCG resulted in it being determined to be unacceptable due to the high level of unknown risk and potential for environmental damage to an area of reef that is not currently exposed to high levels of shipping traffic. By letter dated January 23, 2008, the Captain of the Port rejected this alignment due to safety concerns. A copy of this letter is located in Appendix A. In addition, the U.S. Navy has authority over authorization of activities occurring in this area as a result of federal regulations (see NOS 2010, for limits and regulations). These regulations state "(1) Anchoring, trawling, dredging, or attaching any object to the submerged sea bottom shall be prohibited in the above described area." These regulations require consultation with the Facility Director, Naval Surface Warfare Center, Detachment Dania Beach, Florida. By letter dated February 20, 2008, the Facility Director has rejected any proposed alignment that enters the Navy's restricted zone. The Port Everglades Pilots Association also reviewed this proposed channel alignment and rejected it due to unpredictable, high-velocity currents, and safety concerns. Copies of these letters are located in Appendix A.

> Pursuant to 40 CFR 1502.14(a), agencies are required to "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Reasonableness of an alternative is based on whether it, in large part, achieves the agency's defined purpose and need (Shipley Group 1998).

Northern Reef-Gap Approach. This proposed alignment (see Figure 7) would have ships entering Port Everglades via a natural gap in the reef approximately one-mile north of the existing entrance channel. The ships would make a 90-degree turn to the south, run parallel to and between the middle and outer reef tracts until making a 90-degree turn to the west to enter the existing channel. This plan was eliminated from further consideration because (1) it may be necessary to impact coral reefs in order to construct two offshore turning basins necessary for the ships to complete navigation into the harbor; (2) offshore currents would make such precise turning and safe handling of the vessel extremely difficult; (3) a review of this proposed alignment by the USCG resulted in the conclusion that it would be unacceptable due to the high level of unknown risk and potential for environmental damage to an area of reef that is not currently exposed to high levels of shipping traffic. By letter dated January 23, 2008, the Captain of the Port rejected this alignment due to safety concerns. The Port Everglades Pilots Association also reviewed this proposed channel alignment and rejected it due to safety concerns and navigation difficulties resulting from unpredictable, high-velocity currents offshore. Copies of these letters are located Appendix A.



Alternative Entrance Channel Alignments/Configurations	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 0.5 mile	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 7

Double Dog-leg Approach. In the third plan (see Figure 7), the entrance channel would veer from the straight alignment into a 30-degree angle to the south and then turn again 30 degrees to the north, cutting through the outer reef tract in an area of the reef that shows previous impacts from an unknown source. Ships would enter the Port through this new cut south of the proposed channel alignment; make a 30-degree turn to the northwest and then another 30-degree turn into the existing channel. This plan was eliminated from further consideration because (1) it may be necessary to impact reefs in order to construct an offshore turning basin; (2) offshore currents would make such precise turning and safe handling of the vessel extremely difficult; (3) a review of this proposed alignment by the USCG resulted in the conclusion that it would be unacceptable due to the high level of unknown risk and potential for environmental damage to an area of reef that is not currently exposed to high levels of shipping traffic (letter dated January 23, 2008 from the Captain of the Port). In addition, the U.S. Navy has authority over activities occurring in this area (see Figure 7) as a result of federal regulations (see NOS 2010 for limits and regulations). These regulations state "Anchoring, trawling, dredging, or attaching any object to the submerged sea bottom shall be prohibited in the above described area." These regulations require consultation with the Facility Director, Naval Surface Warfare Center, Detachment Dania Beach, Florida. By letter dated February 20, 2008, the Facility Director has rejected any proposed alignment that enters the Navy's restricted zone. The Port Everglades Pilots Association also reviewed this proposed channel alignment and rejected it due to unpredictable, high-velocity currents, and safety concerns. Copies of these letters are located in Appendix A.

Dog-leg Approach. In the fourth plan (see Figure 7), the entrance channel would veer from the straight alignment into a 30-degree angle and cut through the outer reef tract in an area of the reef that indicates previous impacts from an unknown source. Ships would enter the Port through this new cut south of the proposed channel alignment; make a 30-degree turn into the existing channel. This plan was eliminated from further consideration because (1) it may be necessary to impact coral reefs in order to construct an offshore turning basin; (2) offshore currents would make such precise turning and safe handling of the vessel extremely difficult; (3) a review of this proposed alignment by the USCG resulted in it being determined to be unacceptable due to the high level of unknown risk and potential for environmental damage to an area of reef that is not currently exposed to high levels of shipping traffic (see letter dated January 23, 2008 from the Captain of the Port). In addition, the U.S. Navy has authority over activities occurring in this area (see Figure 7) as a result of federal regulations (see NOS 2010 for limits and regulations). These regulations state "Anchoring, trawling, dredging, or attaching any object to the submerged sea bottom shall be prohibited in the above described area." These regulations require consultation with the Facility Director, Naval Surface Warfare Center, Detachment Dania Beach, Florida. By letter dated February 20, 2008, the Facility Director has rejected any proposed alignment that enters the Navy's restricted zone. The Port Everglades Pilots Association also reviewed this proposed channel alignment and rejected it due to unpredictable, high-velocity currents, and safety concerns. Copies of these letters are located in Appendix A.

2.5.3 Entrance Channel Logistical Alternatives

In addition to the previously discussed structural alternatives, resource/regulatory agencies proposed avoiding impacts to important marine habitats (i.e., the outer reef) by suggesting several structural and non-structural (operational) alternatives for consideration. These additional alternatives are detailed below.

Trucking Alternative. Under this plan, the cargo and petroleum products that would have been proposed to enter a deepened Port Everglades on post-Panamax container-vessels (for containerized cargo only) and Aframax tankers (deep-draft petroleum vessels) would transit to an alternative east coast port-of-call that can accommodate these vessels. The cargo/product would be brought to South Florida on trucks for distribution. Currently the ports of Norfolk, Virginia and New York/New Jersey are the only ports on the east coast of the United States that can accommodate post-Panamax container vessels (the Port of Miami is currently *authorized* for deepening to receive post-Panamax vessels). Trucking goods from containers from such distances is impracticable. This proposal, when petroleum vessels are considered, is also not feasible. Alternative ports for receiving and distributing petroleum products include Port Tampa Bay, the Port of Jacksonville, and Port Canaveral, which are the only three ports other than Port Everglades that have capacity to import petroleum products in Florida. However, none of these ports has the depth for the Aframax tankers to arrive *fully loaded: a*s of June 2013, the Port of Jacksonville's maximum depth is 40 feet, Port Tampa Bay's is 43 feet, and Port Canaveral's maximum depth is 40 feet, which would make transiting to any of these ports less efficient and more costly than transiting to a deepened/expanded Port Everglades. Furthermore, calculations indicated that 297,500 truckloads per year would have to be placed on Florida's highways (following transfer at the three ports noted above) to meet current demand for fuel, even if those ports could accommodate the corresponding number of incoming vessels. In addition, using the fuel consumption projections for the year 2015 (see FDEP 2005), an additional 89,250 trucks per year (or 245 trucks a day) would be required. This petroleum-related traffic does not include any increases in truck traffic attributable to containerized cargo. Population through the year 2040 for Palm Beach, Broward, Miami-Dade and Monroe counties is projected to increase by an additional 1.2 million people, according to South Florida Regional Planning Council (SFRPC), 2012, which will continue to drive the demand for petroleum products entering Port Everglades for the foreseeable future. USACE has determined that this option would burden other ports already operating at/near capacity, cause significant overland traffic issues (including road-way impacts to Florida highways), be extremely costly due to tractor-trailer fuel expenses, and would contribute vast amounts of carbon-combustion by-products to the atmosphere. The final consideration is that this plan does, to some degree, address Objective 2 by reducing existing harbor congestion issues. However, it does not address Feasibility Study Objectives 1 and 3. Therefore, per the evaluation criteria, this alternative is not reasonable for further evaluation.

All measures, plans, and alternatives eliminated from further analyses, as well as the reasons for their elimination, can be found in the Feasibility Study main text, and is incorporated by reference.

Lightering Alternative. Lightering vessels is when part of the commodity on board the vessel is off-loaded outside of the Port onto smaller vessels and then both vessels enter the Port and unload. Lightering would be an option, in lieu of deepening the OEC, to handle the increasing container cargo and petroleum product arriving at Port Everglades. The feasibility of lightering is limited to liquid (in the case of Port Everglades, petroleum-based) products that can be pumped from one ship to another due to safety concerns with lifting and swinging 20-ton cargo containers at sea on rolling vessels. Off-loading petroleum onto shallower-draft vessels outside the Port would create several problems, including increased risk of oil spills during transfer activities, offshore anchoring requirements which could damage habitats, and exposure to homeland security issues as noted by an April 27, 2004 Port Security Notice from the USCG for petroleum operations in the Gulf of Mexico (USCG 2004).

Anchoring of liquid petroleum vessels would have to take place in deeper, exposed, offshore waters, which includes a number of other risks and issues. The smaller classes of vessels

currently coming to Port Everglades, onto which the petroleum products would be transferred, do not have the ability to maintain sufficient anchor chain for deep-water anchoring and would require the designation of a shallower-water off-loading anchorage near shore. This would also result in the larger tanker vessels transiting and anchoring closer to shore to allow for offload of product to the smaller tankers able to enter the Port. Also, offshore anchorages, in addition to the existing USCG designated anchorage, will be required to be developed and maintained in shallow enough water to allow the smaller and larger ships to anchor for offloading actions. Anchoring actions would require a minimum of two anchors per vessel (increasing as sea state increases to ensure the vessels do not move during lightering activities to prevent spillage of petroleum products). These anchorages would have to be placed north of the entrance channel to avoid the U.S. Navy's restricted zone, and would cause additional congestion with ships coming and going from the USCG-designed anchorage as well as transiting to and from Port facilities.

Lightering capability would also be affected by sea state, winds, and vessel size. The smaller the vessel, the less tolerance for increased sea state before transfer would be required to cease. The decision to cease transfer operations is a vessel-by-vessel determination made by the ship's Master under the operating procedures for that particular vessel. This inconsistency of a vessel by vessel determination would make scheduling of product arrivals and ship movements within the Port extremely challenging in periods of rough weather, and could also lead to congestion near the Port entrance and in the anchorage while ships wait for seas to lie down before they could be safely offloaded.

The lightering arrangement is considered to be more risky and unsafe given the unpredictable currents at Port Everglades. It would increase Port congestion because two vessels would be entering rather than one. It is not likely to decrease costs because two vessels have to be used, which increases delays and operating expenditures. Due to safety concerns raised by experts in vessel operations at the Port and in the Port Everglades Pilots Association, and concerns regarding the need for additional anchorage space at Port Everglades to implement this alternative, it was eliminated from further study.

Offshore Petroleum Terminal Alternative. Under this plan, vessels with refined liquid petroleum cargos would anchor offshore and transport their product to inshore facilities via submerged pipelines from a deepwater port facility similar to the Louisiana Offshore Oil Port (LOOP). A deepwater port is a man-made offshore marine terminal located in waters deep enough to accommodate post-Panamax class petroleum tankers which are too large to currently enter Port Everglades in a fully loaded state. A deepwater marine terminal generally consists of several tanker mooring buoys connected to the seafloor pipelines to a nearby pumping platform that is connected by seafloor pipeline(s) to a mainland terminal. A tanker at a mooring buoy pumps its cargo to the pumping platform, which then pumps the oil ashore. The marine terminal complex typically contains operating stations, booster pumps, control valves and manifolds, crew accommodations (feeding and berthing), helicopter pad, radar and communication facilities and on-site pollution response equipment. The only liquid petroleum deepwater port operating in the United States is the LOOP, 18 miles off the Louisiana coast in 150 feet of water.

To construct this alternative, substantial and complex coordination among oil companies and federal agencies, such as the Department of Energy, Bureau of Ocean Energy Management (Department of Interior's "BOEM"), USCG, Federal Energy Regulatory Commission and U.S. Maritime Administration (Department of Transportation) (as well as all environmental regulatory agencies) would be necessary; development and permitting could take several years. Separate pipeline systems would have to be installed to deliver each of the products that would need to be transferred to the Port: gasoline, jet fuel, diesel fuel, fuel oil, asphalt, and propane. Each of these is a separate product, and there are currently no refining facilities at Port Everglades that could

either separate products that have been mixed during transport in a single pipeline or clean the pipelines after being used for a particular product type.

To implement a similar operation at Port Everglades, the marine terminal and pumping platforms would be built offshore as rigid, above water structures. Pipe systems and anchorage areas offshore would likely have significant direct impacts to offshore habitats, and petroleum product spill risk would be increased as traffic increases during anchoring and offloading of each of these products at a separate offloading terminal for each pipeline. Another concern is congestion of vessel traffic in a limited space. All of the pipeline activities (including the currently proposed Liquid Natural Gas, or "LNG," deepwater port facility and the Port Everglades anchorage) must be placed north of the entrance channel due to the naval restricted area depicted in Figure 7, as well as the location of the petroleum facilities within the Port itself. Placement of the additional six deepwater Port facilities cannot hamper vessel movements in or out of Port Everglades and cannot cause unsafe navigation situations for vessels attempting to anchor in the designated anchorage. Should an accident occur that resulted in a leak, the liquid materials in the pipeline would pour into the ocean and cause extensive environmental damage. Systems would have to be shut down during inclement weather due to further increased risk to people, ships, facilities, and the environment. Increased security risks would exist with this plan. Multiple deepwater port anchorages would be less than aesthetically pleasing in the Fort Lauderdale area, where tourism income is important. A large on-shore handling facility would probably be required to be constructed to take the petroleum products arriving via each pipeline and distribute them into the existing Port Everglades distribution system. Infrastructure and further land development would be necessary. This could negatively impact current operations and/or existing natural resources. Finally, while this plan would reduce petroleum ship traffic, it would not relieve container ship or cruise ship traffic congestion in the Port. This alternative addressed Objective 2 of the Feasibility Study, however it does not address Objectives 1 or 3, and USACE's mission as provided by Congress does not comprise such actions. As a result of these factors, it does not meet the evaluation criteria for a reasonable alternative under this EIS, and as such this plan was eliminated from further detailed analysis.

Rail Alternative. Florida is heavily dependent on imported gasoline. This dependency is expected to increase by 9 million gallons per day by 2015 (FDEP 2005). Florida has no petroleum refining capacity, nor is Florida supplied by a gasoline pipeline from the Gulf Coast petroleum refineries. Instead, Florida gasoline is supplied by waterborne tankers and barges from Texas Gulf Coast ports to destinations along the Florida Gulf and Atlantic coasts. Significant foreign supplies are also imported into Florida coastal ports. When refined petroleum products (gasoline, diesel fuel, and jet fuel) reach Florida port destinations, the fuels are transferred to many different supply storage terminals located within the sea ports. Terminal owners then mix their additive packages into gasoline and other refined products at these terminal facilities, at which point they are distributed to gasoline stations, airports, and businesses by tanker trucks. Port Everglades is the primary source of petroleum products for the 12 southern Florida counties (FDEP 2005).

Under this alternative, petroleum products on tankers not able to call at Port Everglades would be directed to an alternative port and product would be placed in rail cars for transport to south Florida. USACE contacted Todd Biscan, Assistant Vice President Intermodal Sales for Florida East Coast (FEC) Railway to investigate the feasibility of this option. There are currently no plans to bring rail infrastructure into Northport where the petroleum facilities of the Port are located. However, in July 2014, the Southport Intermodal Container Transfer Facility (ICTF) was constructed. This will be used for containers, but not petroleum.

This alternative does not address the future increased demand for petroleum products, the demand of which is a portion of the deepening benefits associated with the OEC, specifically

benefits associated with refined petroleum products including gasoline and jet fuel, as there are currently no rail tankers designed to transport such material (Todd Biscan, FEC, pers com 2008). However, if a rail car could be designed for that purpose in the future, and if a rail line to Northport were to be built, it is expected that the new “petroleum tank car” would hold approximately 25,000 gallons of petroleum product per rail car. Given the estimated increase in demand as predicted by the Florida Department of Environmental Protection (FDEP 2005), the additional needed gasoline would require two trains a day of 60 cars in length to meet the demand for gasoline. This calculation is based solely on the projected increase in needed product and assumes that the current ships calling at Port Everglades would continue to bring material at current rates, and that there would be no decrease in vessel calls to the Port by petroleum vessels. Additionally, this alternative does not address the increase in other petroleum-based products imported into Port Everglades including jet fuel and propane. If this alternative were to be considered implementable, the product would be offloaded at another (more northerly) port that possesses the intermodal capacity to transfer petroleum products from the petroleum tanker ship to the tanker cars on the train. The petroleum product would then be transported down the east coast of Florida to Port Everglades where, it would be pumped from the tanker car into the distribution system at Port Everglades. This system would result in two additional handling efforts for the product and is referred to as “double handling”. If a port located north of Port Everglades was unable to accommodate the additional petroleum tanker, and it was offloaded at Port Tampa Bay (the other petroleum port in Florida besides Jacksonville, Canaveral, or Port Everglades), the product would be offloaded to rail cars as previously described in the northern port option, however since there is not a rail system that connects Port Tampa Bay to Port Everglades, the product would have to be taken from Tampa via rail lines operated by CSX Transportation to a rail facility in West Palm Beach operated by FEC, where it would be loaded onto rail cars on the north-south line for transit to Port Everglades, This would result in triple handling of materials and result in significant increases in cost. Due to the lack of tanker technology to transport the products being imported into the Port by rail, and the lack of infrastructure (rail lines) to bring the rail cars into the Port, this alternative cannot be implemented at this time. In addition to the limitations previously stated, this analysis does not capture the increased cost of commodities that would be incurred by the citizens of the 12 South Florida counties due to the double or triple handling of the petroleum products that are provided via the distribution system from Port Everglades. This alternative is not implementable due to the limitations in technology and infrastructure, nor does it meet Feasibility Study Objectives 2 or 3. As a result of these factors, it does not meet the evaluation criteria for a reasonable alternative under this EIS, and as such this plan was eliminated from further detailed analysis.

NOAA "PORTS" Alternative. In a letter dated July 7, 2011, NMFS requested USACE review the potential of implementing the Physical Oceanographic Real-Time System (PORTS) as an alternative to expansion of the OEC. USACE reviewed the PORTS system, reviewed documentation from the Port Everglades Pilots Association (PEPA) and spoke with Mr. Darren Wright, PORTS program manager. In an email dated May 10, 2012, Mr. Wright, stated that “PORTS is designed for safe and efficient navigation to better utilize the water you have but in no way is suppose to replace dredging".

Per the NOAA PORTS website, "The National Ocean Service (NOS) is responsible for providing real-time oceanographic data and other navigation products to promote safe and efficient navigation within U.S. waters. The need for these products is great and rapidly increasing; maritime commerce has tripled in the last 50 years and continues to grow. Ships are getting larger, drawing more water and pushing channel depth limits to derive benefits from every last inch of draft. By volume, more than 95 percent of U.S. international trade moves through the nation's ports and harbors, with about 50 percent of these goods being hazardous materials. A major challenge facing the nation is to improve the economic efficiency and competitiveness of U.S. maritime commerce, while reducing risks to life, property, and the coastal environment. With increased marine commerce comes increased risks to the coastal environment, making marine navigation safety a serious national concern. For example, from 1996 through 2000, commercial vessels in the United States were involved in nearly 12,000 collisions, allisions, and groundings" (http://tidesandcurrents.noaa.gov/ports.html).

PEPA is aware of the PORTS program and have had discussions with NOAA regarding implementation of the PORTS, and may choose to implement the program at their discretion, in concert with the Port and NOAA. The USACE has no mechanism to require the Port or PEPA to adopt and implement PORTS. This alternative partially addresses Objective 3 of the Feasibility Study, however it does not address Objectives 1 or 2, and USACE's mission as provided by Congress does not comprise such actions. As a result of these factors, it does not meet the evaluation criteria for a reasonable alternative under this EIS, and as such this plan was eliminated from further detailed analysis.

In a meeting held on September 27, 2012, NMFS also requested that the USACE determine if the entrance channel flare could be reduced in size via the implementation of the PORTS program. The Corps contacted the PORTS program manager to discuss this alternative. The program manager stated that to his knowledge "PORTS have never been used to reduce dredging." However, the PORTS system can be predictive if sufficient data are collected and analyzed. With that in mind, if Port Everglades and PEPA choose to partner with NOAA and implement the PORTS system in the OEC, and sufficient current direction and speed data are collected, PEPA and the USACE may be able to reduce the width of the OEC, yet continue to provide safe transit for current and future vessels calling at Port Everglades. However, because this data does not yet exist, and NOAA cannot predict the reduction in required width with reasonable assurance that the width will remain sufficient for safe vessel transit, the USACE must maintain the 800-foot width determined by the ship simulation study conducted for the Feasibility Study. If the data becomes available after the Feasibility Study is complete, the USACE can incorporate that data during the Pre-Construction Engineering and Design phase of the project.

Combination of Logistical Alternatives. During the final phases of plan formulation, NOAA staff inquired whether some combination of the above alternatives could support all three of the project objectives. Upon careful consideration, it was determined that even in combination, the above alternatives could not accommodate project objectives and USACE mission (even if cost was not among limiting factors). This is graphically represented in Table 6. Objectives are listed above in Section 2.1.

Table 6 Objectives addressed by logistical alternatives vs. deepening/widening

Alternative	Addresses Objective 1	Addresses Objective 2	Addresses Objective 3
Deepen/Widen	X	X	X
NOAA			
Offshore			Partially (petroleum)
Lightering			Partially (petroleum)
Truck		X	
Rail			Partially (cargo)

2.5.4 Inner Harbor Configuration Alternatives

Southport Access Channel. John U. Lloyd State Park (JUL) is a 287-acres state park located immediately east of the Port, directly across from it, all along the Southport Access Channel (SAC). As part of the original planning for the expansion of Port Everglades, ship passage in the SAC, along the widener, and through the section of the Port known as "the Knuckle" were significant concerns. The passing constriction at the Knuckle was the original reason the Port pursued Congressional authorization for the Feasibility Study in the late 1990s. During vessel movement simulations, it was determined that the channel would have to be widened to the east to allow for safe ship passage of the existing fleet and any newer, larger vessels calling on Port Everglades in the future. The original proposal would have constructed a wider channel using side-slopes that would have resulted in the removal of 38.90 acres of non-mangrove uplands (including park infrastructure) and 25.90 acres of red and black mangroves along the western side of the park (Figure 8). Some of these mangroves were mitigation for the previous creation of the Turning Notch (TN) and could not be removed or they would have to be replaced by the Port as a requirement of the Clean Water Act permit issued for the original construction of the TN in 1989. During the feasibility phase, the proposed channel width was decreased to avoid the vast majority of these impacts.

Turning Notch. The original federal project included the expansion of the TN to the west from the existing footprint and deepening the entire basin to -50 feet MLLW. Construction of this component would result in the removal of 8.59 acres of red and black mangrove wetlands (Figure 9). This component of the project was removed from the federal project for economic reasons. However, because the Port is currently berth-deficient, it has chosen to move forward with this component of the project without federal participation as part of their Master Plan. The Port is pursing permits from the FDEP and USACE for construction of the expanded TN to a depth of -42 feet MLLW. If this project is permitted and constructed by the Port, USACE plans to then deepen the then-existing -42 feet MLLW notch to -52 feet MLLW. The expansion of the TN is considered a "without-project" condition (although the deepening to -50 feet is considered a with-project condition), as the Port has already begun permitting discussions and held a pre-application meeting in August 2012.

Dania Cutoff Canal. Original plans for the Dania Cutoff Canal would have resulted in significant impacts to mature red and black mangrove wetlands on the northern side of West Lake Park (Figure 10). Between 2002 and 2008, the project was modified to significantly reduce the impacts to mangroves through the use of environmentally friendly bulkheads (more information is located in Section 2.9.5). However, since that time, the component has been entirely removed from the Recommended Plan (and other investigated alternatives) for economic reasons.

Alternative (2002) SAC Plan - JUL SAV and Mangrove Impacts	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1,000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 8

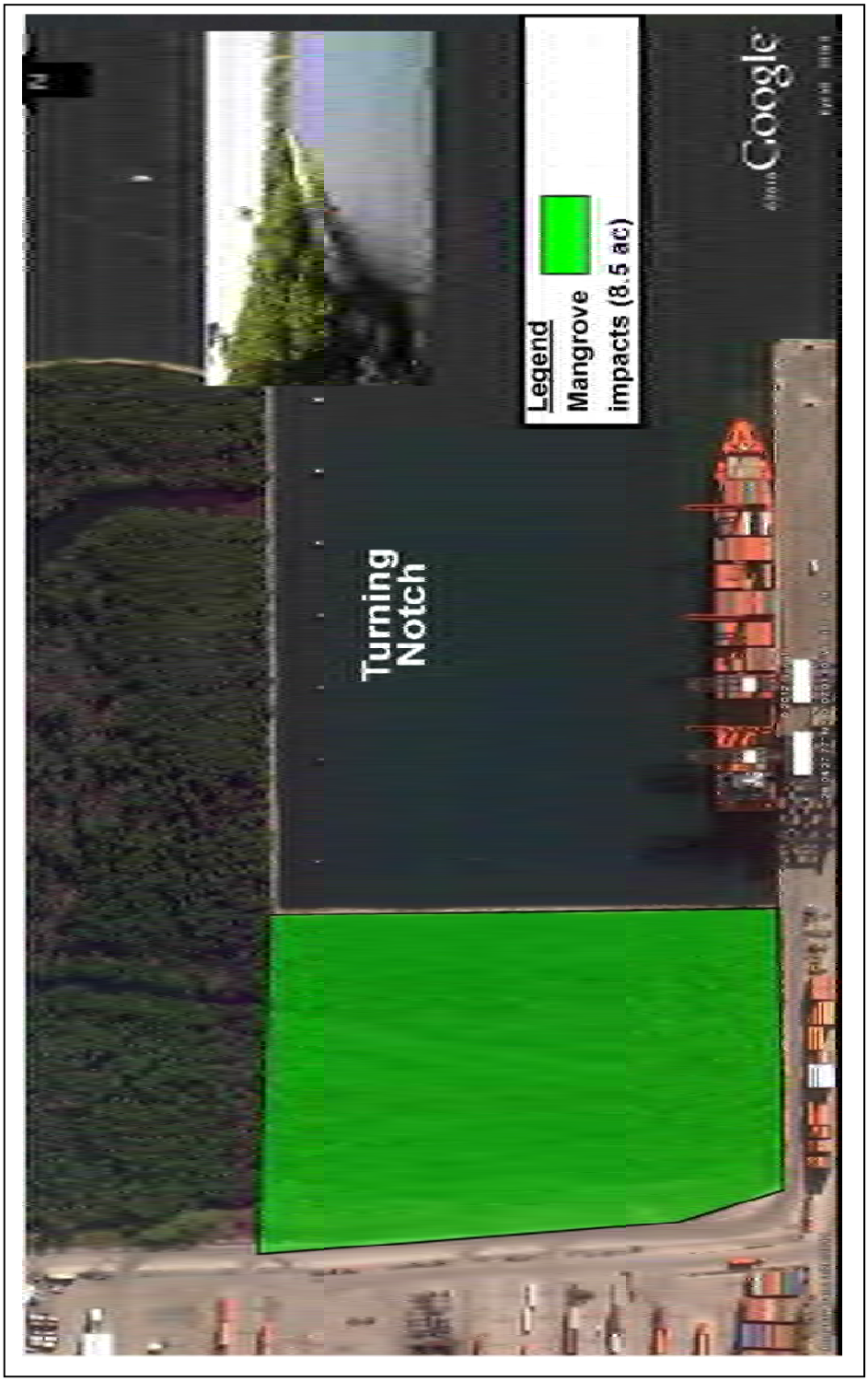
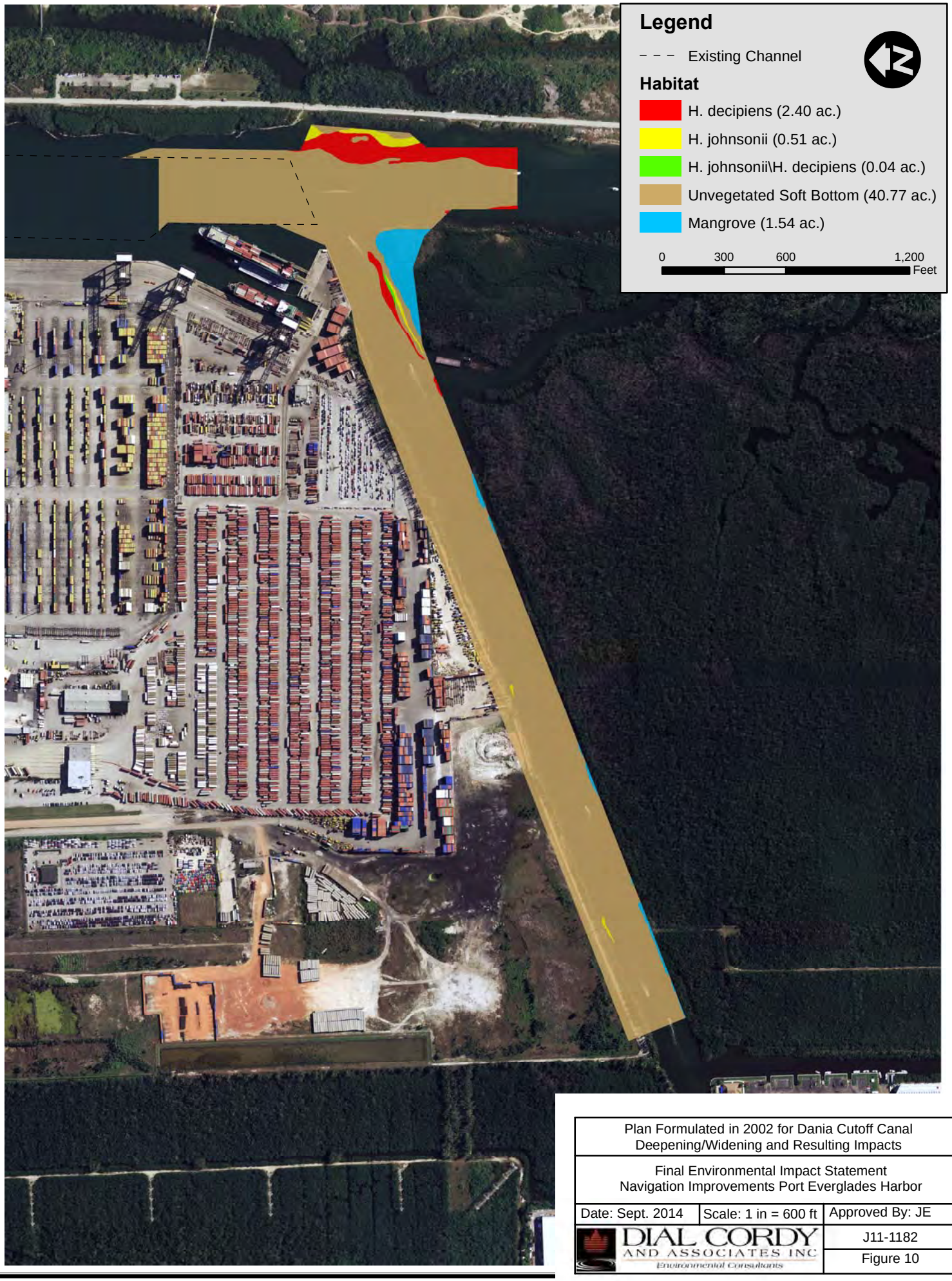


Figure 9 Plan Formulated in 2002 for Turning Notch Deepening/Widening and Resulting Impacts



Plan Formulated in 2002 for Dania Cutoff Canal Deepening/Widening and Resulting Impacts		
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor		
Date: Sept. 2014	Scale: 1 in = 600 ft	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants		J11-1182
		Figure 10

2.5.5 Disposal Alternatives Considered but Discarded

As stated in the Draft Environmental Assessment on Expansion of the Port Everglades Ocean Dredged Material Disposal Site (ODMDS) (USEPA in preparation), "Two potential sites: land belonging to Port Everglades and land belonging to the Fort Lauderdale Airport, were examined as potential upland dredged material disposal sites." Due to development within the Port and further evaluation of the Airport's runway expansion plans, both the Port and the Airport have withdrawn the use of their upland properties as upland placement options. Further, the potential upland disposal sites were considered environmentally valuable in their own right, and neither was more cost-effective than ocean disposal. There are currently no other known upland sites suitable for the placement of dredged materials in the project vicinity. As a result, upland disposal is not a viable option for the placement of dredged materials from the Port Everglades Harbor Federal Navigation Project.

2.6 Alternatives Not Within Mission and Capabilities of Lead Agency

The alternatives discussed in the above section (which arose from coordination meetings with regulatory and resource agencies and the Port), i.e., (1) mooring tankers offshore and use of a pipeline system to offload ships, (2) trucking of goods from use of another port (e.g., Tampa, Jacksonville, etc.), (3) lightering of vessels, (4) the transport of materials by train, and (5) the implementation of the NOAA PORTS system to enhance vessel transit do not fall within the jurisdiction of the lead agency (USACE). While NEPA requires agencies (i.e., USACE with its cooperating partners) to review "reasonable alternatives not within the jurisdiction of the lead agency" (40 CFR 1502.14(c)), these alternatives do not address all three of the Feasibility Study objectives. Therefore, under the evaluation criteria, and for other reasons outlined above, they were removed from further consideration by the USACE. However, USACE will readily review any information/plans from other agencies or the public demonstrating the feasibility of these alternatives if they are likewise shown to meet project objectives.

2.7 Summary of Measures to Avoid and Minimize Impacts to Natural Resources

2.7.1 Habitats

Reductions in the size of the project footprint during the plan formulation process initiated in 1998 have resulted in the avoidance and minimization of various impacts. Dredging in the DCC, STB, and any not-previously-dredged portions of the TN have been eliminated from plans (as discussed above in Section 2.5.4), and there have been significant reductions of impacts in the OEC and SAC (Table 7). These efforts at avoiding and minimizing impacts have resulted in preserving important seagrass, mangrove wetland, hardbottom, and recreational resources.

Mangrove wetland impacts assessed for plans formulated in 2001 ranged from approximately 26 to 53 acres for various alternatives. The recommended plan now proposes to impact only approximately 1.16 acres of mangroves, a reduction of up to 98% of impacts based on initial plans. Regarding mangrove impacts in the SAC only, the original proposal would have constructed a wider channel using side-slopes (for stabilization) that would have resulted in the removal of 25.90 acres of red and black mangroves (as well as 38.90 acres of non-mangrove uplands, including park infrastructure) along the western side of the park (Figure 8 above). For the TN, construction in its original configuration would have resulted in removal of 8.59 acres of red and black mangrove wetlands as part of the federal project (Figure 9 above).

A substantial reduction in hardbottom impacts was achieved through the reduction of the proposed OEC "flare" on the eastern terminus (see detailed description above in Section 2.5.2). Planners (based on vessel simulations and application of absolute minimum safety standards) reduced the width of the flare (i.e., the width of the channel at the point where vessels would enter the channel) from 1,000 feet to 800 feet (Figure 6 above). It was also determined from geotechnical data that proposed channel side slopes could be reduced to a more vertical configuration, resulting in further reductions of permanent impacts to reefs. These refinements resulted in the reduction of impacts to hardbottom and reef habitats by approximately 23 acres, i.e., resulting in a 58% reduction of impacts when compared to original plans from early in the feasibility phase.

Table 7 Avoidance and Minimization of Direct Impacts During Plan Formulation Process

Component	2000 (ac)	2004 (ac)	2008 (ac)	Net change (ac)
JUL non-mangrove habitats and recreational properties	38.90	0	0	*-38.90*
DCC Seagrasses	0.66	0.66	0.49	*-0.66*
MTB Seagrasses	0.1	0.1	0.1	*-0.1*
SAC Mangroves	25.90	1.9	0.31	*-24.70*
DCC Mangroves	18.49	1.9	1.54	*-18.49*
TN Mangroves	8.5	8.5	8.59	*-8.59*
OEC HR (Linear, Spur/groove, Ridge)	25.61	10.82	10.5*	*-15.51*
OEC LR (Pavement/rubble)	13.97	14.89	4.57**	*-9.82*

HR- High relief reef types (spur & groove and linear); LR- Low relief hardbottom classifications (pavement and rock/boulder/hardbottom); *adjusted to 9.79 ac due to more updated (2008) bathymetric data (incorporated into 2013 and 2014 GIS analysis); **adjusted to 4.83 ac due to updated bathymetric data and incorporation of not-previously mapped hardbottom habitat (0.09 ac) (incorporated into 2014 GIS analysis)

2.7.2 Fish, Wildlife, and Invertebrates

The avoidance and minimization of the habitats discussed above directly benefit the fish, wildlife, and invertebrate species that would have otherwise been lost had those discarded plans been used. Furthermore, the impact minimization of the areas listed above will have the added benefit (apart from a decreased acreage of impacts for the various habitats) of decreasing the *length of time* for construction/dredging. Ultimately, this decreases the time during which species using the Port and adjacent habitats may be directly or indirectly affected by deployed equipment and activities.

In order to further ensure impacts to resident species are reduced as much as is practicable, numerous protocols have been adopted for use during construction. Measures to minimize impacts to the water column, bottom substrates, managed species, and protected species include the implementation of the following plans, guidelines, and best management practices:

- Turbidity monitoring protocols (see requirements in State of Florida water quality certification, when issued)
- Blasting protocols (see Section 2.9.3.2 below)
- Species protection actions and construction protocols, including the following:
    - Standard Manatee Construction Conditions (see Sections 2.9.2.1 and 4.5.6 below)
    - Standard Sea Turtle and Smalltooth Sawfish Construction Conditions (see Section 4.7 below)
    - Removal and transplantation of any acroporid corals from the project footprint, if they are observed in the footprint during pre-construction surveys (see below).

- Plans to be developed during the PED phase:
    - Coral relocation plan detailing efforts that will be taken prior to impacts to the expansion areas to relocate corals greater than 10 cm in height or width
    - Continued development and refinement of the biological monitoring plan (Appendix E-5) detailing the efforts that the project will take to monitor construction impacts, including sedimentation, turbidity, and anchor/cable damage (if applicable) associated with construction of the project as well as post-construction monitoring

A major effort to avoid and minimize damage to reef organisms will be the careful, direct removal (and ultimate transplantation) of scleractinian corals (over 10 cm in diameter or height) from the direct impact area to mitigation sites, or, if recipient sites are not yet available/constructed, to coral nursery areas, just prior to construction of the Recommended Plan. Approximately up to 12,235 of these corals are greater than 10 cm in diameter or height and would be relocated. Providing corals that are at least *25 cm* in diameter (there are at least 716 of these as a *subset of the above number*) ensures that the oldest and most sexually mature corals in the impact area are preserved (Soong 1993). To allow for these corals to be relocated directly to the mitigation sites just prior to construction, the contractor will install either purchased, quarried, or dredged/construction-produced native limestone or rock.

Finally, where impacts are not avoidable, compensatory mitigation will be provided to ensure that resources in the project area are not depleted. The mitigation plan is summarized in Section 5.0 and provided for review in Appendix E.

2.8 Alternatives with the Maximum/Minimum Environmental Impact

The alternative with the *maximum* environmental impact is Alternative 2C. It is described above in Section 2.3. The alternative with the *least* environmental impact *that accomplishes all project objectives* is Alternative 2E, the Recommended Plan, described above in Section 2.3 and in greater detail below. Furthermore, among the potential OEC depths analyzed for Alternative 2E, the depth increment with the greatest environmental impact is the -50 MLLW project depth (i.e., 59-foot actual depth). This option was discarded due to greater relative economic benefits of a shallower depth option with a smaller footprint on offshore reef habitats. Alternative 2E's -48 MLLW project depth (57-foot actual depth) for the OEC is the alternative selected for full analysis in this document, and is compared to the future without-project-condition, i.e. the No-Action Alternative.

2.9 Construction of Recommended Plan (Alternative 2E)

2.9.1 Overview

Alternative Plan 2E described above in Section 2.3 comprises the Recommended Plan. Notwithstanding the uncertainty inherent in the bidding and construction process (see below paragraphs), certain assumptions can be made regarding methods that may be needed to complete construction. Dredged material would most likely be excavated using either a hydraulic cutterhead dredge or mechanical excavator with some of the material pretreated using some method to break the rock prior to dredging, such as confined underwater (CU) blasting using explosives. Geotechnical data indicate that the majority of the material to be dredged may be able to be removed without blasting (although additional core borings will provide more specific information regarding positions of massive hardened materials (i.e., rock) during the PED phase of the project), but it is almost certain that some material will require CU blasting to break some rock formations, particularly in the MTB, STB, NTB and northern portions of the SAC.

The specifications will limit the extent of CU blasting to only those areas where excavation cannot be accomplished by dredging equipment without rock pre-treatment. Equipment capable of dredging rock without blasting includes a hydraulic pipeline dredge with a rock cutterhead or certain types of clamshell and backhoe dredges. Use of small or inappropriate dredges will be discouraged through the use of minimum monthly production standards or other language within the specifications. The contractor may employ the use of more than one dredge at a given time; this possibility will be left open in the project specifications.

Construction phasing is based on USACE estimates for dredging durations and element costs, and provides the plan for contract phases per fiscal year. The number of contracts required to complete this project is a function of the funding stream, the contractor's proposal, construction methodologies, equipment availability, and construction window compliance. Available data is insufficient at this time to determine the precise number of contracts that may be required, therefore a single continuing contract is assumed. This will allow the contractor to group like items, meet Port implementation schedules, have flexibility with component construction due to weather or environmental conditions, and reduce mobilization and demobilization costs. USACE estimates project construction may take up to five years (Table 33, Section 6.1, Feasibility Study).

This is based on a conservative estimate for funding of the project on a piecemeal basis. It is assumed that if required funding is received in a timely manner, the overall project phasing could be expedited considerably. It is estimated that with proper funding and contractor performance and availability, total project construction from start to finish could be accomplished in three years.

In general, USACE does not specify types of equipment and construction methods within its specifications due to the federal acquisition regulations implementing the Competition in Contracting Act requiring federal agencies to limit how specific specifications are written to prevent limiting competition among contractors (C. Tolle, USACE-SAJ Contracting, pers com). The contractor selected by USACE will determine the most efficient construction methodology for the project, in their professional opinion, and submit that as part of a proposal to USACE. USACE can, and does, specify the intended results of construction through detailed plans and specifications. Generic information regarding several construction techniques and their possible utility for the Port Everglades project is discussed below.

2.9.2 Potential Material Removal Methods

Dredging equipment uses either hydraulic or mechanical means to transport material from the substrate to the surface. Hydraulic dredges use water to pump the dredged material as slurry to the surface and mechanical dredges use some form of bucket to excavate and raise the material from the channel bottom. The most common hydraulic dredges include suction, cutter-suction, and hopper dredges and the most common mechanical dredges in the U.S. include clamshells, backhoes, and marine excavator dredges. Public Law 100-329 requires dredges working on U.S. government projects have U.S. built hulls, which can limit the options for equipment types. If a new type of dredge is developed overseas it cannot be used until that new technology is adopted by a U.S. dredging company and built in the U.S.

Various project elements influence the selection of the dredge type and size. These factors include the type of material to be dredged (rock, clay, sand, silt, or combination); the water depth; the dredge cut thickness, length, and width; the sea or wave conditions; vessel traffic conditions; environmental restrictions; contaminants; other operating restrictions; and the required completion time. All of these factors impact dredge production and as a result costs. Multiple dredges of the same or different types may be used on projects where conditions vary between dredging locations or to expedite the work.

The following discussion of dredges and their associated impacts will be limited to potential dredging equipment suitable for the Port Everglades expansion project, based upon historic review of expansion operations at Port Everglades and similar projects, as well as the expert opinion of the USACE construction and operations staff. The key elements for this project include the following:

- Much of the material is rock, much of which is classified as hard to very hard and will likely require pretreatment (such as CU blasting or use of a punch barge) prior to dredging.
- Other areas include an overburden of silt, sand, and soft rock over the hard rock areas.
- Significant environmental resources, including hardbottoms and seagrass, are located adjacent to and within the project footprint.
- Potential historic properties may exist within the project footprint.

- Project includes both open water and protected water dredging.
- To date, no contaminated material has been identified in the project footprint that will be dredged (Appendix J).

The project scale for Port Everglades limits potential equipment to large-scale hydraulic or mechanical dredges. Potential equipment must be able to reach 55 to 60 feet in depth depending upon wave and tide conditions as well as excavate large material volumes. In some areas the rock will likely require some type of pretreatment prior to dredging such as CU blasting or use of a punch barge.

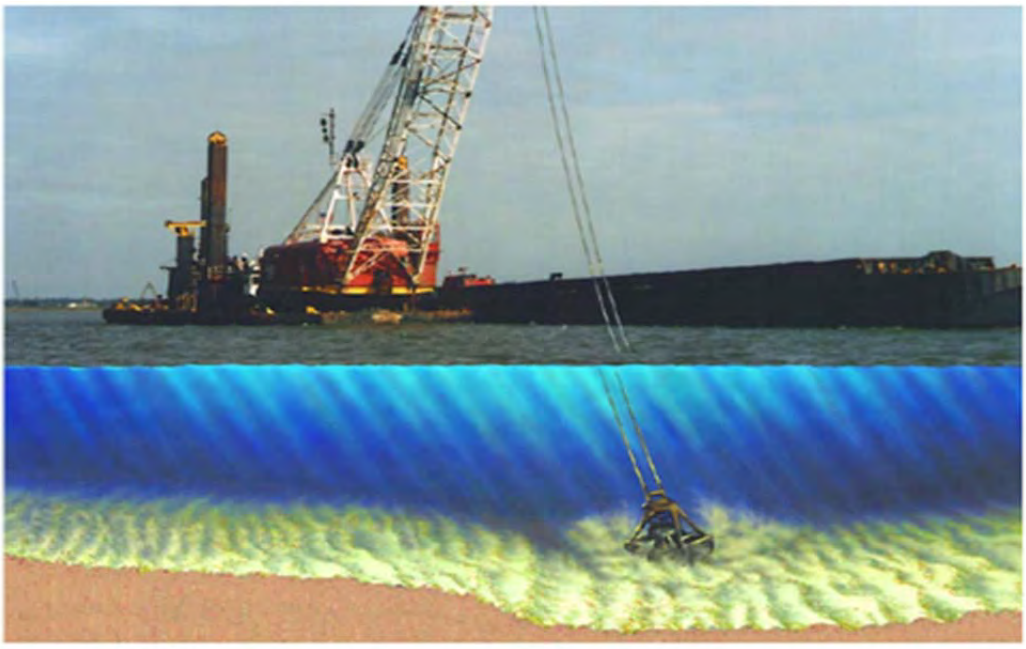
2.9.2.1 Mechanical Dredging

Mechanical dredges are classified by how the bucket is connected to the dredge. The three standard classifications are structurally connected (backhoe), wire rope connected (clamshell), and chain and structurally connected (bucket ladder). The advantage of mechanical dredging systems is that very little water is added to the dredged material by the dredging process and the dredging unit is not used to transport the dredged material. This is important when the disposal location is remote from the dredging site. The disadvantage is that mechanical dredges require sufficient dredge cut thickness to fill the bucket to be efficient and greater re-suspended sediment is possible when the bucket impacts the bottom and as fine-grained sediment washes from the bucket as it travels through the water column to the surface. Clamshell or backhoe marine excavators are likely to be employed on portions of the Port Everglades project.

Clamshell Dredge. Clamshell dredges (Figures 11 and 12) are the most common of the mechanical dredges. Clamshell dredges use a number of different bucket types for mud, gravel, unconsolidated rock, or boulders. The clamshell dredging operation cycle is to lower bucket in open position to bottom surface, close bucket penetrating material with weight of bucket, raise bucket above hopper level, swing, dump, swing, and repeat. The length of the wire to lower the bucket limits the dredging depth and production depends upon the bucket size, dredging depth, and type of material. The dredged material is placed in a scow or on a barge for transport to the disposal site. More details on transportation of dredged materials are included in section 2.9.2.5. Clamshell dredges are able to work in confined areas, can pick up large particles, and are less sensitive to sea (wave) conditions than other dredges. However, their capacity is low and they are unable to dig in firm or consolidated materials, such as rock. Clamshell dredges may be used to remove the unconsolidated overburden in Port Everglades. The dredge requires a tug to move it to and from a location. Potential clamshell dredging environmental impacts in unconsolidated sediments include resuspension of sediments when the clamshell drops on to the bottom and as material washes from the bucket as it rises through the water column. Operational controls such as reducing the bucket speed as it drops to the bottom and as it rises through the water column may reduce impacts, as well as use of a closed bucket system. An animation showing the operation of a clamshell is located online at http://el.erdc.usace.army.mil/dots/trip.html.

Photo Courtesy of Great Lakes Dredge & Dock Company

Figure 11 Clamshell Dredge (left) with Scow (right)



Photo/drawing: Engineer Research and Development Center 2007

Figure 12 Clamshell Dredge Contacting Substrate

Clamshell dredges have commonly been used in areas where manatees are known to congregate, and on rare occasions, manatees have been anecdotally documented as being attracted to water dripping off of the clamshell bucket. To ensure that clamshell dredges do not adversely impact manatees, USACE implements standard protection conditions when a clamshell dredge is proposed to be utilized during a project in addition to the standard manatee protection requirements located in Section 4.5.6.2. These protections include the following standard language in the USACE environmental specifications:

> Manatee Monitoring (Clamshell Only): During clamshell dredging operations, a dedicated observer shall monitor for the presence of manatees. The dedicated observer shall have experience in manatee observation and be equipped with polarized sunglasses to aid in observing. Nighttime lighting of waters within and adjacent to the work area shall be illuminated, using shielded or low-pressure sodium-type lights, to a degree that allows the dedicated observer to sight any manatee on the surface within 200 feet of the operation. The dredge operator shall gravity-release the clamshell bucket only at the water surface, and only after confirmation that there are no manatees within the safety distance identified in the standard construction conditions.
>
> Report Submission: The Contractor shall maintain a log detailing sightings, collisions, or injuries to manatees occurring during the contract period. The data shall be recorded on forms provided by the Contracting Officer (sample Daily Manatee Reporting Log is on the first web site indicated in paragraph CONSTRUCTION FORMS AND DETAILS below). All data in original form shall be forwarded directly to Chief Environmental Branch, P. O. Box 4970, Jacksonville, Florida, 32232-0019, within 10 days of collection and copies of the data shall be supplied to the Contracting Officer. Following project completion, a report summarizing the above incidents and sightings shall be submitted to the appropriate USFWS and FWC offices.
>
> Special Operating Conditions:
>
>> (1) All vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom, and vessels shall follow routes of deep water whenever possible. Boats used to transport personnel shall be shallow-draft vessels, preferably of the light-displacement category, where navigational safety permits. Mooring bumpers shall be placed on all barges, tugs, and similar large vessels wherever and whenever there is a potential for manatees to be crushed between two moored vessels. The bumpers shall provide a minimum stand-off distance of four feet.
>>
>> (2) If a manatee(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by the Contractor to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. If a manatee is closer than 50 feet to moving equipment or the project area, the equipment shall be shut down and all construction activities shall cease within the waterway to ensure protection of the manatee. Construction activities shall not resume until the manatee has departed the project area.

The full set of Master Environmental Specifications utilized by USACE is located online at http://www.saj.usace.army.mil/Portals/44/docs/Engineering/MasterGuideSpecs/015720.pdf. Animation showing how a clamshell operates is located on the following website - http://el.erdc.usace.army.mil/dots/trip.html.

Backhoe Marine Excavator.
A backhoe dredge is an excavator that is usually mounted on pontoons or a barge. The backhoe digs toward the dredge with the bucket penetrating from the top of the cut face. The operation cycle is similar to the clamshell dredge, as are the factors affecting production. Backhoe marine excavators have accurate positioning ability and are able to excavate firm or consolidated materials. However, they are susceptible to swells and have low to moderate production. Backhoe marine excavators could be used to excavate unconsolidated overburden, fractured rock, and possibly some unfractured rock. The dredging depth for backhoe marine excavators is limited to the reach of the excavator arm. The dredge also requires a tug to move to and from a location.

Potential environmental impacts of backhoe marine excavators dredging unconsolidated sediment are similar to those of a clamshell dredge, as are the operation controls to reduce inadvertent impacts. The key is slowing the movement of the bucket through the water. Environmental impacts may be significantly less for a backhoe marine excavator dredge removing fractured (blasted) rock as the volume of fine-grained sediment is significantly less in fractured rock than unconsolidated sediment, and as a result, the potential for sediment resuspension is reduced. The same operational controls can be applied to fractured rock as unconsolidated sediment, basically slowing the bucket's speed in the water.

Both types of mechanical dredges require transport barges to move the dredged material from the dredge to the disposal site. The type and size of barges will depend upon the distance to the disposal site and the production rate of the dredge. Barges are less expensive than dredges, therefore, the operation is generally designed so that the dredge is always working and does not experience down time waiting for a barge to be available to load. Barges or bottom dump scows may be used to transport dredged material to the ODMDS for disposal. Details concerning dredged material disposal are located in Section 2.9.4 of this EIS.

Potential barge environmental impacts could occur as the barge is loaded if material is allowed to spill over the sides, during transport if the barge leaks material, and during disposal if the material escapes from the disposal area. Operational controls eliminate spilling material during loading by monitoring the dredge operator to make sure that the dredge bucket swings completely over the barge prior to opening the bucket. Requiring barges in good repair with new seals minimizes leaking during transport, and monitoring changes in draft throughout the transport allows for determination of leaking scows for each and every load of material being transported to the disposal site. Hauling rock is often damaging to transport barges; so intermediate inspection and repairs may be required during the project to maintain the barges in good working condition. Seals may require replacement. Operating in compliance with the Site Management and Monitoring plan prepared by USEPA for the ODMDS would minimize environmental impacts during disposal. The barges would be required to use positioning equipment to place dredged material within the designated ODMDS and inspectors may be required to monitor disposal activity.

2.9.2.2 Hydraulic Dredging

Hydraulic dredges mix dredged material into a sediment-water slurry and pump the mixture from the bottom surface to a temporary location such as a barge or re-handling site, or to a permanent location such as a confined or unconfined upland or aquatic site. The advantage of hydraulic dredges is that there is less turbidity (re-suspended sediments) at the dredge than with mechanical dredges. The disadvantage of hydraulic dredges is that a large quantity of water is

added to the dredged material and this excess water must be dealt with at the disposal location. Examples of hydraulic dredges include hopper dredges and cutterhead dredges.

Hopper Dredge.

Hopper dredges (Figures 13 and 14) are self-propelled ocean-going vessels that hydraulically lift dredged material from the bottom surface and deposit it into an open hopper within the ship. The draghead(s) operates like a vacuum cleaner being dragged along the bottom. When the hopper is full, the dredge transits to a disposal location and releases the dredged material into an underwater disposal site by opening doors on the hopper bottom or in some cases the vessel is designed to split open longitudinally. Hopper dredges can also be designed to hydraulically pump the material from the hopper to an upland location. This is often used for beach nourishment projects. Hopper dredges are not efficient in removing treated (broken) or untreated rock; however, this equipment could be used to remove unconsolidated overburden material or accumulated maintenance material above the rock, especially in the entrance channel. Since hopper dredges are self-propelled, they are more maneuverable than dredges that rely upon tug boats to move. However, they require numerous passes over the same area to remove the required material; they are inefficient in small confined dredging areas and are most effective in removing sand and other unconsolidated materials. Animations and video of hopper dredges operations can be located online at http://el.erdc.usace.army.mil/dots/trip.html.

A hopper dredge could be used to remove unconsolidated overburden material from the entrance channel. However, only a small volume of this material is present which may reduce the efficiency of this method. Environmental impacts from hopper dredges include localized suspended sediment along the bottom around the draghead and fine-grained sediment turbidity plumes from hopper overflow. This could impact both water quality and the hardbottom communities adjacent to the channel. The turbidity can be reduced or eliminated by restricting the amount of hopper overflow time, eliminating hopper overflow, or directing the hopper overflow toward the channel bottom through tubes. Suspended sediment is expected to settle quickly because overburden in the entrance channel is mostly sand.

Hopper dredges are also known to take threatened and endangered sea turtles resting on the bottom of entrance channels and in sand borrow areas. The NMFS, in a November 2003 biological opinion for the use of hopper dredges in the Gulf of Mexico makes the following statement:

> "The construction and maintenance of federal navigation channels have been identified as a source of turtle mortality since turtle takes were first documented during hopper dredging operations in Canaveral Channel, Florida, in 1980… Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore sand mining areas, move relatively rapidly and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving turtle."

As a result of these findings, the South Atlantic Division of USACE (which includes the Jacksonville District) completed a regional consultation for the use of all types of dredges throughout the southeast Atlantic from the Virginia-North Carolina state line to Key West, Florida. This consultation resulted in a regional biological opinion (the *South Atlantic Regional Biological Opinion*, referred to as "SARBO") for the use of hopper dredges in USACE-maintained entrance channels and borrow areas and provided for protective measures required to reduce the likelihood of turtle entrainment. A project-specific biological assessment has been developed for the Port Everglades project that includes the use of a hopper dredge as a construction technique, which incorporates the terms and conditions of the SARBO as part of the proposed action (Appendix F).

Photo/drawing: Engineer Research and Development Center 2007

Figure 13 Typical Hopper Dredge

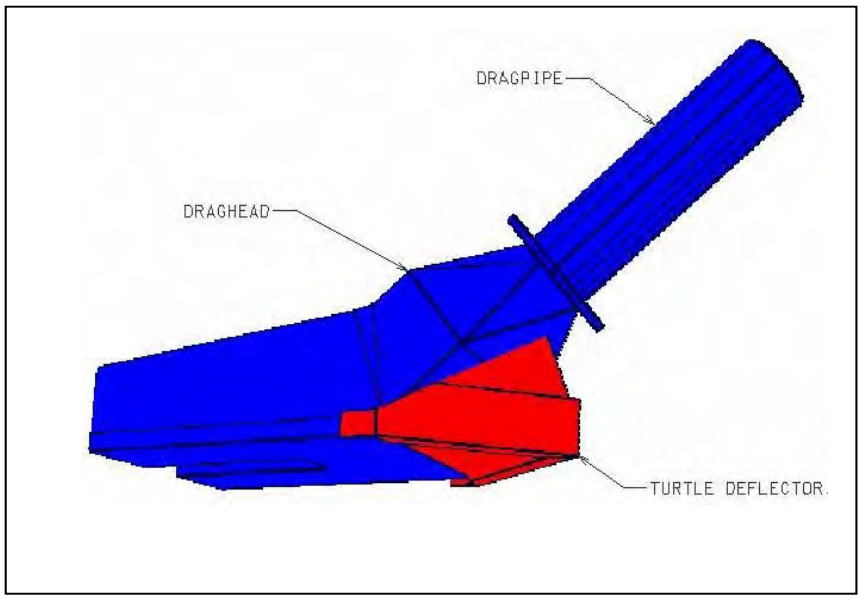


Figure 14 Hopper Dredge Draghead Detail

Cutter-Suction Dredge.

Large cutter-suction dredges (Figures 15, 16, and 17), or cutterhead dredges, are mounted on barges. The cutter suction head resembles an eggbeater with teeth (Figure 18). It mobilizes the dredged material as it rotates. The mobilized material is hydraulically moved into the suction pipe for transport. The cutter suction head is located at the end of a ladder structure that raises and lowers it to and from the bottom surface. The cutter suction dredge moves by means of a series of anchors, wires, and spuds. The cutter suction dredges as it moves across the dredge area in an arc as the dredge barge swings on the anchor wires. One corner of the dredge barge is held in place by a spud and the dredge rotates around that spud. The dredge requires workboat or tug assistance to move the anchors and a tug is required to move the dredge to and from a location. Some cutter-suction dredges have spud carriages that allow the dredge to be moved forward without the assistance of tugs (Figure 16). The discharge pipeline connects the cutter suction dredge to the disposal area. The dredged material is hydraulically pumped from the bottom, through the dredge, and through the discharge pipeline to the disposal location. This is generally an upland site, but can be a barge for transport to a remote location or an in-water site. Dredge pumps are located on the barge with additional pump(s) often located on the ladder, especially for deep water dredging projects. Booster pumps can also be added along the discharge pipeline to move the material greater distances. Cutter-suction dredges are limited to dredging depths within reach of the ladder.

Figure 15 Hydraulic cutterhead dredge vessel

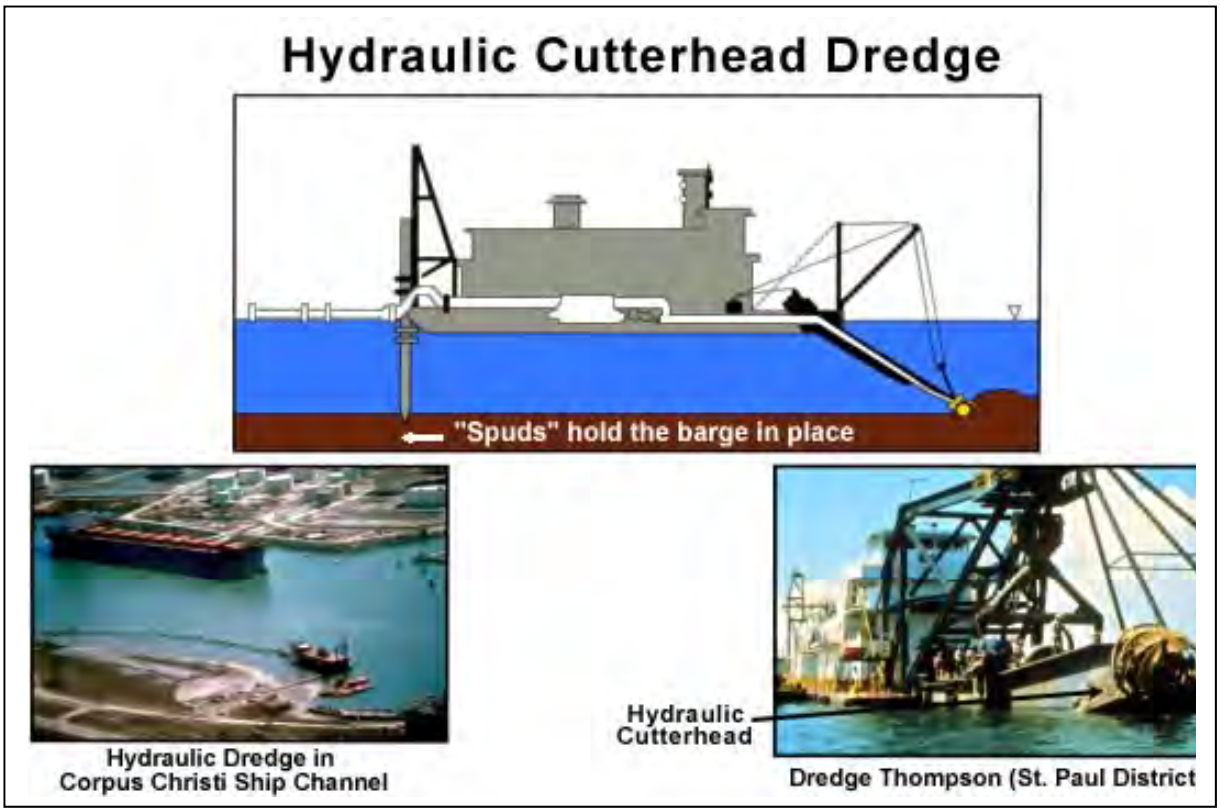


Figure 16 Cutterhead Dredge Configuration

Photo/drawing: Engineer Research and Development Center 2007

Figure 17 Cutterhead Dredge Contacting Substrate

Figure 18 Typical Large Cutterhead

Depending upon their design and the hardness of the material to be removed, cutterhead dredges may be used to remove blasted or untreated rock and unconsolidated material. Cutterhead dredges are more limited than hopper dredges to the sea state condition (size of waves) they can work in and for a cutterhead dredge to work in open ocean conditions, it must be ocean certified by the USCG.

A large cutterhead dredge could be used for at least portions of the deepening project. Some pretreatment (cracking of the rock prior to dredging) may be required for portions of the rock. Disposal options include direct placement of the dredged material in mitigation sites or transport by barges to the ODMDS (See Section 2.9.4).

Potential environmental impacts from cutterhead dredges include localized suspended sediment along the bottom around the cutterhead and fine-grained sediment turbidity plumes from barge overflow or pipeline leaks. Overflow and leaks can be reduced or eliminated by restricting the amount of overflow time, eliminating barge overflow, and performing regular inspections of the pipeline. Locating barges the furthest possible distance from resources can further reduce environmental impacts. If booster pumps are used, noise impacts may increase.

Anchors are placed to both sides of the cutterhead dredge to provide the ability to swing the dredge. The anchors are placed using a crane on a workboat. Implementation of an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat would occur through the Request for Proposal (RFP) process and would include incentives to encourage potential contractors to avoid hardbottom impacts. The evaluation criteria in the RFP would consider the technical aspects of the contractor's proposal as the most significant factor. As a result, the vessel operational and anchoring plan that best avoids or reduces impacts to reefs would receive the highest evaluation and the incentives that follow. Possible suggestions, provided ultimately by resource agency staff, dredging firms, and other consultants, that may appear in contractor proposals for evaluation during the RFP process include

- use of surge buoys along the anchor cable to help lift it up off the reef areas during dredging operations to minimize the area impacted by the anchor cable
- restricted anchor placement, which restricts placement of the anchors for the cutter-suction dredge to within the channel edge limits. That method reduces impacts but almost doubles dredging time since only half of the channel can effectively be dredged at a time.

Video clips of how cutterhead dredges operate are located on the following website: http://el.erdc.usace.army.mil/dots/trip.html.

2.9.2.3 Post-Dredging Operations

Since dredging equipment does not typically result in a perfectly smooth and even channel bottom (see discussion above); a drag bar, chain, or other item may be pulled along the channel bottom to smooth down high spots and fill in low spots. This finishing technique also reduces the need for additional dredging to remove any high spots that may have been missed by the dredging equipment. It may be more cost-effective to use a drag bar or other leveling device (and possibly less hazardous to sea turtles) than to conduct additional hopper dredging (Figures 19 and 20, courtesy Bean Dredging Company and Weeks Marine Incorporated).

Figure 19 Davit-mounted Drag Bar

Figure 20 Dual-block Drag Bar

2.9.2.4 Target Dredge Depth

The plans and specifications normally require dredging beyond the project depth or width. The purpose of the "required" additional dredging is to account for shoaling between dredging cycles (reducing the frequency of dredging required to maintain the project depth for navigation). In addition, the dredging contractor is allowed to go beyond the required depth. This "overdepth grade" accounts for the inherent variability and inaccuracy of dredging equipment (normally ±2 feet). In addition, the dredge operator may practice over-cutting. An "over-cut" along the sides of the channel (where substrates are unconsolidated materials, like sand and silts) may be employed in anticipation of movement of material down the sides of the channel. Over-cut throughout the channel bottom may be the result of furrowing or pitting by the dredging equipment (the suction dredge's cutterhead, the hopper dredge's drag arms, or the clam-shell dredge's bucket). Figures 21 and 22 illustrate these concepts.

In addition, some mixing and churning of material below the channel bottom may occur (especially with a large cutterhead). Generally, the larger the piece of dredging equipment, the greater the potential for over-cut and mixing of material below the "allowable" channel bottom. Some of this material may become mixed-in with the dredged material. If the characteristics of the material in the overcut and mixing profile differ from that above it, the character of the dredged material may be altered. The quantity and/or quality of material for disposal or placement may be substantially changed depending on the extent of over-depth and over-cut.

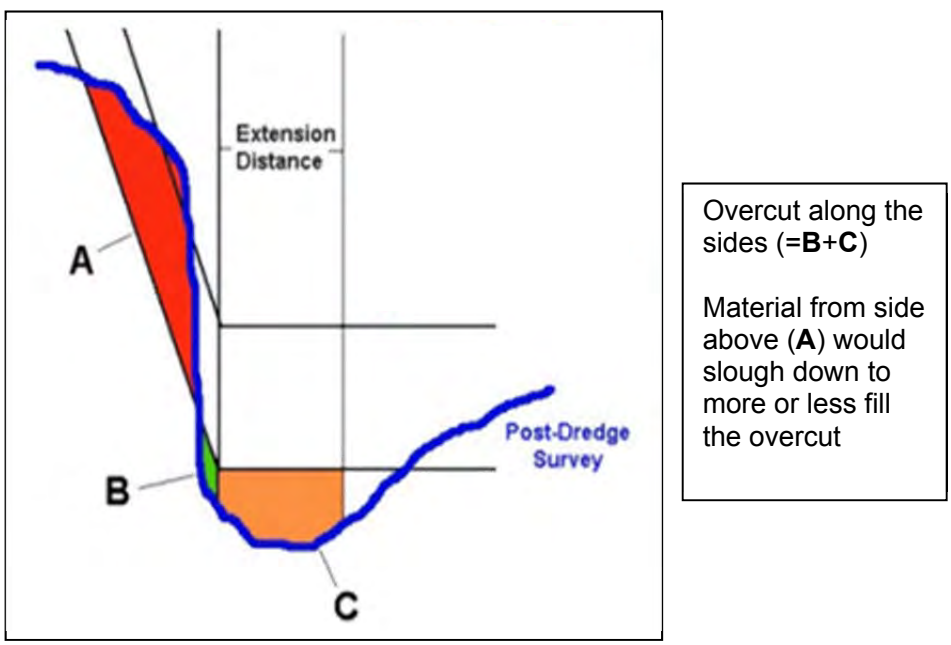


Figure 21 Diagram of Overcut in Dredged Channel Cross-Section

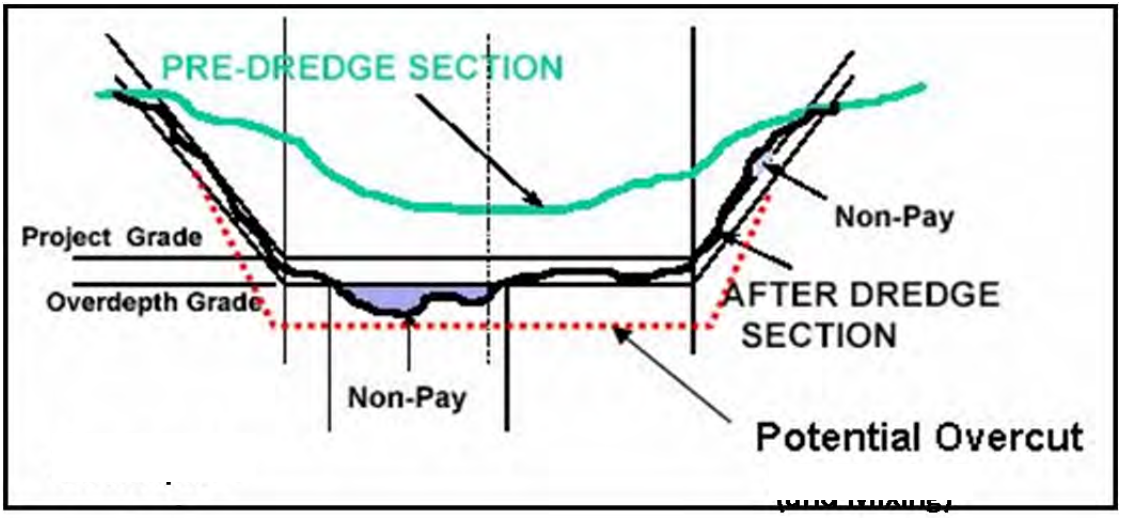


Figure 22 Typical Cross-Section Showing Project Grade Relative to Overdepth Grade

2.9.2.5 Dredge Material Transport Vessels

All three barge types discussed below are typically pushed or pulled to the disposal site by a tug (Figure 23).

Split Hull Barge.
A split hull barge (Figures 24 and 25) has two hulls connected with hinges at the front and back. The two-door hinged configuration, allows the hulls to swing apart, opening at the bottom to allow dredged material to fall from the barge. This provides a rapid disposal of dredged material, which, as a result, is placed within a small area. The rapid descent of material through the water column reduces the potential for resuspension of sediments into the water column during disposal. Such a barge may be used for ODMDS disposal. A rubber seal (similar to a gasket or weather-stripping on a door), is pinched between the two doors, limiting the leakage of water and dredged material from the barge. This seal does not prevent 100% of water and dredged material from leaking; however it minimizes it to the maximum extent practicable. During transport, the barge's draft and ullage are monitored and recorded and this data is reviewed after each load to detect loss of draft, which is assumed to represent loss of material. If a barge has a net loss of more than one foot in draft between the dredge site and disposal site(s) (averaged between the bow and stern monitoring locations), this serves as a "red flag" to conduct an investigation as to why the draft loss occurred. If the draft loss can be determined due to high seas and sloshing of material, no other action is required. However, if the loss is not as a result of high seas and sloshing, the barge is temporarily removed from the rotation and has the seals tested and repaired (if necessary). If a particular barge demonstrates a trend of material loss that does not resolve itself after seal testing and repair, the barge is removed from the dredging operation. One-foot of loss has been determined by USACE and USEPA to be a good threshold for notification, because all barges have some amount of draft loss through leakage or water

sloshing out of the barge due to sea conditions and weather, although the amount is typically minimal.

Figure 23 Split Hull Barge Being Pushed by Tug

Figure 24 View of Stern of Split-hull Scow

Figure 25 Loading a split-hull barge using a clamshell dredge

Bottom Dump Barge.

A bottom dump barge has doors on the bottom of the hopper, which opens at the disposal site to allow the dredged material to fall to the bottom. This type of barge has slower disposal than split hull dump barges and material spreads over a larger area. This barge may be used for ODMDS disposal. As with split hull barge, the bottom dump barge has seals around each of the doors to minimize leakage of material and water from the barge. The barge is monitored in the same method as the split hull barge and the same response is taken if the barge loses more than a net foot of draft.

Dredged materials are placed in the bottom dump and split hull barges using either a pipeline, a bucket or backhoe dredge, where one is loaded at a time or via a device called a “spider-barge” (Figure 26) which allows two barges to be in different states of loading (one being loaded, while one settles while a third is transiting to and from the disposal site) and is a much more efficient system for loading barges. For split hull and bottom dump barges, the disposal action is triggered remotely from the tug to the barge. The exact time the signal is given to the barge, and when the doors open and close are recorded in a tracking system for further data analysis and compliance monitoring.

Flat Top Barge.

A flat top barge transports dredged material stacked on a barge deck and must be unloaded mechanically at the disposal site. As a result disposal time is slow but it is possible to drain dredged material with filters prior to disposal. This type of barge generally has a shallower draft requirement than the other two barge types and may be used for construction of mitigation site during final filling stages or when access is limited by depth of water.

Figure 26 Loading two scows via a "spider-barge"

2.9.3 Rock Pre-Treatment Techniques

2.9.3.1 Spudding/ Hydrohammer/ Use of Punch Barge

Pre-treatment techniques are used to break-up consolidated, massive materials, like rock, prior to removal of this material by a dredge. Such factors as location, rock hardness, cost, and amount of surface requiring treatment are among factors to be taken into account when determining which method is most suitable and practicable for a given project.

USACE investigated methods to pre-treat the rock within the harbor without CU blasting using a punch barge/hydrohammer (also called spudding). Spudding is the process of fracturing the rock by dropping an array of chisels or spuds onto the rock, causing a fracture (see Figure 27). A hydrohammer is a jackhammer mounted on a backhoe. A dredge (hydraulic or mechanical) then follows this process and excavates the rock. This is a slow process and can be relatively expensive. The punch barge would work for 12-hour periods, striking the rock below approximately once every 30 to 60-seconds. The primary environmental impact of spudding or hydrohammer is noise and vibration. This constant pounding would serve to disrupt marine mammal behavior in the area, as well as impact other marine species that may be in the area. The impulse spectrum is broadband and can have components well into the kHz range (Laughlin, 2005 and Laughlin 2007 in Spence *et al*. 2007). Low frequencies (<200 Hz) typically dominate the overall levels for impact pile driving as seen with hydrohammer or punch-barging (Spence *et al.* 2007). The effects of related sound waves are very similar to the effects of underwater blasting

and may result in injuries similar in nature to those of unconfined underwater blasting. Spence *et al.* also noted that underwater sound data published in the literature typically shows a fairly wide variation in the levels generated by pile driving type activities (similar to use of a punch barge or hydrohammer). They found variations on the order of 5-10dB from one hit to another. Using the punch barge will also extend the length of the project temporally due to the lower production with the harder materials, thus temporally increasing any potential impacts to all fish and wildlife resources in the area.

Use of a punch barge was previously attempted, unsuccessfully, at Port Everglades in 1981. The rock in the inner harbor proved to be much too hard for the chisel to crack, and the chisel bounced off of the bottom without cracking the rock. The operation was very noisy and the vibration of the chisel on bottom caused direct impact to nearby structures, including homes (A. Sosnow, Port Environmental Director-Ret, pers com).

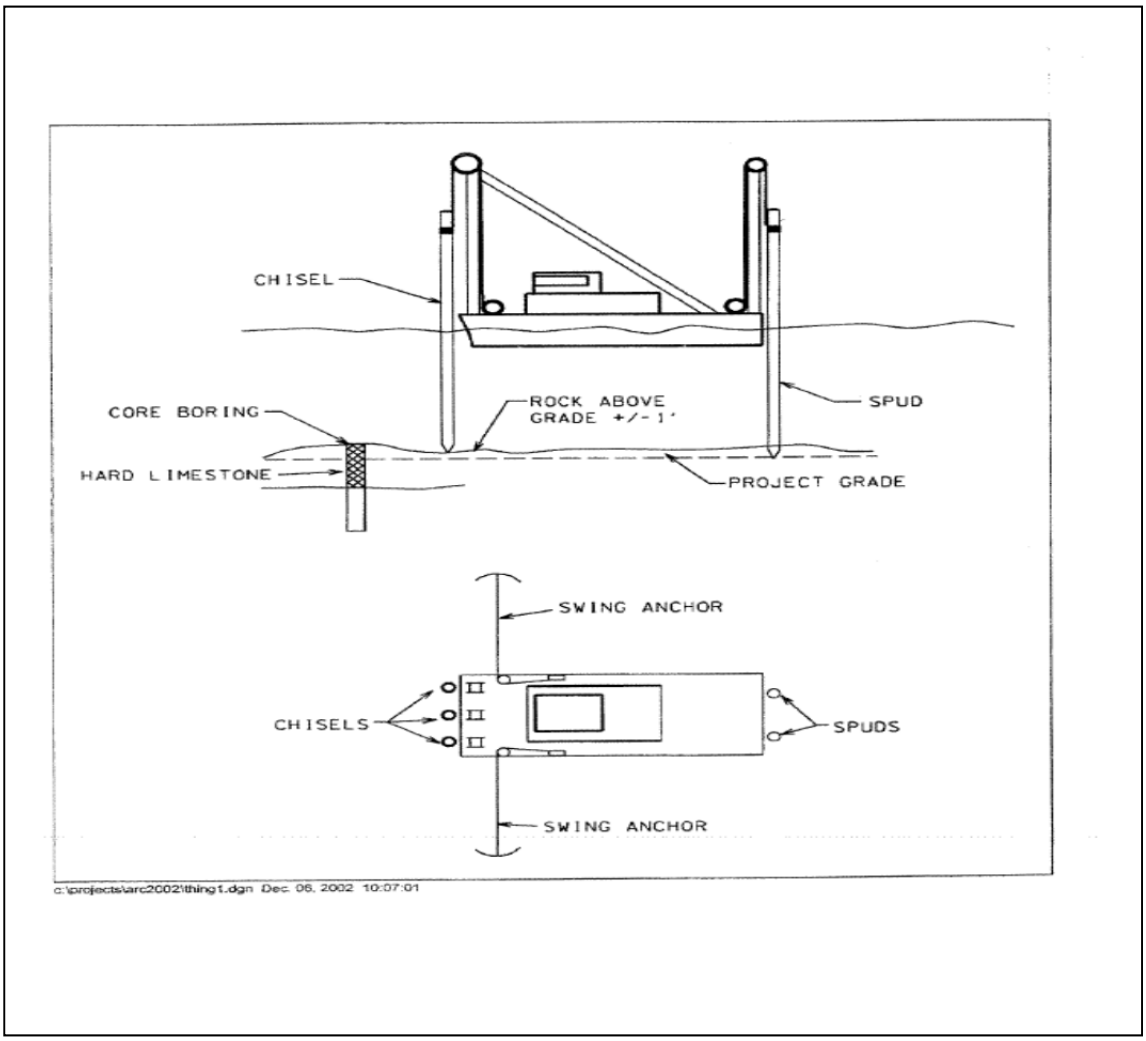


Figure 27 Drawing of a Typical Punch Barge Configuration

2.9.3.2 Confined Underwater Blasting

2.9.3.2.1 Locations

To achieve the deepening of Port Everglades from the existing depth of -45 feet to project depth of -57 feet (authorized depth of -48 feet), pretreatment of some of the rock areas may be required. The use of confined underwater blasting as a pre-treatment technique is anticipated to be required for some of the deepening and widening of the authorized federal project, where standard construction methods are unsuccessful due to the hardness of the rock. The term "confined" indicates that the explosive shots would be "confined" in the rock, and not in the water column. USACE has used three criteria to determine which areas are most likely to need blasting for the Port Everglades expansion (these criteria are taken from the Engineering Appendix of the Feasibility Study):

1. Areas documented by core borings to contain hard massive rock.
2. Areas of frequent punch barge attempts in the 1980's deepening.
3. Areas of low production in the 1980's deepening.

The following analysis of potential blasting needs for the current project performed by the USACE Engineering Division staff is based on evaluations of core boring logs, punch barge usage, and production rates of previous deepening projects at the Port. Areas currently identified as having the hardest rock and most likely in need of blasting prior to dredging are the main, south, and north turning basins. A significant quantity of rock will require blasting; approximately 40-50% of the material in these areas is hard rock (Table A-13, Section 3.7.2, Engineering Appendix of the Feasibility Study). In general there is a wide ridge of hard massive rock that extends in a north-south direction from the north harbor extension, through the center of the harbor, and through the south harbor extension. There may also be some smaller patches of hard rock in the OEC that may require blasting for pre-treatment as well (see Table 22 or the Feasibility Study).

Information regarding the possibility of blasting in other areas of the project footprint is evaluated in the Engineering Appendix (Section 3.7.2) of the Feasibility Study. Text therein notes that blasting was used to aid in the original excavation of the SAC. However, blasting was not needed *due to the rock characteristics* but, rather to allow the contractor to deepen the channel using available dredging equipment. Based on the historic core borings drilled along the SAC, it appears that the materials can be dredged in the future deepening of the channel by using a rock cutter/suction hydraulic dredge. It is possible that harder, more massive rock could be encountered at lower elevations that would require blasting for economic and environmental (i.e., use of other methods could cause additional disturbance/damage) reasons.

2.9.3.2.2 Methods

Rock is usually treated using confined blasting at several positions for each effort. Typically, each blast array is set up in a square or rectangle area divided into rows and columns (Figures 28 & 29). An average blast array is 10 holes long by 4 holes wide with holes being spaced 40 feet apart, covering an area of 4,000 ft^2. Blast arrays near bulkheads can be long-linear feature of one-hole wide by 8 or 10 holes long (Figure 30).

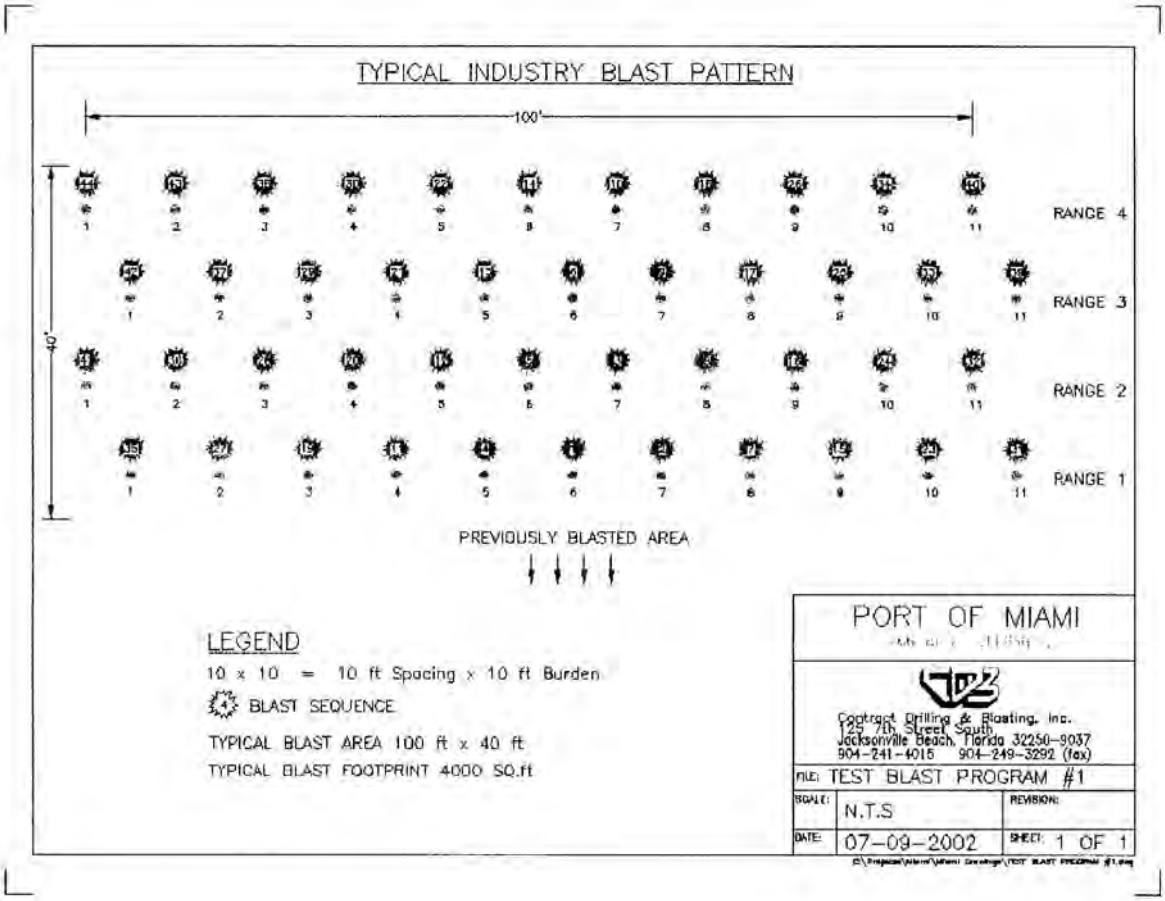


Figure 28 Typical Blast Array Planview

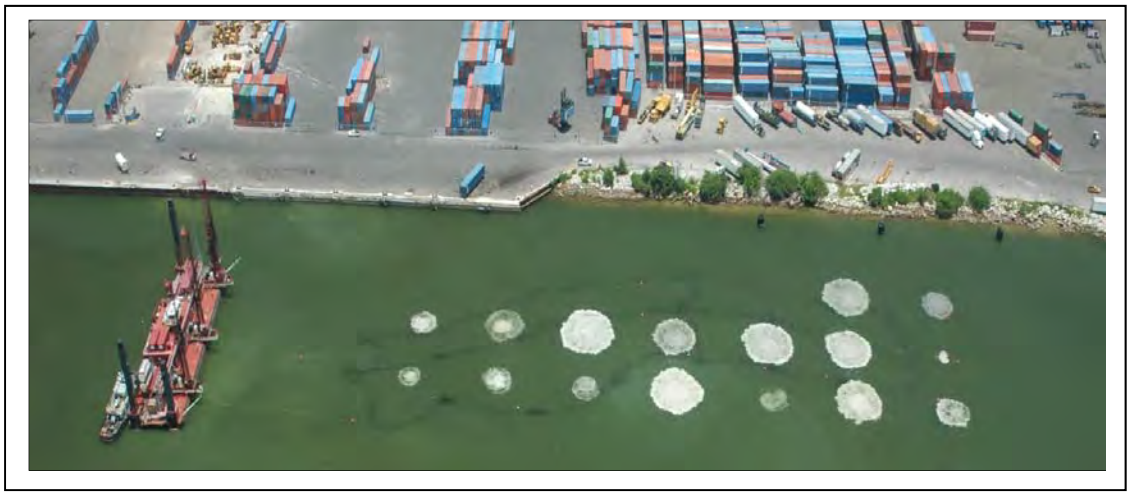


Figure 29 Typical rectangular blast array- water surface signature

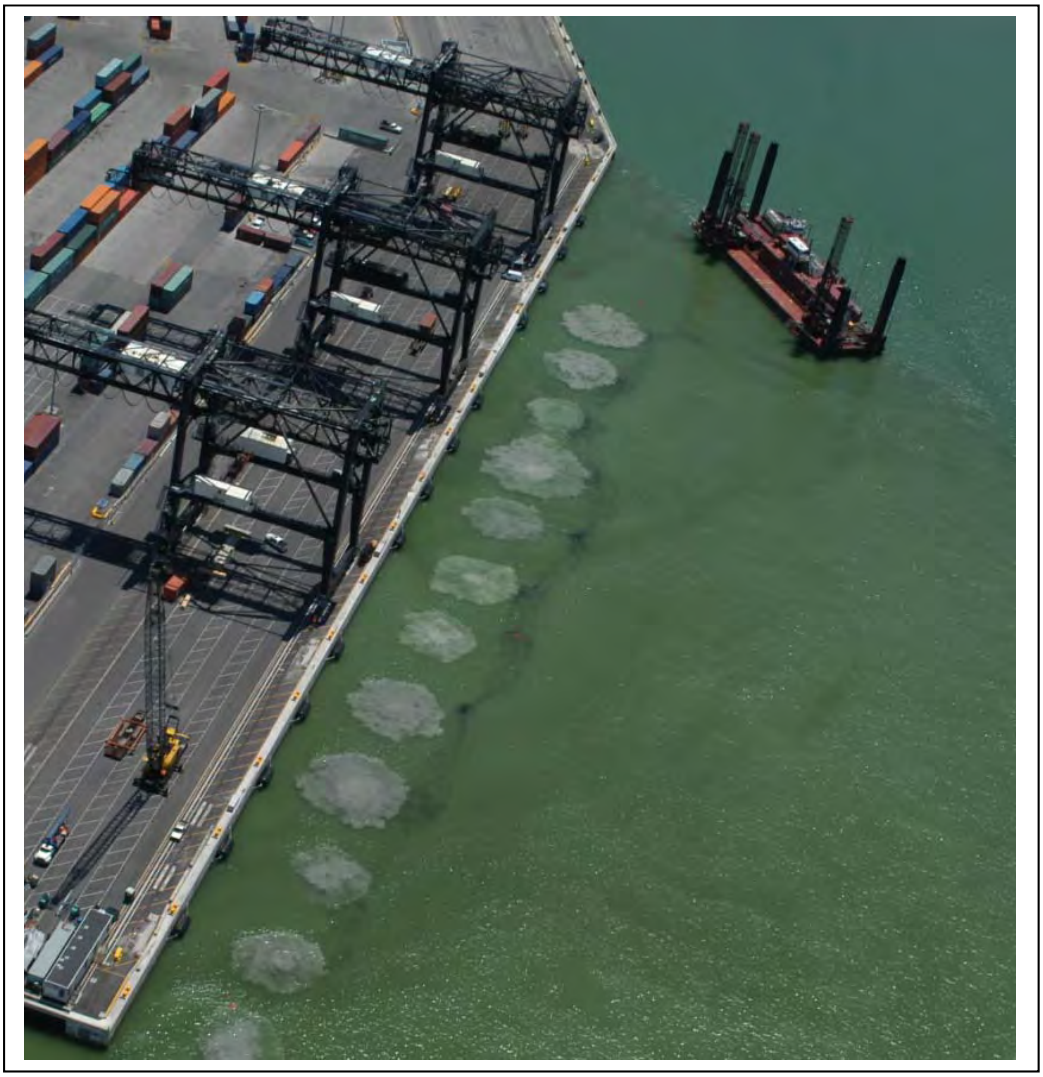


Figure 30 Linear blast array along a bulkhead

Charge weight and size of array are dependent upon the size and type of dredging equipment each contractor proposes to include in their contract bid. There is an inverse relationship between dredging equipment size (cutterhead size, horsepower behind the cutterhead, backhoe size) and the frequency, size and spacing of drill holes of individual detonation events. As the size of the equipment increases, the size and number of detonations decreases and the spacing between the individual holes increases. Since USACE does not have construction bids and specifications at this time, it is assuming that any area that meets the three previously stated criteria (above) will require blasting.

In addition to confining each blast in the rock, each blast may also be broken up into smaller sub-blasts by a time delay, referred to as a “delay”. A delay (usually measured in milliseconds) that breaks up a larger blast into small component blasts. If enough time is put between the smaller components shots (no less than 8 milliseconds), the pressure intensity is also broken into smaller components that have less impact than the total shot weight, had it been fired all at once. These delays are then detonated in a pattern to allow the rock to be cracked in a certain order which assists in the pre-treatment of the harder rock. In Figure 31, the delays are numbered 1-8. Any holes labeled 1 will be fired first, followed by those numbered 2, then 3 and so on Figure 29 shows varying plume sizes that demonstrate time delays when detonating in performed in sequence.

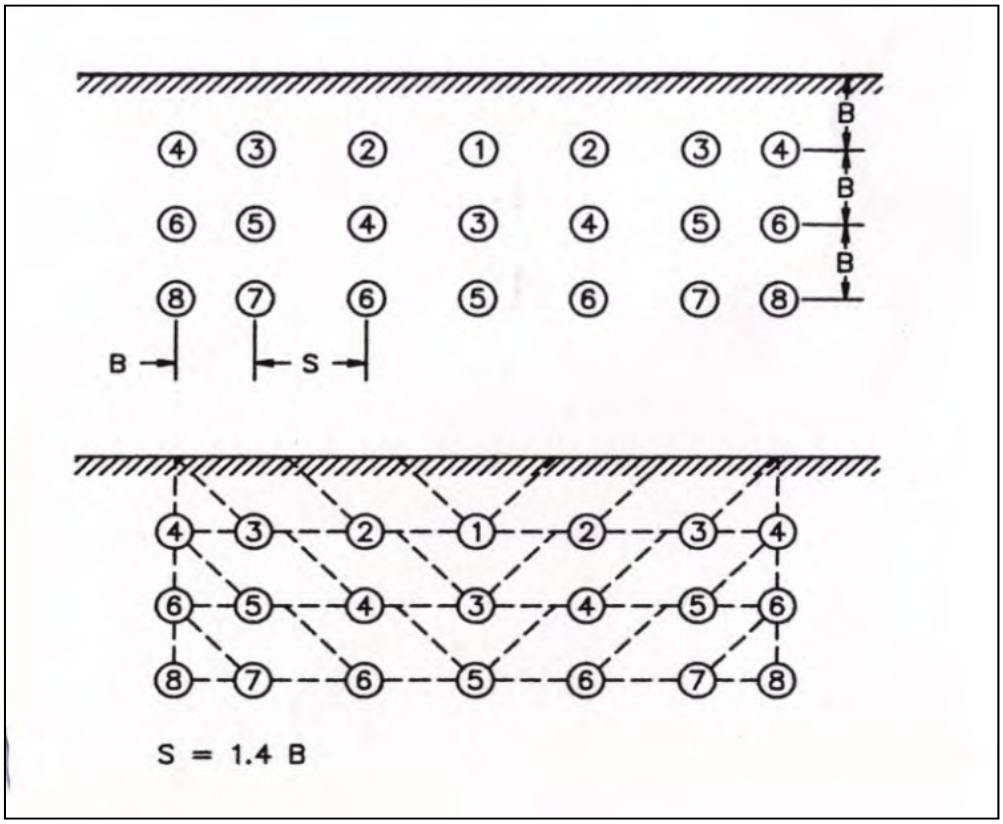


Figure 31 - Delay Pattern for a Blast Array

Regardless of pattern or timing for CU, each charge is placed in a hole drilled in the rock approximately 5-10 feet deep below the desired depth (see Figure 32) depending on how much rock needs to be broken and the intended project depth. The hole is then capped with an inert material, such as crushed rock (Figure 33: each bag as shown contains approximate volume of material used per discharge). This process is referred to as “stemming the hole.” The blasting charge is set and then the chain of explosives within the rock is detonated.

For the Port of Miami Phase II expansion in 2005, which used blasting as a pre-treatment technique, the stemming material was angular crushed rock. It is expected that the specifications for any construction utilizing blasting at Port Everglades would have similar stemming

requirements as those that were used for the Miami Harbor Phase II project. The optimum size of stemming material is material that has an average diameter of approximately 0.05 times the diameter of the blast hole. Material must be angular to perform properly (Konya 2003). For the USACE project, project-specific specification will be prepared by the geotechnical branch of the District. In the Miami Harbor Phase II project, the following requirements were in the specifications regarding stemming material:

> "*1.22.9.20 Stemming.* All blast holes shall be stemmed. The Blaster or Blasting Specialist shall determine the thickness of stemming using blasting industry conventional stemming calculation. The minimum stemming shall be 2 feet thick. Stemming shall be placed in the blast hole in a zone encompassed by competent rock. Measures shall be taken to prevent bridging of explosive materials and stemming within the hole. Stemming shall be clean, angular to subangular, hard stone chips without fines having an approximate diameter of 1/2-inch to 3/8-inch. A barrier shall be placed between the stemming and explosive product, if necessary, to prevent the stemming from settling into the explosive product. Anything contradicting the effectiveness of stemming shall not extend through the stemming."

It is expected that the specifications for any construction utilizing blasting at Port Everglades would have similar stemming requirements as those that were used for the Miami Harbor Phase II project. The length of stemming material will vary based on the length of the hole drilled. However, minimum lengths will be included in the project specific specifications. Studies have shown that stemmed blasts have up to a 60-90% decrease in the strength of the pressure wave released, compared to open water blasts of the same charge weight (Nedwell and Thandavamoorthy, 1992; Hempen *et al*. 2005; Hempen *et al*. 2007). However, unlike open-water, i.e., unconfined blasts (Figure 34), very little peer-reviewed research exists on the effects that confined blasting can have on marine animals near the blast (Keevin *et al*. 1999). The visual evidence from a typical confined blast is shown in Figure 35.

To estimate the maximum poundage of explosives that may be utilized for this project, USACE has reviewed two previous blasting projects, one at San Juan Harbor, Puerto Rico in 1994 and one at Miami Harbor in 2005. The San Juan Harbor project's heaviest delay was 375 lbs per delay (i.e., the time interval provided by blasting caps which permits firing of bore holes in sequence) and in Miami it was 376 lbs per delay. Based on discussions with USACE's geotechnical engineers, it is expected that the maximum weight of delays for Port Everglades will be larger since the rock is much harder than what is seen at the Port of Miami. It is unknown at this time what the maximum delay weight will be for Port Everglades. This will be determined during the test blast program.

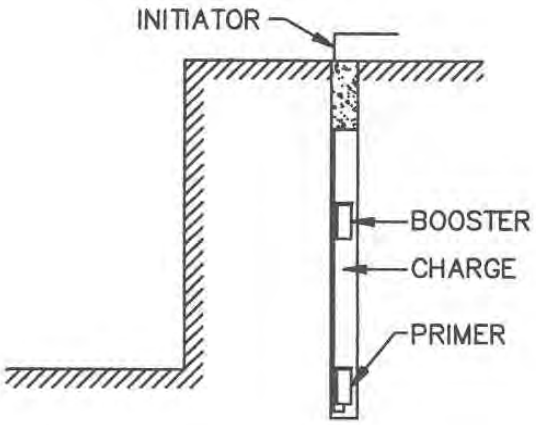


Figure 32 Typical Stemmed Hole for Loading Charges

Figure 33 Stemming Material

Figure 34 Unconfined Blast of Seven Pounds of Explosives

Figure 35 Confined Blast of 3,000 Pounds of Explosives

2.9.3.2.3 Minimization of Confined Blasting Impacts to Fish and Wildlife

Blast specifications. Although the rock at Port Everglades is believed to be harder than Miami or San Juan Harbors, as noted above, USACE biologists, working with senior geologists, concluded that the assumptions set forth concerning minimization of the effects of blasting are applicable and accurate for the Port Everglades project. To that effect, based upon industry standards and USACE Safety & Health Regulations, the blasting program may consist of the following:

1) The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock.
2) Drill patterns are restricted to a minimum of 8-foot separation from a loaded hole.
3) Hours of blasting are restricted from two hours after sunrise to one hour before sunset to allow for adequate observation of the project area for protected species.
4) Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.
5) Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.
6) The blast design will consider matching the energy in the "work effort" of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.
7) Delay timing adjustments to a minimum of 8 milliseconds (ms) between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water.

Safety radii. The confined underwater blasting program will incorporate the use of three safety radii (Figure 36) typically utilized for projects involving unconfined blasts. This conservative use of an *unconfined* blast in development of the safety radii for a *confined* blast will increase the protections afforded marine species in the area. These three zones are referred to as the "Danger zone" – which is the inner most zone, located closest to the blast; the "Safety zone" – which is the middle zone and the "Watch zone" the outer most zone.

The danger zone radius will be calculated to determine the maximum distance from the blast at which mortality to protected marine species is likely to occur. The danger zone is determined by the amount of explosives used within each delay (which can contain multiple boreholes). These calculations are based on impacts to terrestrial animals in water when exposed to a detonation suspended in the water column (unconfined blast) as researched by the U.S. Navy in the 1970s (Yelverton *et al*. 1973; Richmond *et al.* 1973) as well as observations of sea turtle injury and mortality associated with unconfined blasts for the cutting of oil rig structures in the Gulf of Mexico (Young 1991; O'Keefe and Young 1994). The reduction of impact by confining the shots would more than compensate for the presumed higher sensitivity of marine species. USACE believes that the danger zone radius, coupled with a strong protected species observation and protection plan is a conservative, but prudent, approach to the protection of marine wildlife species. Based on a review by NMFS-OPR for the Miami Harbor phase II project, NMFS and USFWS found these protective measures sufficient to protect marine mammals under their respective jurisdictions (NMFS 2005c, USFWS 2002, NMFS 2011).

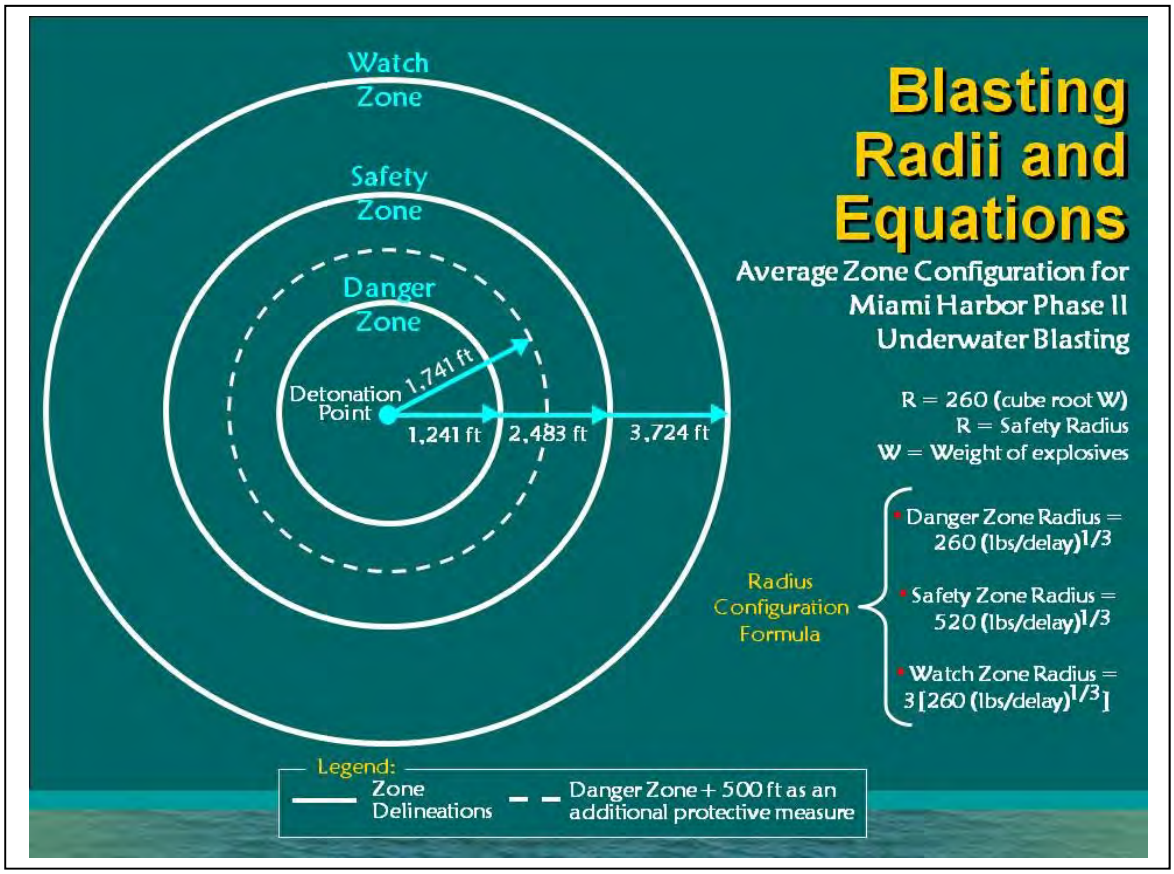


Figure 36 Confined Underwater Blast Zone Radii and Equations from Miami Harbor Expansion Project

These zone calculations will be included as part of the specifications package that the contractors will bid on before the project is awarded. Ideally the safety radius should be large enough to offer a wide buffer of protection for marine animals while still remaining small enough that the area can be intensely surveyed.

Radii specifications are as follows:

1) Danger Zone (NMFS refers to this as the Caution Zone and is equivalent to Level A harassment as defined in the MMPA): The radius in feet from the detonation beyond which no expected mortality or injury from an open water explosion is likely to occur (NMFS 2005c). The danger zone (ft) = 260 [79.25 m] X the cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

2) The Safety Zone is the approximate distance in feet beyond which injury is unlikely to occur from an open water explosion (NMFS 2005c). The safety zone (ft) = 520 [158.50 m] X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

3) The Watch Zone is three times the radius of the Danger Zone to ensure that animals entering or near the Exclusion Zone are spotted and appropriate actions can be implemented before or as they enter any impact areas (i.e., a delay in blasting activities).

4) Exclusion Zone extends to 500 feet outside the Danger Zone radius. Detonation will not occur if a marine mammal or reptile may be within that zone (based on observational data).

Because of the potential duration of the blasting and the proximity of the inshore blasting to a seasonal manatee high use area (Port Everglades FP&L discharge canal), a number of issues will need to be addressed. Due to the likelihood of a large number of manatees in the area during the winter months, USACE has agreed as part of the ESA consultation with USFWS not to blast between November 15 and March 15 of each year. Other dredging and construction activities may take place inside the Port during this period of time, but confined underwater (CU) blasting will not be utilized during this period.

It is crucial to balance the demands of the blasting operations with the overall safety of protected species in the project area. A radius that is excessively large will result in significant delays that prolong the blasting, construction, traffic, and overall disturbance to the area. A radius that is too small puts the animals at too great of a risk should one go undetected by the observers and move into the blast area. Because of these factors, the goal is to establish the smallest radius possible without compromising animal safety and provide adequate observer coverage for whatever radius is agreed upon.

Monitoring/watch plan. A watch plan will be formulated based on the required monitoring radii and optimal observation locations. The watch plan will be consistent with the program that was utilized successfully at Miami Harbor in 2005 and will consist of at least five observers including at least one aerial observer, two boat-based observers, and two observers stationed on the drill barge. A sixth observer will be placed in the most optimal observation location (boat, barge, fixed structure, shore, or aircraft) on a day-by-day basis depending on the location of the blast and the placement of dredging equipment, as determined by the blaster in charge and the chief protected species observer. This process will insure complete coverage of the three zones as well as any critical areas. The watch will begin at least one-hour prior to each blast and continue for one-half hour after each blast (Jordan *et al*. 2007).

Data provided by Broward County Aviation Department on June 22, 2004 indicated that there do not appear to be flight path/altitude conflicts with a helicopter hovering 300-400 feet from the water surface in the MTB/upper SAC. Specific flight and observation plans will be coordinated with the FAA and Broward County Aviation Department to determine if aerial overflights are authorized throughout the entire project area due to the Port's proximity to Fort Lauderdale/Hollywood International Airport (FLL). If any conflicts develop due to the proximity of FLL to the Port that would prevent overflights of specific areas of the project that have been determined to require blasting, alternative monitoring methodologies will be investigated and

coordinated with the resource agencies with jurisdiction for those issues. During the blasting conducted at Port Everglades in 1981, boat-based manatee surveys were conducted using a color fish-finder which resulted in detecting two additional manatees that were not located by aerial observers.

Fish repulsion. In the past, to reduce the potential for fish to be injured or killed by the blasting, USACE has allowed, and the resource agencies have requested, that blasting contractors utilize a small, unconfined explosive charge, usually a 1-lb booster, detonated about 30 seconds before the main blast to drive fish away from a blasting zone. It is assumed that noise or pressure generated by the small charge will drive fish from the immediate area, thereby reducing impacts from the larger and potentially more-damaging blast. Blasting companies use this method as a "good faith effort" to reduce potential impacts to aquatic resources. The explosives industry recommends firing a "warning shot" to frighten fish out of the area before seismic exploration work is begun (Anonymous 1978 *cited in* Keevin and Hempen 1997).

There is limited data available on the effectiveness of fish scare charges at actually reducing the magnitude of fish kills and the effectiveness may be based on the fish's life history. Some states require the use of fish scares (Illinois, New Jersey and Washington) while others (Alaska and Texas) have determined that they are ineffective and "potentially harmful to piscivorous fishes, marine mammals and birds which are attracted to feed on fish that are stunned or wounded by the repelling charge." Florida does not have a regulation specific to the use of scare charges associated with blasting (Lisa Gregg, Florida FWC, pers. com., August 5, 2011), but FWC has requested the use of scare charges associated with previous projects that utilized blasting like the 2005 blasting at Miami Harbor. Numerous incidental observations (cited in Keevin *et al.* 1997) during blasting operation suggest that these charges are not effective in scaring fish from the blasting zone.

Keevin *et al.* (1997) conducted a study to test if fish scare charges are effective in moving fishes away from blast zones. They used three freshwater species, largemouth bass; channel catfish and flathead catfish, equipping each fish with an internal radio tag to allow the fishes movements before and after the scare charge to be tracked. Fish movement was compared with a predicted LD 0% mortality distance for an open water shot (no confinement) for a variety of charge weights. Largemouth bass showed little response to repelling charges and none would have moved from the kill zone calculated for any explosive size. Only one of the flathead catfish and two of the channel catfish would have moved to a safe distance for any blast. This means that only 11% of the fish used in the study would have survived the blasts.

These results call into question the true effectiveness of this minimization methodology. However, some argue that based on the monetary value of fish (American Fishery Society 1992 in Keevin *et al.* 1997) including high value commercial or recreational species like snook and tarpon found in southeast Florida inlets like Port Everglades, the low cost associated with repelling charge use would be offset if only a few fish were moved from the kill zone (Keevin *et al*. 1997).

Protocol. A blast-day (or blast-event) is made up of all the actions during a blast from the Notice to Project Team and Local Authorities two hours before the blast is detonated through the end of the protected species watch 30 minutes after the blast detonation. The typical events in a blast-event are:

Typical Blast Timeline:

- T minus 2 HOURS - Notice to Project Team and Local Authorities
- T minus 1 HOUR - Protected Species Watch Begins

- T minutes 15 MINUTES - Notice to Mariners (channel closes)
- T minus 1 MINUTE - Fish Scare
- Blast detonation
- T plus 5 MINUTES - All Clear Signal
- T plus 30 MINUTES - Protected Species Watch Ends
- DELAY CAPSULE (can occur between T - 1 hour and detonation): If an animal is observed in either the danger or safety zones, the blast is delayed to monitor the animal until it leaves, on its own, from both the danger and safety zones

This timeframe lasts a minimum of two hours and 35 minutes, although it can be extended if a protected species (like a dolphin, manatee, or turtle) enters the exclusion zone. The animal is monitored until it leaves, on its own, from both the danger and exclusion zones. There can be more than one blast-day (blast event) in a calendar day, although two is typically the maximum for each drill barge used during construction.

2.9.3.2.4 Vibration and Pressure Monitoring

Vibration. In an urban environment such as the Port, which is surrounded by commercial properties, utilities, and residential communities, protection of structures must be considered. Once the areas of the project requiring blasting have been identified, critical structures within the blast zones would be determined. Where vibration damage may occur, energy ratios and peak particle velocities shall be limited in accordance with state or county requirements, whichever is more stringent. Furthermore, vibration-monitoring devices will be installed to ensure that established vibration limits are not exceeded. If the energy ratio or peak particle velocity limits are exceeded, blasting will be stopped until the probable cause has been determined and corrective measures taken. Critical monitoring locations may include structures such as bulkheads, hazardous materials storage areas, and buried utilities.

Ground-borne vibration can be generated by a number of sources, including road and railways, construction activities such as piling, blasting, and tunneling. Vibration can be defined as regularly repeated movement of a physical object about a fixed point. The parameter normally used to assess the ground vibration is the peak particle velocity (PPV) expressed in millimeters per second (mm/s). In order to completely define ground vibration, the amplitude and frequency of the motion are measured in the three orthogonal directions generally in terms of velocity which is considered to be the best descriptor for assessing human comfort and the potential damage response of structures. The vibration velocity signals are summed (in real time) and the maximum amplitude of this vector sum is defined as the Peak Vector Sum (PVS). Vibration can cause varying degrees of damage in buildings and affect vibration-sensitive machinery or equipment. Its effect on people may be to cause disturbance or annoyance or, at higher levels, to affect a person's ability to work.

USACE reviewed data from the two most recent blasting projects completed by the district: the deepening of San Juan Harbor in 2000 and of Miami Harbor in 2005. Both used confined underwater blasting. Both projects had significant structural resources located near the blast that were of concern (the San Juan site included the National Park Service's Castillo San Felipe del Morro, a 400+ year old fortress overlooking the harbor and 30 additional historic sites within boundaries of the National Monument). In Miami, the harbor is bounded on the north by the port facilities and on the south by Fisher Island, a residential island. For both areas, a network of monitoring locations was established by the blasting contractor to capture vibration associated with the detonation of each blast. Additionally, at El Morro, the contractor installed monitoring devices on each crack in the stucco that covers the structure's interior walls, and a photo was

taken after installation to serve as a pre-construction baseline. During construction, the crack was monitored throughout the blasting project to ensure that crack's width or length had not increased (Figure 37).

At Miami the maximum PVS allowed for the project was 1.0 mm/s. The average maximum PVS for the Miami Harbor deepening in 2005 was 0.3828mm/s with a range of 0.0819mm/s - 1.08mm/s during the 40 blast detonations. During both projects, no adverse impacts were reported to any of the surrounding structures by either the vibration monitoring contractor, or the building's owners/trustees.

Air Pressure. The USACE Safety and Health Requirements Manual (EM 385-1-1 3, September 1996) limits of "air blast pressure exerted on structures resulting from blasting shall not exceed 133 dB (0.013 psi)" and industry standard vibration limitations would be incorporated into the design process. A conservative regression analysis of similar projects may be used to develop the design and then continually updated with calibration of the environment. The contractor will also be required to abide by state and local blasting requirements in addition to the USACE Safety Manual previously referenced in this paragraph.

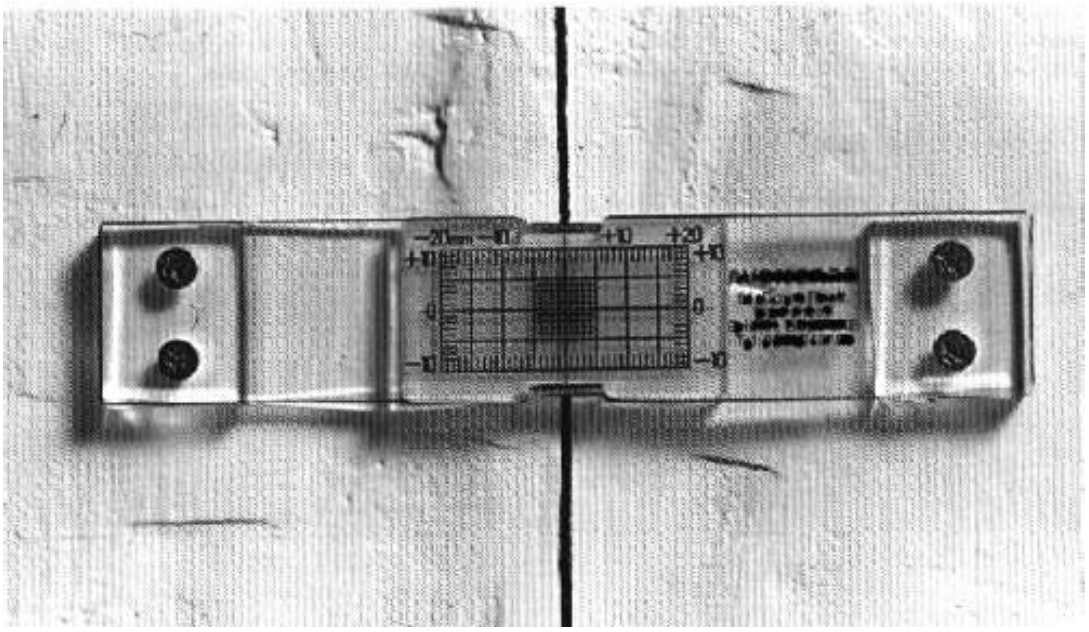


Figure 37 Typical Crack Monitor Device

2.9.3.2.5 Duration and Schedule of Confined Blasting

The duration of the blasting (pre-treatment) is dependent upon a number of factors including hardness of rock, how close the drill holes are placed, and the type of equipment that will be used to remove the pre-treated rock. For comparison, the harbor deepening project at Miami Harbor in 2005-2006 estimated between 200-250 days of blasting with one-shot per day (a blast-day) to pre-treat the rock associated with that project. However, the contractor completed the project in 38 days with 40 blasts. Plans for the ongoing expansion at Miami Harbor (initiated November 2013) currently include up to 600 blast-days for the entire project footprint. However, no blasting has been required in the outer entrance channel to date, significantly reducing the estimated amount of blasting. Using both Miami projects as a guide, and recognizing that approximately 50% of the project footprint has been identified as possibly needing pre-treatment, USACE estimates between 300-400 blast-days for the Port Everglades project among the total, approximate 1,100-day uninterrupted construction interval. This estimate is subject to change based on more detailed geotechnical analysis during the preconstruction, engineering and design (PE&D) phase of the project.

Blasting operations will take place 24-hours a day, typically six days a week. The contractor may drill the blast array at night and then blast after at least two hours after sunrise (1-hour, plus one-hour of monitoring). After detonation of the first array, a second array may be drilled and detonated before the one-hour before sunset prohibition is triggered. Blasting activities normally will not take place on Sundays due to local ordinances.

2.9.3.2.6 Adaptive Improvement of Blasting Specifications and Methods

Test Blast Program. Prior to implementing a construction blasting program, a test blast program will be completed. The test blast program will have all the same protection measures in place for protected species monitoring as if blasting for construction purposes. The purpose of the test blast program is to demonstrate and/or confirm the following:

- drill boat capabilities and production rates
- ideal drill pattern for typical boreholes
- acceptable rock breakage for excavation
- tolerable vibration level emitted
- directional vibration
- calibration of the environment

The test blast program begins with a single range of individually delayed holes and progresses up to the maximum production blast intended for use. The test blast program will take place in the project area and will count toward the pre-treatment of material, since the blasts of the test blast program will be cracking rock. Each test blast is designed to establish limits of vibration and air blast overpressure, with acceptable rock breakage for excavation. The final test event simulates the maximum explosive detonation as to size, overlying water depth, charge configuration, charge separation, initiation methods, and loading conditions anticipated for the typical production blast.

The results of the test blast program will be formatted in a regression analysis with other pertinent information and conclusions reached. This will be the basis for developing a completely

engineered procedure for construction blasting plan. During the testing the following data will be used to develop a regression analysis:

- distance
- pounds per delay
- peak particle velocities (TVL)
- frequencies (TVL)
- peak vector sum
- air blast, overpressure

Fish Kill Monitoring. In addition to monitoring for protected marine mammals, sawfish, and reptiles in the area during blasting operations, USACE will work with the resource agencies to develop a monitoring plan for fish kills associated with each blasting event. This effort may be similar to the effort that was developed by FWC in association with the Port of Miami Phase II project, and is currently a requirement of the ongoing Miami Harbor deepening project. This plan will be developed in detail during the PE&D portion of the project, but may include collection, enumeration and identification of dead and injured fish floating on the surface after each blast. In addition, blast data will be collected from the daily blasting reports provided after each shot by the blasting contractor, as well as environmental data such as tidal currents (in-coming or out-going). Due to health and safety restrictions, all collections will be made from the surface only. No diving to recover fish carcasses is authorized.

Coordination. As part of the development of the protected species protection and observation protocols, which will be incorporated into the plans and specifications for the project, USACE will continue to coordinate with the resource agencies (specifically BCEPD, NMFS, FWC, USFWS and USEPA) to address concerns and potential impacts associated with the use of blasting as a construction technique.

Study Data. In addition to coordination with the agencies, findings from any new scientific studies regarding the effects of blasting (confined or unconfined) on species that may be in the area (marine mammals, sea turtles, fishes (both with a swim bladder and without) and reptiles will be incorporated into the design of the protection measures that will be employed in association with confined blasting activities in the Port. Examples of these studies may include the following:

- “Caged Fish Study”. As part of the August 1 & 2, 2006 After Action Review conducted for the Miami Harbor Phase II dredging project, which included blasting as a construction technique, USACE, in partnership with FWC, committed to conduct a study on the effects of blast pressures on finfishes with air bladders in close proximity to the blast. This study would attempt to answer the questions regarding proximity to the blast array, injury and death associated with confined blasting not resolved with research conducted with the Wilmington Harbor blasting conducted in 1999 (Moser 1999a and Moser 1999b). This study is expected to be completed as part of the Miami Harbor 2013-2015 dredging project.
- Other blasting project monitoring reports for projects, both from inside and outside of Florida using confined underwater blasting as a construction technique completed prior to development of plans and specifications.

2.9.3.2.7 Conclusion

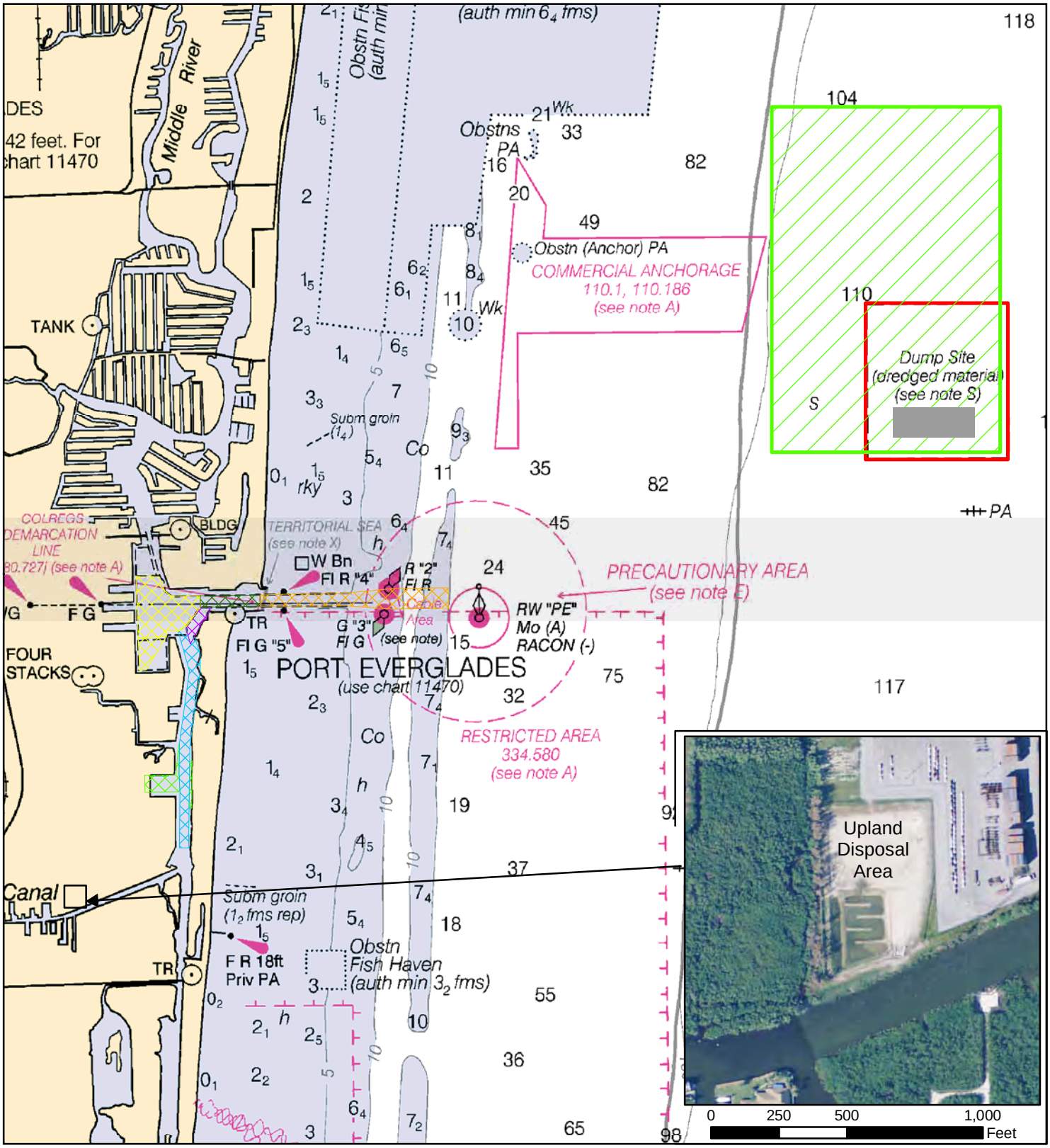
USACE has concluded that confined blasting is the *least* environmentally impactful method for pre-treatment of hard, consolidated rock in the Port. Each blast will last no longer than 15 seconds in duration, and may even be as short as two seconds. Additionally, the blasts are confined in the rock substrate with stemming. Because the blasts are confined within the rock structure, the distance of the blast effects are reduced significantly as compared to an unconfined blast (Nedwell and Thandavamoorthy 1992; Hempen *et al*. 2005; Hempen *et al*. 2007).

2.9.4 Disposal of Removed Materials

With the exception of dredged rock that may be used for construction of the offshore reef mitigation site (if such a plan becomes finalized), the ODMDS (Figure 38) designated by USEPA (on 18 January 2005) is the preferred dredged material disposal location for this project. However, the ODMDS requires expansion by USEPA and is currently undergoing the expansion process, as detailed in Section 1.8 above. USEPA completed a post-disposal monitoring event in 2014 following the most recent operation and maintenance (O&M) dredging event. When available, conclusions from the monitoring event report will help determine if the disposal site is sufficient to contain all material within the existing boundaries or if a site expansion is needed to accommodate post-project operation and maintenance (O&M) dredging material.

All of the material dredged from the project area is expected to be suitable for disposal at the ODMDS. Dredged material which does not meet the EPA dredged material disposal criteria will be placed in an existing upland disposal site located on port property (inset, Figure 38). This site has previously been used by the port when (1) the amount of material which was dredged made it not economically feasible to transport the material to the ODMDS, or (2) the material that has not met EPA criteria for ocean disposal. The site was constructed in 2011 by the Florida Inland Navigation District (FIND) and is designed to treat the associated runoff water and process/dry the material for offsite transport/disposal. The capacity is approximately 20,000 cy, but it was permitted and designed for continuous material flow-through. The only project for which the site was used to date was the FIND DCC project in 2011-2013. In that case, the disposal site was used to process just over 100,000 cubic yards, in addition to 4,500 cy from port berth maintenance. If additional upland capacity is required for non-ODMDS suitable material, USACE will locate an additional upland site and/or utilize an available landfill site.

If a mechanical dredge is used for the project, larger rock material may be recovered and segregated at the construction site for use in constructing the artificial reef portion of the hardbottom mitigation sites. Larger rock material would be placed on one barge to be transported to the artificial reef mitigation site, while other materials would be placed on a separate barge/scow for placement at the ODMDS. The rock to be used at mitigation sites would be clean and free of debris, and be of sufficient size to prevent it from becoming mobile during a 50-year storm, as recommended by the FWC's artificial reef criteria.



Legend

- Disposal Release Zone
- Existing ODMDS
- Recommended Expansion

0 0.5 1 2 Miles

Ocean and Upland Disposal Site Locations	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1 mile	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 38

The type of dredge(s) used will affect methods used to convey the material to the disposal sites. Split hull or similar barges will most likely be used for delivering dredged material to the ODMDS. To minimize potential impacts to adjacent hardbottom and reef habitats associated with transport of material to the ODMDS, vessels transiting to and from the ODMDS and any artificial reef construction locations will be restricted to staying inside the marked federal navigation channel.

None of the dredged material is expected to comprise beach-quality sand (based on geotechnical analysis) that could be used for renourishment of down-drift beaches, as previously evaluated in the Environmental Assessment for Maintenance Dredging of Port Everglades (USACE 2005).

2.9.5 Other Construction Details

Environmentally Friendly Bulkheads.

In consultation with staff from NMFS, USEPA, and USFWS early in project evaluation between 1999 and 2001, USACE discussed the concept of an "environmentally friendly bulkhead" (EFB) to be used in certain portions of the project where the improved channel would be adjacent to sensitive resources. This type of bulkhead will be constructed of steel sheet-pile below the surface of the substrate and rip-rap from the substrate surface to the surface of the water, and would look, at the surface, very similar to the rip-rap areas currently protecting the mangroves along the IWW at JUL (Figure 39). The rip-rap would allow sufficient water to pass through the rocks to continue flushing of mangroves located behind them and allow juvenile fishes access to the mangroves. Notches in the rip rap, similar to those at the JUL mangrove areas, may also be able to be installed to allow greater flushing and subsequent access by juvenile fishes (Figure 40). Installation would most likely be from waterborne barges to protect the resources along the shoreline. Proposed locations for these EFBs are shown in Figure 41, which shows 3,300 linear feet of EFB associated with the SAC and 2,970 linear feet associated with the TN (combined east and west sides of the SAC in the vicinity of the notch), which indicated approximately 7,670 linear feet of such new bulkheads. The bulkhead along the northern edge of the TN will be constructed by the Port as part of their proposed expansion of the TN. As currently proposed, the bulkheads stop across from berth 29, and then begin again just north of the TN until berth 31. This gap may be removed during the PE&D phase if constructability dictates a continuous structure. More details on construction techniques for bulkheads can be found in Section 3.8.3 of the Engineering Appendix of the Feasibility Study.

In order to construct the steel sheet-pile bulkheads, pile-driving equipment will be required. Bulkheads along the SAC will require piles to be driven from a barge in the channel. The steel sheet-pile bulkheads will have to be driven into rock. In order to drive the steel sheet-pile bulkheads to their proper tip elevations, it is anticipated that pre-treatment of the rock will be required. Land-based construction equipment will not be used for installation because there is no access to the site at these locations for such equipment. Equipment staging will not be conducted within the park to avoid any impacts to park resources, infrastructure, and activities.

The bulkheads shall be installed prior to the channel excavation, which will prevent sloughing of materials into the channel via erosion) in those areas with significant resources located immediately adjacent to the channel, like the mangroves at JUL. Small gaps in the rip-rap will be placed to ensure sufficient flushing of the existing mangroves, as well as new mangrove recruitment behind rip-rap. This would also ensure access to these areas by juvenile fishes and larvae that utilize these mangroves as refugia and foraging habitat. In addition to these benefits, some bulkheads may be strategically placed to create "cells" along shore that encourage seagrass colonization (See Section 5.0 for details).

Figure 39 Existing Rip Rap Bulkhead Along John U Lloyd State Park

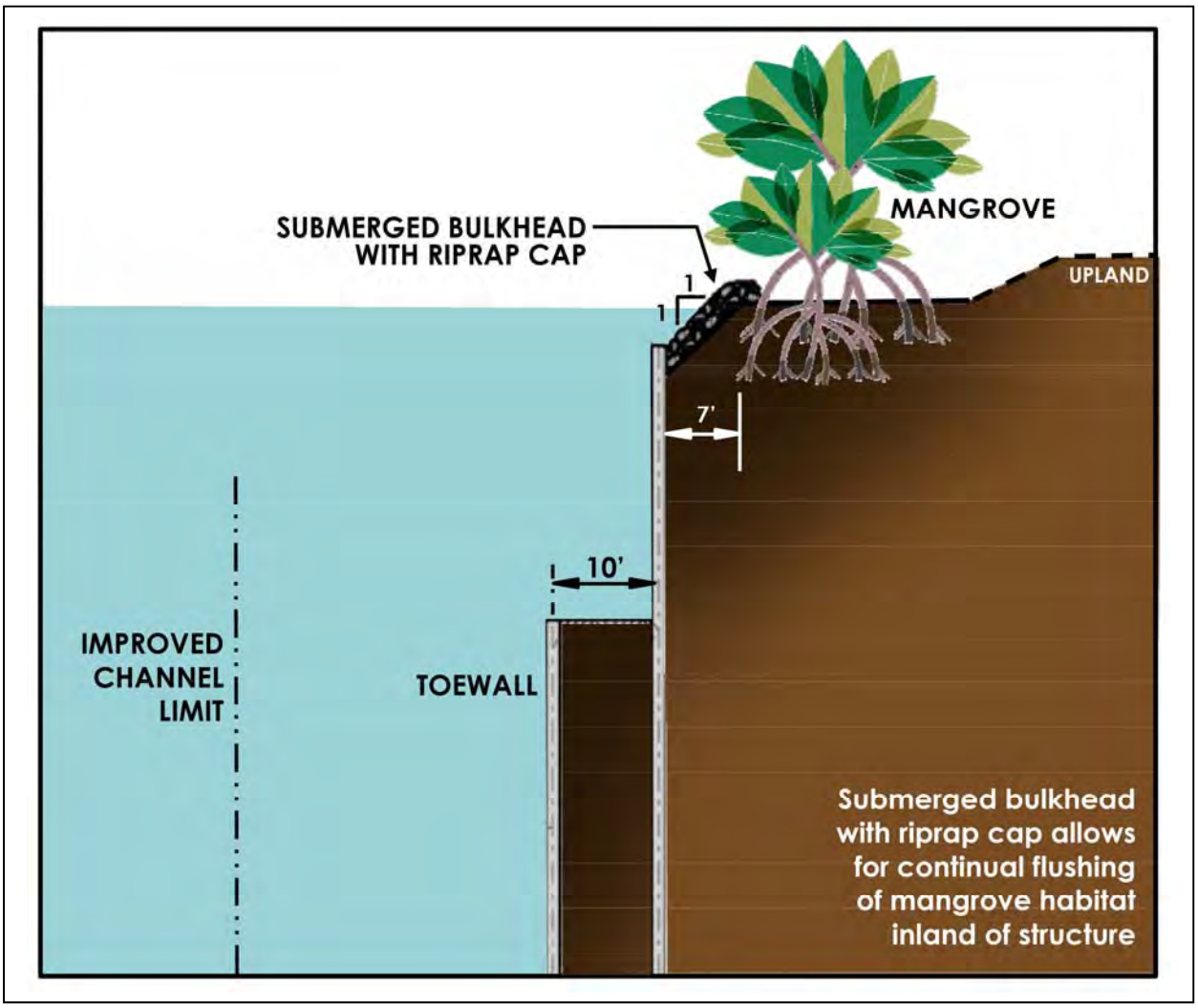


Figure 40 Typical cross section of an environmentally friendly bulkhead on the Southport Access Channel

Figure 41 Proposed positions of environmentally friendly bulkheads

Bulkheads at USCG Basin

The USCG Basin bulkheads (Figures 42 and 43) can be constructed with equipment from inside the basin and from the land side. The bulkheads for the new USCG Basin shall be in place prior to the basin being excavated to its final depth. Once the bulkheads are in place, the concrete cap and facing can be completed at all the locations. Monitoring for the presence of protected marine species (mammals, reptiles, and fishes) will also be a required component of this work.

Sideslope Excavation.

It is proposed that 2 (horizontal) to 1 (vertical) (i.e., 2:1) sideslopes would be dredged in those areas of the project where the resulting sloughing of the substrate would not adversely affect adjacent resources. Waterborne construction methods such as the use of a dredge (to cut the slope in a tiered fashion) may be employed. Land based methods may include the use of truck mounted or crawler cranes with a clamshell attached, use of a Gradeall, use of loaders or dozers, or similar equipment. The excavated material may be placed into barges, pumped to scows for transport to the ODMDS, or placed in trucks. Although not likely, the use of cofferdams or shoring may be employed.

Staging Areas.

It is the Port's responsibility to arrange for staging area(s) for the Contractor. The staging area(s) will have to be defined early in the plans and specification preparation phase for each contract. The Port will need to provide sufficient land for the Contractor to install construction trailers, park vehicles, and stage dredging and construction equipment. The staging area(s) must have navigable water access to allow the contractor to use work-boats to shuttle the crew to the dredge(s). Landside areas with mangroves will be rejected as proposed staging areas.

One or more mooring areas will need to be provided for the dredge(s). The Port has identified and previously utilized an area between Slips 2 and 3 for contractor staging. Slip 2 is the northern most of the three "cuts" on the west side of the MTB that contains berths 4-6. Slip 3 is the southern-most "cut" on the west side of the MTB that contains berths 12-15. Between each of the slips (1, 2, and 3) is dock.

Navigation Aids.

The USCG is responsible for providing and maintaining the proper number of navigational aids needed for day and night navigation of the federal project. Preliminary discussions with the USCG indicate that navigational aids may include, but are not limited to, two additional buoys in the OEC, two navigation lights in the Widener, and four navigation lights defining the turning basin at the juncture of the SAC.

Phasing of Construction.

The construction of the project will be phased to meet USACE and Port funding constraints. Details can be located in the main text of the Feasibility Study Report.

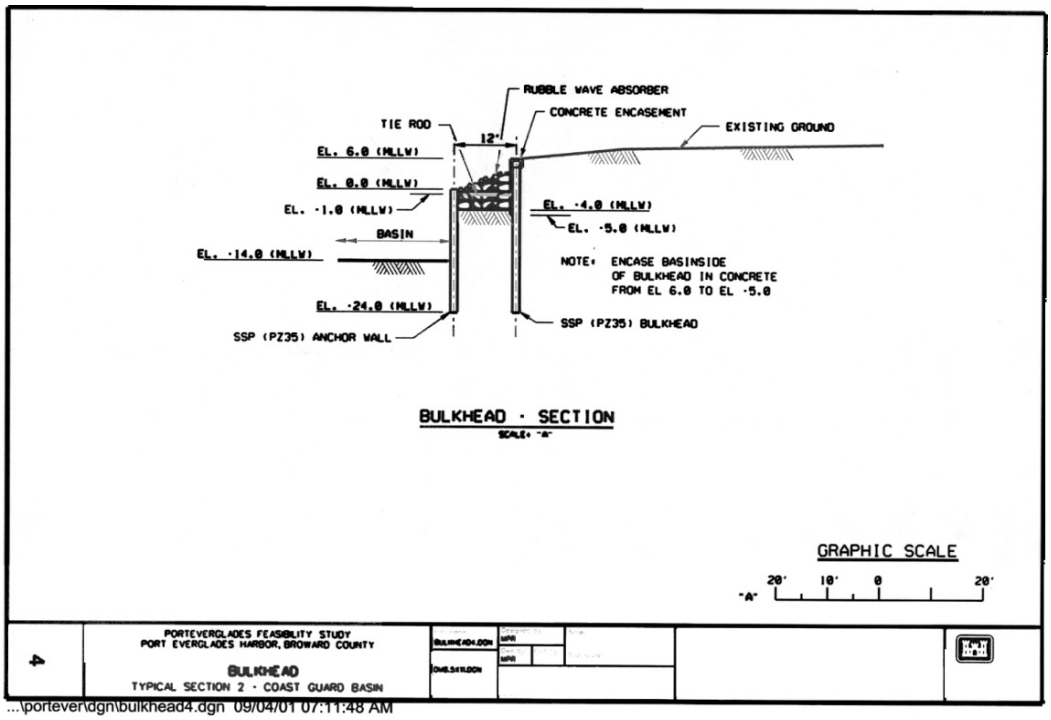


Figure 42 Cross-section of the bulkheads at the U.S. Coast Guard Station (1 of 2)

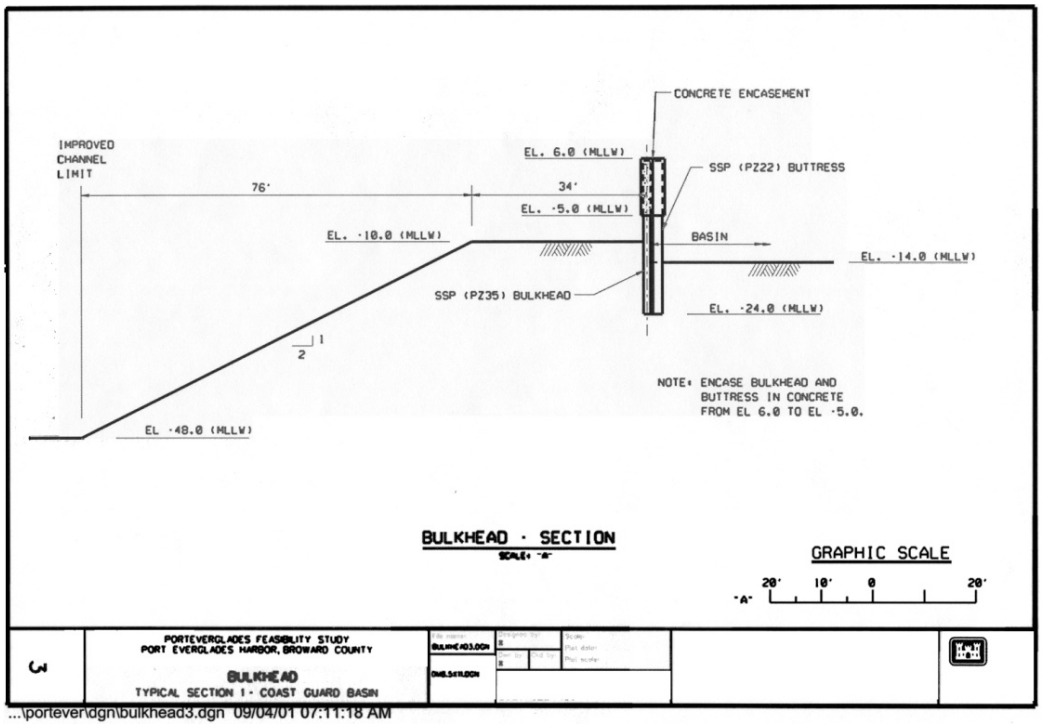


Figure 43 Cross-section of the bulkheads at the U.S. Coast Guard Station (2 of 2)

3.0 AFFECTED ENVIRONMENT

3.1 Geography

Port Everglades is situated on the southeast coast of Florida in the greater Fort Lauderdale area of Broward County, approximately 27 nautical miles north of Miami. The Port is positioned for immediate access to the Interstate Highway system, including I-595, I-95, I-75, US-1 and Florida's Turnpike system as well as to a continent-wide rail network through its proximity to the Florida East Coast Railway. Fort Lauderdale-Hollywood International Airport is located immediately adjacent to the Port.

3.2 Land Use

Broward County is the second most populous county in the State of Florida, with over 1.7 million citizens (U.S. Census Bureau 2011). Adjacent Miami-Dade County, to the south, is the most populous (over 2 million). Port Everglades lies within the urban, eastern section of Broward County. To the east of the Port is a barrier island that contains the U.S. Navy facility, the Nova Southeastern University Oceanographic Center (NSUOC), USCG Station Fort Lauderdale, and John U. Lloyd Beach State Park (JUL) and adjacent beaches. South of the DCC is an undeveloped coastal system encompassed by West Lake Park. West of the Port is Federal Highway (i.e., US 1), which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.

3.3 Coastal Environment

The climate at Port Everglades is categorized as tropical. The annual mean temperature for the region is approximately 75° F with an average humidity range of 60 to 87%. The average annual rainfall is 60 inches with about 65% occurring during the summer and early fall months (June through October).

During the summer months, Port Everglades experiences predominantly east and southeast trade winds. Between December and March, frontal weather patterns driven by cold Arctic air masses can extend as far as South Florida. These fronts generate "Northeaster' storms that typically generate northeast winds behind the frontal boundary. Hurricane season for the Atlantic runs from June 1 to November 30. Hurricanes have historically had significant impact to Port Everglades and the adjoining shorelines. Between 1889 and 2009, over 100 hurricanes have made landfall on the coastline of Florida. See Appendix A of the Feasibility Study for more data on hurricanes and storm surge.

Tides at Port Everglades are semi-diurnal (two high and two low daily). Mean tidal range in the harbor entrance and main harbor area is 2.53 feet. Table 8 presents tide statistics at three locations within the Port.

Table 8 Tidal Data for Port Everglades, Broward County, Florida

	N. Turning Basin	Southport Channel	Dania Canal
Highest Observed Water Level	4.42 ft	----	3.26 ft
Mean Higher High Water (MHHW)	2.81 ft	2.78 ft	2.56 ft
Mean High Water (MHW)	2.69 ft	2.66 ft	2.47 ft
N. American Vertical Datum – 1988	2.31 ft	2.28 ft	
Mean Sea Level (MSL)	1.43 ft	1.43 ft	----
Mean Tide Level (MTL)	1.42 ft	1.42 ft	1.32 ft
Mean Low Water (MLW)	0.16 ft	0.18 ft	0.17 ft
Mean Lower Low Water (MLLW)	0.00 ft	0.00 ft	0.00 ft
Lowest Observed Water Level	-1.27 ft	----	-0.19 ft

[1] For information on period of record see companion table in Engineering Appendix

Two types of currents affect Port Everglades: offshore currents and currents within the harbor itself. Offshore currents affecting Port Everglades Harbor include littoral currents, inlet related tidal currents, and strong currents resulting from the proximity of the Atlantic Gulf Stream. Currents within the harbor arise from flood and ebb tides, river outflows, and power plant discharges. According to the *Coast Pilot* (NOS 2010), "the entrance channel has dangerously strong cross-currents which vary in strength and are unpredictable in direction." These currents generally run at right angles to the direction of the entrance channel making transit hazardous for deep draft vessels, especially without local knowledge. These currents have been reported to be as swift as 5 knots. As a ship exits the entrance channel, and passes the outer reef, water depth increases quickly, since the edge of the continental shelf (and Gulf Stream) is closest to shore at this point along the entire Atlantic coast of the United States. As the Gulf Stream flows north along the Florida peninsula, it sheds numerous eddies, many of which impinge upon the reefs and Port entrance channel (Shefter and Grose 1996, Martinez-Padraja *et al.* 2004). Due to the previously mentioned offshore geometry with the parallel reefs, the eddies are channeled into a current which crosses the Port entrance channel (Figure 44), at times making safe navigation extremely difficult. This situation is further complicated by tides entering and exiting the entrance channel (Shefter and Grose 1996).

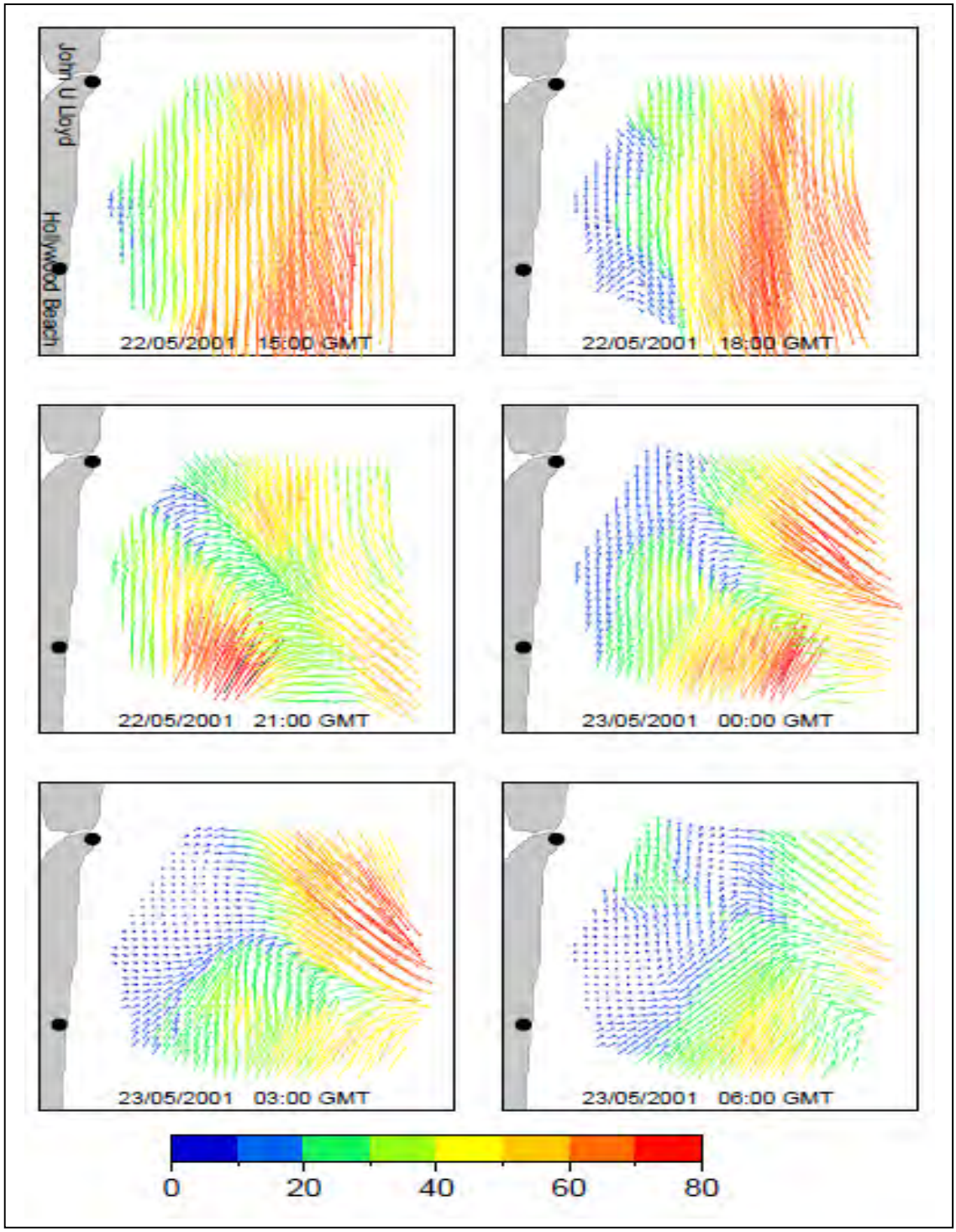


Figure 44 Current Direction and Intensity Changes in 24-hour Period Offshore of Port Everglades (Martinez-Pedraja *et al*. 2004)

Cross-currents are stronger at the outer reef than the middle reef based on information gathered during the bypassing feasibility study (USACE meeting notes: Alternative Meeting March 2007; Martinez-Pedraja *et al*. 2004, Shay *et al*. 2000; Shay *et al*. 2002). More generally, cross-currents increase from the shore to the outer reef, though tidal currents may be stronger near the jetties. Additionally, eddies breaking off of the Gulf Steam can be quite strong and substantial reverse currents are frequently encountered (Shefter and Grose 1996). PEPA and the U.S. Naval Surface Warfare Center's South Florida Testing Facility (SFTF) previously partnered beginning in 1995 an attempt to "map" the currents in the entrance channel to increase safe navigation of large cargo and military vessels entering Port Everglades. These efforts utilized an Acoustic Doppler Current Profiler (ADCP) that was placed in the entrance channel between the middle and outer reef. The system was an automated system that recorded current data (1995-2005) via the ADCP, transmitted the data to the SFTF, and then could be transmitted to pilots via a voicemail system. Data were collected on and off between 1995 and 2005 by this system. However, in Port/USACE discussions with PEPA, it became apparent that the single point ADCP did not provide sufficient information in a fast enough fashion to be of extensive use by pilots bringing in large cargo and petroleum vessels. Approximately four years of the data was provided to the NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), was subjected to QA/QC (1995-1999), and is currently available for download from their website (http://www.aoml.noaa.gov/phod/adcp/). The remainder of the data was archived by the SFTF (2000-2005), but did not undergo QA/QC, and has since been provided to USACE as part of the Port Everglades project. Due to the wealth of published, peer-reviewed data concerning the currents at Port Everglades and the four years of data that was subject to QA/QC procedures, the decision was made not to analyze the remainder of the data since they would require extensive and costly QA/QC. However, they are maintained as part of the administrative record for this project.

3.4 Geology and Sediments

Southern Florida is part of the geologic formation formally called the "Florida Peninsula," which is a large carbonate platform containing a thick sedimentary sequence that was constructed generally from the Jurassic (Mesozoic Era) to the Miocene (Cenozoic Era) (from about 180 - 5 million years before present) (Davis 1997). Carbonate, evaporite, and silicilastic sediments began to accumulate over basement rocks consisting predominantly of late Triassic – Early Jurassic mafic (rich in magnesium and iron) volcanic suites (Winston 1992) on what eventually became the Florida Peninsula, which was associated with the development of the Gulf of Mexico depositional basin, probably in the early Jurassic (Winston 1992).

The Atlantic and Gulf coast sedimentary environments are influenced by bedrock controls (e.g. Evans et al. 1985) on bathymetry and sediment distribution patterns. The southern east coast shoreline consists of one to two meters of beach sand that overlies lithified sands, beach rocks, and coquina, belonging to the Anastasia Formation (Duane and Meisburger 1969, Finkl 1993). Rock outcrops of the Anastasia Formation are common along the coast at about the mean tide level, but there are notable outcrops at one or two meters above sea level, as well as underwater where they form hardgrounds (Finkl 1994). These shore-parallel structural (comprising rock and coral-algal components) systems, composed of inshore exposure of the Pleistocene Anastasia Formation (a cemented, quartzitic, molluscan grainstone that formed in beach and shallow-water nearshore environments) and coral-algal reef tracts, increase in depth offshore, forming distinct tracks, referred to as the nearshore (0.1 to 2 m), middle (3 to 6 m), and outer (8 to 10 m) reefs. The parabathic (shore-parallel) reef tracts extend southwards into Miami-Dade County. Sedimentary troughs that contain admixtures of clean, free-running sands, discontinuous lenses

or stringers of silts and clays separate the reef tracts, or carbonate rubble accumulations deposited in association with paleo-inlets that cut through the reef tracts (Duane and Meisburger 1969; Finkl 1993; Finkl *et al.* 1997).

Approximately 40 to 80 percent of the coastal sediments deposited on the Florida peninsula are carbonates locally produced by calcite producing plants and animals. It is estimated that 20 to 60 percent of the carbonate material is reworked material from offshore Pleistocene outcropping formations. The quartz sand component is a combination of quartz sand that migrated southward along the Atlantic coast and Pamlico sand that was previously deposited over the entire region.

Located in south Florida, Broward County is geologically divided into four parts: the Everglades to the west, the Atlantic Coastal Ridge to the east, the barrier islands, and nearshore deposits (see Engineering Appendix). The barrier islands and the nearshore deposits are underlain by the Miami Limestone. The beach sand in Broward County consists predominately of carbonate grains and shell fragments. A small amount of quartz grains are present.

The majority of benthic materials within the project area include inter-bedded layers of sand and rock with occasional massive formations of very hard rock. Additional materials include silts, clays, and organic peat material. Sediment constituents encountered at the Port vary greatly according to core boring location and elevation. The Engineering Appendix of the Feasibility Study contains detailed core boring logs and several grain-size curves. USACE analyzed a number of core borings that have been drilled in and around the Port. Broward County has also drilled two groups of core borings (total 36 borings) in support of this study.

Sediments in the harbor have also been examined, but will undergo further examination. Sediment information may be found from the Port's routine collection and examination of sediment samples for chemical constituents and at times, bioassay results, prior to conducting maintenance dredging. Sediments sampled within the OEC, IEC, NTB, MTB, and STB were tested under Section 103 of the Marine Protection, Research and Sanctuaries Act (MPRSA) and were found suitable for ocean disposal (PPB Environmental Laboratories 2005). In addition, for the last two dredging projects, sample analysis for State water quality criteria conducted during dredging operations, indicated that acceptable levels (set by FDEP) for heavy metals were not exceeded. In addition to those sampling events, heavy metal sampling was conducted within the boundaries of the Port's widener project. Analyses from these samples did not indicate adverse sediment quality.

The most recent sampling event took place in November and December of 2011. Five zones representing various port components were tested for ocean disposal. Zone 1 included the Southport Access Channel Cuts 1 and 2. South Access Channel Cut 3 (including the Turning Notch and port berth 30) were included under Zone 2. Zone 3 included the Main Turning Basin, North Turning Basin and the South Turning Basin. Zone 4 included port slips 1 through 3, and Zone 5 included the South Turning Basin and Port berths 19, 20, 26, and 27. Material in all zones was found suitable for ocean disposal (ANAMAR, August 2012). An MPRSA Section 103 concurrence was provided by EPA on September 11, 2012.

For the proposed project, material from the SAC and TN may be suitable for ocean disposal, but sediments may require chemical and bioassay testing pursuant to MPRSA. The MPRSA assigns basic responsibility to EPA and USACE for ensuring that ocean dredged material disposal activities will not unreasonably degrade or endanger human health, welfare, or amenities or the marine environment (MRPSA Sections 102 and 103). In order to achieve this, the dredge material proposed for ocean disposal may undergo a four-tiered evaluation to demonstrate compliance with the requirements of 40 CFR 227. Tiers I and II use existing information and relatively simple,

rapid procedures for determining the potential environmental impacts of dredge material proposed for ocean disposal. If it is readily apparent that the material has the potential to cause substantial environmental impacts (or lack thereof), the information collected in Tier I and Tier II evaluations may be sufficient for making a decision as to the suitability of the material for ocean disposal. However, where the potential environmental impacts are not clear or where sufficient information is lacking, more extensive evaluation through Tiers III and IV may be needed. Each successive tier incorporates more intensive procedures that provide increasingly detailed information for assessing the potential environmental impacts of the dredge material. The intent of this tiered approach is to ensure the suitability of dredge material proposed for ocean disposal while using economic resources efficiently. This is achieved by testing the proposed material only as intensely as is necessary to provide sufficient information for making the disposal suitability decision (USEPA and USACE 1991). The application of this tiered process will ensure that only material suitable for ocean disposal will be placed at an ODMDS.

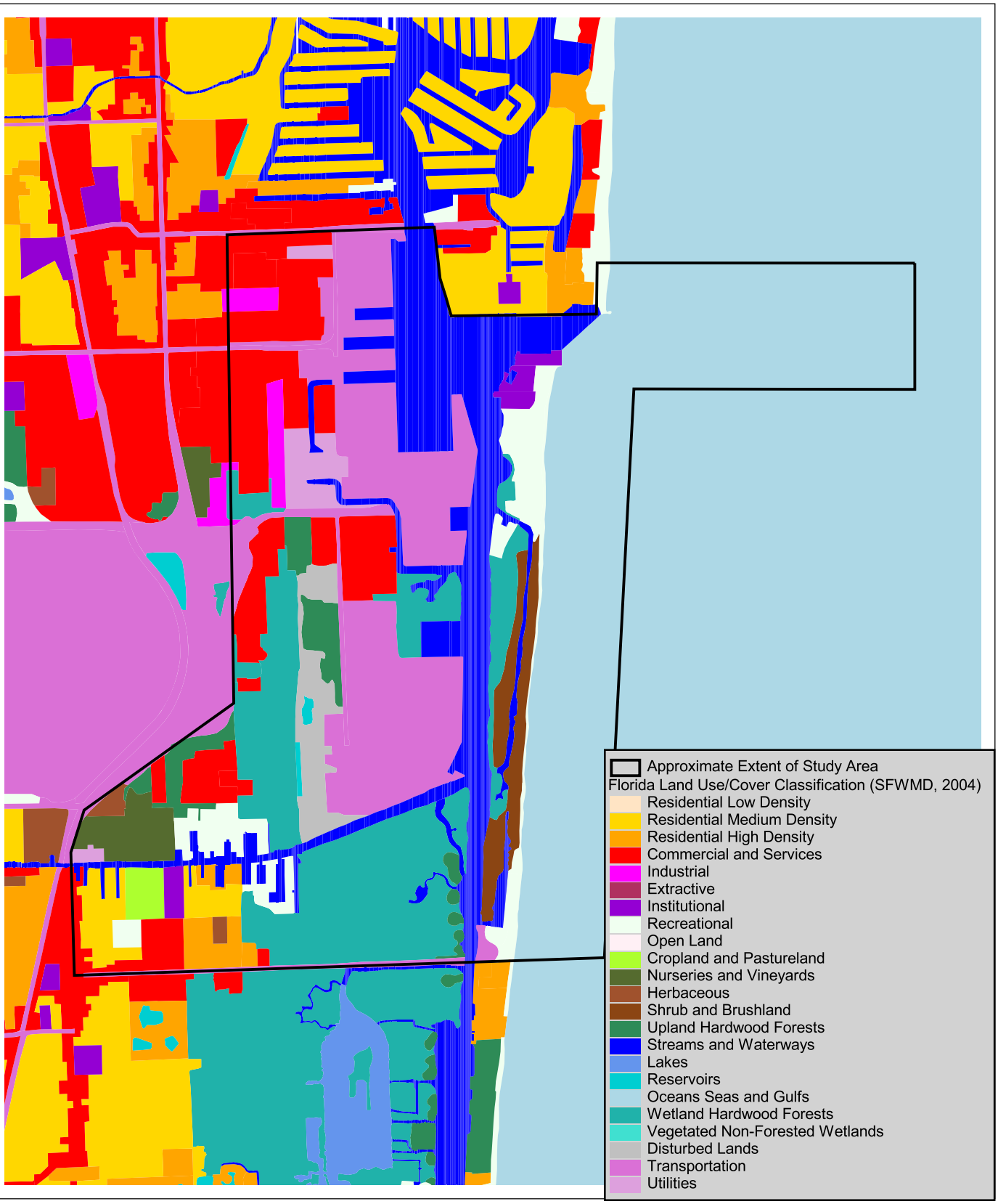
All MPRSA-required testing and analysis of material proposed for disposal at the ODMDS will be completed during the PED phase of the project. Some of the material may meet exclusionary criteria under MPRSA and may not require testing (e.g., sand or rock) while other areas may require additional testing. All required testing will be performed in accordance with *Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual*, also known as the "Green Book", and the latest version *USEPA Region IV/COE South Atlantic Division Regional Implementation Manual* (SERIM).

3.5 Terrestrial Biotic Communities

3.5.1 Upland Habitat

A land-use cover map (Figure 45), using categories from the Florida Land Use Cover and Forms Classification System (FLUCCS) (SFWMD 2004), illustrates existing land-use and ecological communities within the study area. Most of the uplands are developed, including the Port and adjacent parcels. A common vegetation feature on developed parcels, shorelines, and other areas is Australian pine (*Casuarina spp.*), a non-native, invasive species that has proliferated much of south Florida. Contrary to its name, Australian pine is actually a hardwood. Its name is derived from its needle-like leaves and its characteristic cone-shaped crown structure. Australian pine was introduced to south Florida from Australia. It is common on disturbed sites, forms dense mono-culture thickets and, in the past, was frequently planted as a windbreak and a soil stabilizer.

Productive, terrestrial (i.e., non-wetland) habitats within the project area are generally confined to JUL, where maritime hammock, coastal strand, and beach dune habitats exist (see "Adjacent Properties" section for details). Common components of these habitats are saw palmetto (*Serenoa repens)*, sand live oak (*Quercus geminata)*, myrtle oak (*Q. myrtifolia*), yaupon (*Ilex vomitoria*), railroad vine (*Ipomoea pes-caprae*), sea oats (*Uniola paniculata*), sea purslane (*Sesuvium maritimum*), sea grape (*Cocoloba uvifera*), Spanish bayonet (*Yucca aloifolia*), and prickly pear (*Opuntia* sp.). These species are generally found in dune and white sand areas above the mean high tide line.



0.5 0 0.5 1 1.5 2 Kilometers

0.5 0 0.5 1 Miles

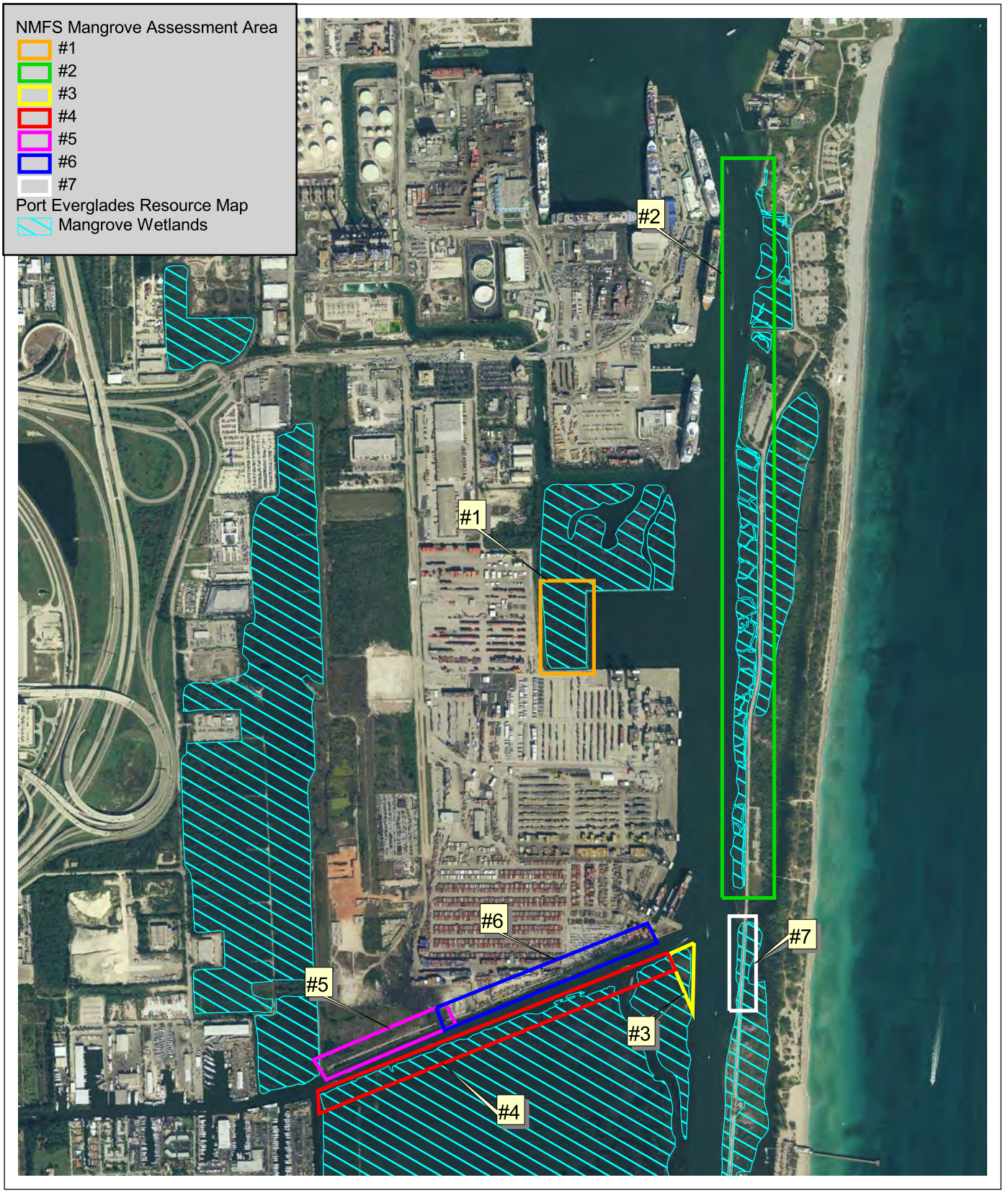
Land Use and Ecological Communities	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1 kilometer	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 45

3.5.2 Wetlands (Mangroves)

Jurisdictional wetlands within the study area are dominated by mangroves (see Figure 46). Mangroves also represent the largest natural habitat within the project boundaries and are found in both natural and created wetlands. These habitats comprise either stands of red mangrove (*Rhizophora mangle*) or mixed stands of red mangrove and black mangrove (*Avicennia germinans*). Major associates include white mangrove (*Languncularia racemosa*) and buttonwood (*Conocarpus erectus*). Mangroves are important for shoreline protection and stabilization. In addition, mangrove habitats provide many important ecological functions, including providing refugia for juvenile stages of managed fish species, and have been identified as significant resources for seven federally protected species, and four federally protected subspecies (Odum and McIvor 1990). These systems also provide organic matter that forms the basis of a littoral-zone, marine food web. Sloughs (channels of slow-moving water) penetrate mangrove wetlands adjacent to channel areas. Some of these sloughs are natural, while some are man-made. These are extremely important areas that provide species with passageways for movement into and out of interior mangrove areas. They are also important for refuge and feeding areas for various fishes and invertebrates.

Two sets of wetland assessments specific to the project have been carried out since outset of scoping activities for the study. In the first assessment, for inclusion in DC&A (2001), USACE contractors and agency staff (USFWS and NMFS) characterized five mangrove areas in the Port Everglades area, referred to in Figure 46 as Assessment Areas 1, 2, 3, 4, and 7. These five areas were grouped during the assessment into mangrove "types" (an arbitrary term *not* referring to any formal wetland classification scheme), according to functionality, maturity, elevation, soils, exposure to tides, and position in the project. Field notes from that interagency effort, which resulted in an Estuarine Wetlands Rapid Assessment Procedure (EWRAP), are summarized in relevant sections below (as per mangrove type/location). These data were also used to help assign functional value scores to the areas under the State of Florida Uniform Mitigation Assessment Methodology (UMAM).

In the more recent of the two assessments, NMFS led an interagency site visit on May 6, 2008, and characterized seven mangrove assessment areas that were defined based on similarities in water depth, water quality and clarity, and landscape position (Figure 46). Additional field investigations on the mangroves in the project area have been conducted by FDEP in April 2007, BCEPD in December 2007, and a Port contractor in February 2008 (CSI 2008).



1500 0 1500 3000 Feet

Wetland Map	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1500 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 46

The largest (by area) mangrove habitats in the project area occur along the western shore of JUL and north and west of the TN. Some fringing mangrove wetlands in JUL comprise habitat created by the Port as mitigation for previous impacts to native areas of mangrove. Mangroves to the north and west of the TN fall under a FDEP conservation easement. Sloughs, both manmade and natural, are associated with both of these major mangrove areas. The following paragraphs provide descriptions of the various mangrove community categories (i.e., "types") that were developed for DC&A (2001) along with transcribed text relating to each, if available, from the "Characterization of Essential Fish Habitats in the Port Everglades Expansion Area" (NMFS 2011) (Appendix H). Figure 46 designations are not based on the "types" from the first (i.e., 2001) assessment, but relate to NMFS (2011) designations. Positions of the mangrove "types" from the first assessment are described in the text remarks below, but to avoid confusion with that NMFS report, are shown graphically in DC&A (2001) and *not* in Figure 46.

Type 1 mangroves comprise mixed stands of black and red mangroves and non-native invasive species, such as Brazilian pepper (*Schinus terebinthifolius*). These habitats are located north of the most northern mangrove creation area and south of the USCG facility along the eastern side of the waterway. The width of the area averages 20 feet, and mangrove coverage is less than 50%. Per EWRAP field data sheets prepared by NMFS and USFWS for this area, it appears that this area provides minimal benefits to wildlife or protected species, aside from providing temporary roosting areas. Steep banks and the depressional nature of the system are evidence of altered hydrology. This is the only wetland area that would be impacted by the Recommended Plan.

Type 2 mangroves are described as mature, fringing red mangrove habitats. In the project area, these comprise mangrove islands surrounded by the IWW to the west and sloughs on all other sides. These red mangroves appear mature and productive and provide valuable refugia and foraging area for fishes and motile invertebrates, such as juvenile Florida lobster (*Panulirus argus*) and mangrove snapper (*Lutjanus griseus*).

Type 3 mangroves are created habitats. As mitigation for Port improvements in the mid-1980s, mangrove habitat was created from uplands along the east shore of the Intracoastal Waterway at several areas from just north of the JUL boat ramp south to the DCC/IWW intersection. These wetlands are dominated by red and black mangrove with heights ranging from 2 to 12 feet. All of the areas appear successful, based on productivity and system functionality. However, while some areas appear to flush well with tides, others do not, partially due to inadequate tidal cuts in the existing rip- rap wall built in the 1990s along the waterway.

Type 4 mangroves comprise fringing red and black mangrove separated from open water by riprap. This category applies to the area of moderately mature trees along the east side of the IWW next to the parking lot of JUL, and the mature trees west of the TN. The riprap wall associated with the latter is approximately 6+feet MLW high; tidal flushing and fish passage are limited. The only marine corridor into this system occurs at the north end of the mangrove area, south of the MTB. Most of the mangroves observed were healthy and range from 6 to 25 feet in height.

The above mangrove Types 1, 2, 3, and those of 4 *associated with JUL* are described in NMFS (2011) in the following manner (Figure 47):

> "*Mangrove Assessment Area #2*
> This area is the only mangrove habitat area contained within the current expansion area. This area contains narrow fringes of mangroves, well-developed mangrove wetlands, a mixed mangrove tidal creek, and oxbows. The area is located within John U. Lloyd State Park and south of the U.S. Coast Guard station along the east side of the IWW. The northern portion of this assessment area was visited on May 6, 2008, during an interagency field inspection that characterized this area as beach sand with a narrow fringe of mangrove (approximately one tree deep). The southern stretch of this mangrove area contains a well-developed mangrove wetland with tidal creeks and oxbows [Figure 47]. Some of the mangrove habitat in this assessment area is mitigation for previous wetland impacts associated with the Turning Notch Project in the mid-1990s (DC&A 2001). Approximately 23 acres of mangroves were planted along the eastern edge of the IWW at John U. Lloyd State Park for mitigation associated with the Turning Notch Project, however they were not placed under a conservation easement, as they were on state owned land."

The Type 4 mangroves that are *associated with the TN* are described in NMFS (2011) in the following manner:

> "*Mangrove Assessment Area #1* (near Turning Notch)
> This 8.7-acre area is known as the Turning Notch mangrove assessment area. Fish and Wildlife Service field notes from the Estuarine Wetland Rapid Assessment Procedure (USFWS 2001) noted mature and "pure" red (*Rhizophora mangle*), black (*Avicennia germinans*), and white (*Laguncularia racemosa*) mangroves. This mangrove area is mitigation for previous wetland impacts associated with the Turning Notch Project (DC&A 2001). During the interagency site visit in May 2008, it was noted this area contains a mature mangrove community and the riprap revetment between the mangroves and open water appears to provide sufficient spacing to allow for detrital exchange and fishery resource access."

While sufficient water flow exists through the existing rip rap in Assessment Area #1, there are currently no gaps in the riprap that surrounds the mangroves.

Type 5 mangroves comprise stunted red and black mangroves (less than five feet in height) that have recruited on old spoil deposits (Figure 48). This type is located on the southwest corner at the intersection of the IWW and DCC. Elevations are slightly higher than the adjacent mature mangroves to the west and soils are heavily laden with shell materials. Rainwater collects and pools in some areas, and much of the habitat is utilized by fiddler crabs and is adequate for use by wading birds. Elevations are too high to support persistent tidal waters and as such do not provide direct benefits to marine fish or other marine macro-invertebrates. The Type 5 mangroves in this location are described in the NMFS (2011) in the following manner:

"*Mangrove Assessment Area #3* (Salina Assessment Area)
This is the easternmost polygon along the south side of the DCC. This area was separated from 4 because it appears to be functioning more as a "salina" (or salt flat), than it is functioning as a mangrove community. NMFS and other agencies visited this area on May 6, 2008, and characterized this area as a triangular shaped spoil area. It also appears to be at a higher elevation than mangroves to the south. The area is surrounded by riprap 3 feet to 5 feet wide that becomes patchy towards the south along the DCC. Red and black mangroves are present along the shoreline and there are little to no invasive, non-native species."

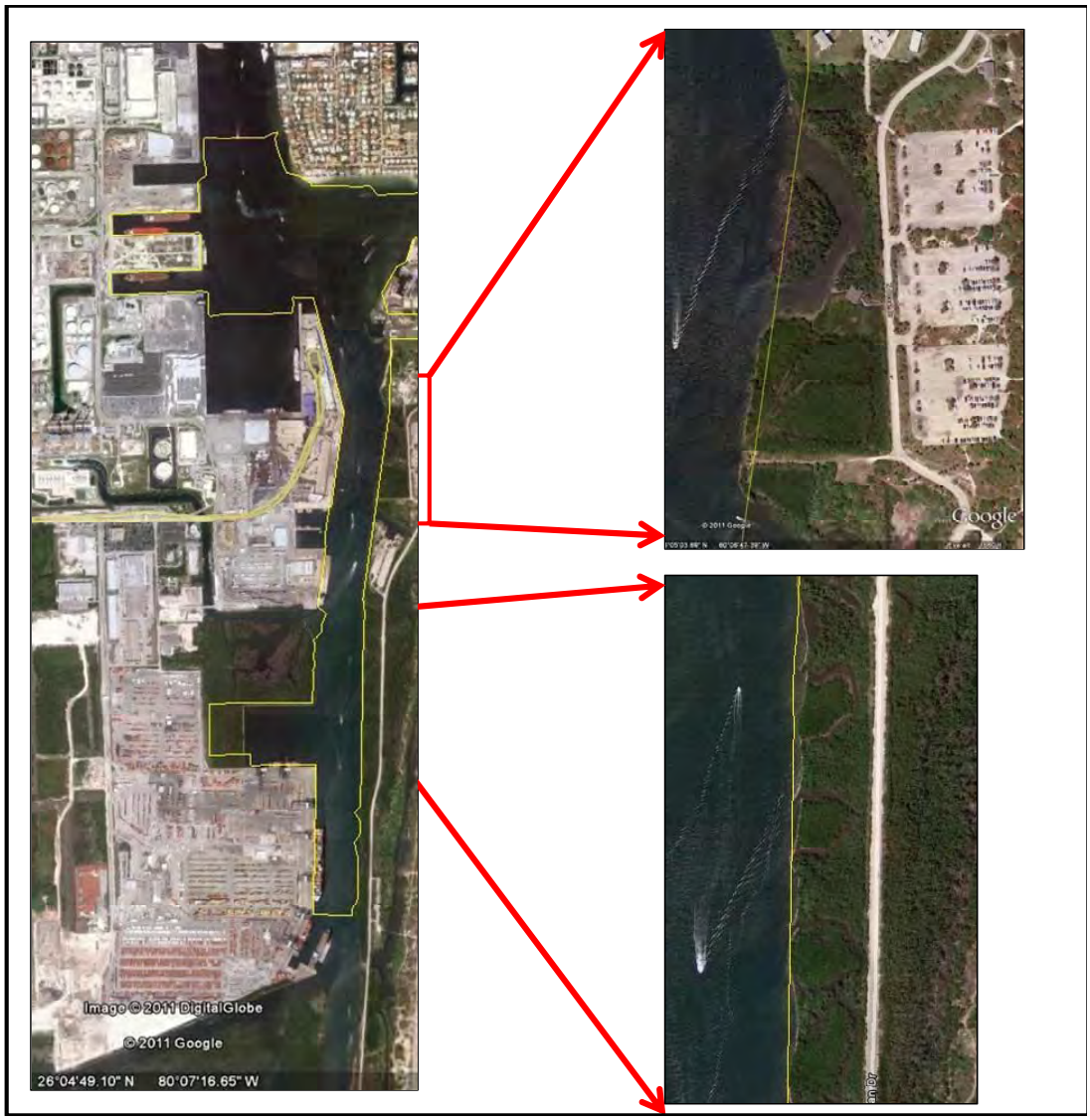


Figure 47 Mangrove Resources Detail along SAC (NMFS 2011)

Figure 48 Mangroves in the Salina Assessment Area (2005), View to NE

Type 6 mangroves comprise mature red mangrove trees on the DCC just west of the Type 5 mangrove area, adjacent to Whiskey Creek. This habitat type appears to be a healthy functioning system, although it is adjacent to the stunted mangrove community along the DCC (Assessment Area #3). Trees average 12 to 16 feet in height along associated tidal creeks and offer numerous ecological functions including food chain support, roosting areas for wading birds, and refugia for many invertebrates and benthic fishes. These mangroves are described in the NMFS (2011) in the following manner:

> "*Mangrove Assessment Area #4*
> This area is along the southern side of the DCC. Most of the area has riprap along the shoreline. This area is characterized as actively eroding (Broward County West Lake Park, Conceptual Master Plan C 2001). This was verified during the field visit in May 2008. Specifically the frequent large vessel traffic and associated large wakes are thought to contribute to the erosion. This area is characterized as supporting a mature red mangrove community (USFWS 2001). This was confirmed by agencies during a field visit in May 2008. In addition, biologists noted that the red mangroves just beyond the eroded zone seem relatively stable and are tidally influenced."

Type 7 mangroves comprise occasional lines of predominantly white and black mangroves with some red mangroves that have grown among scattered rock on the eroding north shoreline of Dania Cutoff Canal. Behind the average 10-foot high trees is a row of Australian pine trees and an access road. Average width of this habitat is 20 feet. These trees may provide "islands" of habitat structure to species migrating through the canal, and occasional roosting site for birds, but do not add significant input to the detritus-driven food web. These mangroves are treated as west and east sections in NMFS (2011), which describes them, respectively, in the following manner:

> "*Mangrove Assessment Area #5*
> The only available information for this area is from an interagency field visit during May 2008. This area is located along northwestward side of DCC. A fence exists between assessment areas 5 and 6. This area is characterized as red, black, white mangroves and is tidally influenced. Fringes are 10 feet to 15 feet wide in some areas; 3 feet to 5 feet wide in other areas. The shoreline is generally riprapped and the boulders vary in size. This area has some exotic infestation of invasive species, including Australian pines and Brazilian peppers."
>
> "*Mangrove Assessment Area #6*
> This area is along the northeast side of the DCC and supports black and white mangroves; a few red mangroves are also present – generally along the eastern site of this area. The landward portions of this area are tidally influenced. The shoreline is riprapped and the boulders vary in width and size. This area has some infestation by Australian pine and Brazilian pepper. The area between the bulkhead to the east and a riprap wall is devoid of mangroves. There is also a "fill area" that is devoid of shoreline resources."

NMFS (2011) also mentions Assessment Area 7 (Figure 46):

> "*Mangrove Assessment Area #7*
> DC&A (2001) depicts this area as a 'fringing mangrove.' No other habitat characterization is available for this area; however, the mangroves appear to be tidally influenced."

3.6 Marine Resources

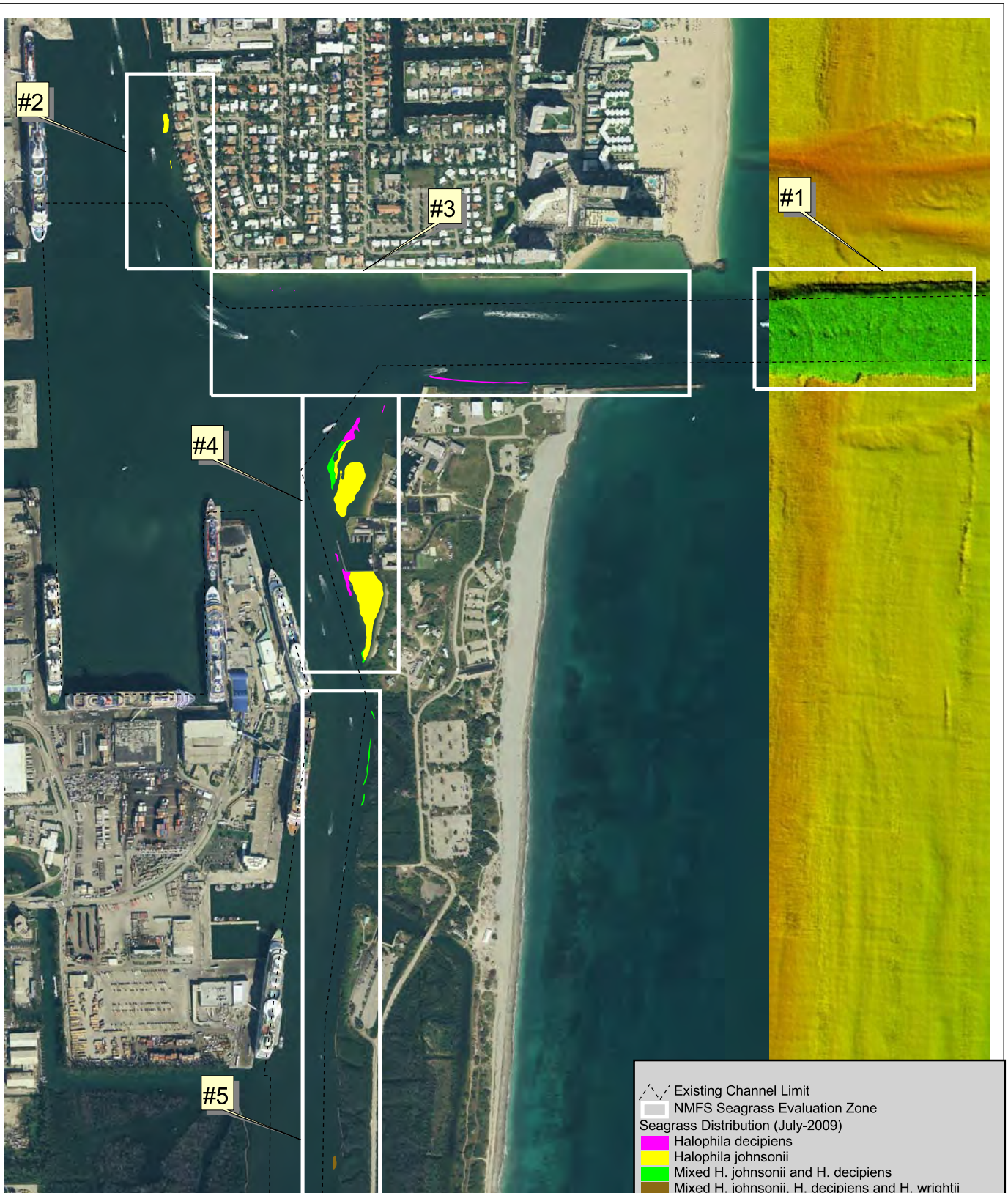
3.6.1 Seagrass Communities

3.6.1.1 Investigations

Seagrass habitat cover type, abundance, and density for the study area are described in the surveys conducted in 1999, 2000, 2001, 2006, 2009, and 2013 (DC&A 1999, DC&A 2000, DC&A 2001; DC&A 2006; DC&A 2009). Additional surveys were carried out by Broward County's Beach and Marine Resources Section in 2001 and 2004 and by the Broward County's Port Everglades Department in 2013 (DC&A 2013). The 1999 environmental baseline surveys for seagrasses occurred within the project area, which started approximately 1,200 feet north of the Port Inlet, then south along the IWW to approximately 1,000 feet south of the DCC juncture, and also along the DCC (DC&A 2000). In the 2000 survey, additional survey transects were located within the area 1,000 feet south of the DCC on the east side of the channel, and on the west side, from the DCC south to the Dania Beach Boulevard Bridge. Also, in order to field verify whether seagrass occurred in the OEC, as reported by the BCEPD staff (pers com, Steve Higgins, Beach Erosion Administrator, Broward County), an integrated video survey was performed within the OEC in 2001 (DC&A 2001). In 2006 thorough reconnaissance of the entire project area was completed, verifying that seagrasses were limited to the areas previously mapped in 1999 and 2000. After the reconnaissance effort, detailed seagrass surveys were conducted in the same project area (not including areas further south than approximately 1,000 feet south of the intersection of the DCC with the IWW; see DC&A 2006 for details) during 1999 and 2000. In 2009, further thorough reconnaissance of the entire project area was completed, verifying that grasses remained in the previously mapped areas and had not established beds in new areas. After this reconnaissance effort, detailed seagrass surveys were conducted in the same project area as 2006 surveys (again, not including areas further south than approximately 1,000 feet south of the intersection of the DCC and the IWW) (DC&A 2009; see Appendix D).

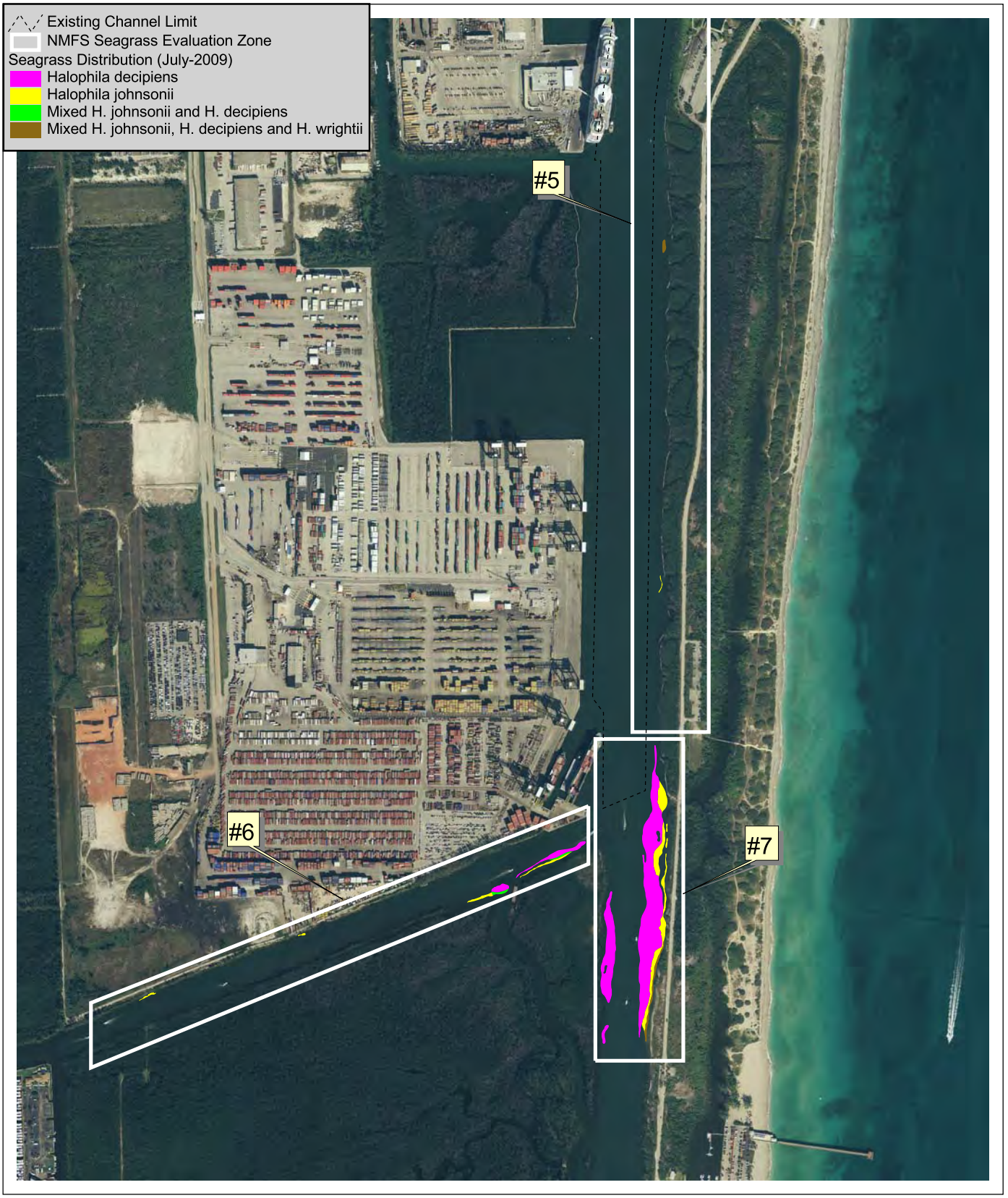
Several other seagrass surveys and anecdotal observations have occurred in the project area, including a Broward County seagrass survey in 2001, and a Broward County/FDEP QA/QC assessment for a previously conducted seagrass survey near the USN facility (the south side of the IEC) for a proposed Navy project in 2004. A permanent transect was established in April 2006 adjacent to the USCG station to monitor annual changes in the documented *Halophila johnsonii* bed by Fish and Wildlife Research Institute (FWRI) (Jennifer Kunzelman, FWRI, pers com, January 25, 2008). Also in 2008 seagrass surveys were conducted for NSUOC's boat basin and adjacent areas (Coastal Eco-Group 2008). Most recently in the summer of 2008, an interagency team conducted qualitative surveys within the project area. These studies have provided valuable supplemental information on seagrass populations changes and trends since 2001. In 2008 and 2009, Miller Legg conducted surveys for West Lake Park within the DCC portion of the project area. Due to the data collection methods, which may have included GPS point data in many cases, these data are not displayed in seagrass habitat maps, except for the 2009 dataset, which surveyed areas identified in the 2008 interagency survey effort.

NMFS characterized seven seagrass assessment areas that were categorized based on similarities in water depth, water quality and clarity, and landscape position (Figures 49 and 50). A summary of each assessment area is provided below and is based on six seagrass mapping, surveying, or verification efforts conducted in Port Everglades between 1999 and 2009 (Table 9).



1000 0 1000 2000 Feet

Seagrass Distribution (2009) - Northern Portion of Study Area	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 49



1000 0 1000 2000 Feet

Seagrass Distribution (2009) - Southern Portion of Study Area	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 50

Table 9 Seagrass surveys performed in Port Everglades 2001 to 2009 (NMFS 2011)

Study Reference*	Date of Study	Spatial Scope of Survey
DC&A 2001	1999-2001	Expansion area (except OEC) and surrounding areas
DC&A 2001	2001	Outer Entrance Channel
DC&A 2006	2006	Areas where seagrass was observed in DC&A 2001
FDEP 2008	2008	Project area, except OEC and portions of the SAC
NSU 2008	2008	Portions of the Widener Shoal
Miller Legg 2008	2008-09	Dania Cut-off Canal
DC&A 2009	2009	Expansion area, except Outer Entrance Channel

The most recent area-specific SAV survey was precipitated by a qualitative assessment performed by Broward County staff (with federal and state agency staff) along the south margin of the Port Everglades OEC in July 2013, when divers recorded GPS points at two locations that defined the edge of a seagrass bed between the nearshore hardbottom and middle reef. *Halophila decipiens* was confirmed within the seagrass bed, and members of that dive team suggested that *H. johnsonii* may also have been present. Therefore, a subsequent survey, organized by USACE and Broward County's Port Everglades Department, consistent with the Johnson's seagrass protocol (see Fonseca et al 1998) was justified. That quantitative survey was performed in August 2013. *H. decipiens* was the only species observed, and beds were sparse to moderately dense, with density of seagrass decreasing from east to west across the occupied area, which comprised just over an acre (DC&A 2013).

3.6.1.2 Seagrass Species Biology and Ecology

The Port project area supports sub-tropical and tropical seagrass communities including *Halophila decipiens* (paddle grass), *Halodule wrightii* (shoal grass), *H. johnsonii* (Johnson's seagrass), and associated green calcareous and brown algae, such as *Penicillus* spp., *Halimeda* spp. and *Caulerpa* spp. Quantitative seagrass surveys were conducted by USACE in 1999, 2000, 2001, 2006, and 2009 (and jointly with the Port for the OEC in 2013). In 2008 interagency surveys qualitatively assessed seagrasses within the project area, dividing the site into seven assessment areas (Figures 49 and 50). Below is a description of each seagrass species biology and ecology within the project area.

Halophila decipiens.
H. decipiens is the only seagrass species identified in all seven assessment areas during survey events. *H. decipiens* is also the only seagrass species that has been observed in assessment areas #1 (OEC) and #3 (IEC) (Figure 49). This species is highly fecund and cosmopolitan, occupying niches that larger-sized perennial species cannot utilize (Hammerstrom and Kenworthy 2003). The short life history of *H. decipiens* and the apparent existence of a buried, but moveable seed bank means that spatial organization of this community is dictated by first large-scale dispersal of plant propagules (hundreds of meters) and then, within a growing season, by physical perturbation, bioturbation, and clonal organization of the seagrass operating over very small distances (Fonseca *et al*. 2008). This species can contribute to a more clumped distribution early in the growing season with subsequent vegetative extension. Fonseca *et al*. (2008) point out that large-scale disturbance events, such as hurricanes, act to redistribute *H. decipiens* propagules, whereupon clonal organization of the plants in their spring to fall existence likely

dictates the pattern of seafloor occupation. Furthermore, bioturbation plays an important role in either burying seeds or bringing seeds to the sediment surface where they can germinate. They further note that this species appears to have the facility for resiliency of natural disturbances (e.g., hurricanes) of its community that appear to be able to move the seed bank hundreds, if not thousands of meters, leading to tremendous seasonal changes in the spatial distribution of the plants. The small seed size and the burial of unvegetated substrate by sediments, coupled with movement along with sediment is a plausible mechanism to explain the inter-annual patterns of seagrass distribution (Josselyn *et al*. 1986). Thus, the definition of "seagrass habitat" for the *Halophila* genera can be highly misleading if presently vacant spaces among patches are not properly considered as requisite space for persistence of the community (Fonseca *et al*. 1998).

Despite a smaller size and a relatively low rate of production, *H. decipiens* makes an important contribution to primary production in an ecosystem (Iverson and Bittaker 1986). It is important to note that *H. decipiens* communities are a mosaic of seasonally ephemeral seagrass patches that provide the valuable ecological functions recognized for the larger seagrasses (Hammerstrom *et al*. 2006), therefore the patchy abundance of *Halophila* is a function of the genus dynamics and should be recognized as the ambient condition (pers com, Judson Kenworthy, NOAA National Centers for Coastal and Ocean Science, 2010). Rapid growth, high turnover rates, and labile tissues make *Halophila* spp. a good source of nutrition for several marine herbivores and detritivores (Kenworthy *et al*. 1989).

Halodule wrightii.
H. wrightii occurred in four of the seven seagrass assessment areas including 2, 5, 6, and 7. It was not observed in any of the seagrass assessment areas in 2006 (DC&A 2006), however it was observed in the middle and southern reaches of the Port Everglades area during 2008 and 2009, primarily in assessment areas 5, 6, and 7. *H. wrightii* is a highly productive seagrass under a variety of light, nutrient, and salinity conditions and because of this it is known to have ubiquitous distribution and an opportunistic strategy as a colonizing species (Dunton 1996). This species can persist under diminishing environmental conditions by reclamation of nutrients and stored reserves from senescing shoots and rhizomes (Onuf 1996). Rhizome growth and branch rate for *H. wrightii* is high compared to climax seagrass species (e.g., *Thalassia testudinum*) which allows it to rapidly occupy the space they colonize, however they have a high shoot mortality and low life expectancy which implies they may not occupy the space for long (Gallegos *et al*. 1994).

Heidelbaugh (1999) conducted a study within a 372 square meter (0.09-acre) study area that examined benthic fauna associated with seagrass and unvegetated bottoms and collected 117 species and 690 macrofaunal organisms from *H. wrightii* beds. The most abundant infaunal organisms belonged to the phylum Nematoda while the most abundant epifaunal species were amphipods and tanaids. The majority of macrofaunal organisms consisted of decapod crustaceans (*Callinectes sapidus*), fishes (*Eucinostomus* sp.), and some gastropods (especially *Bursatella leachii*). An additional study compared nekton densities among *Halophila engelmannii*, *H. wrightii*, and non-vegetated habitats and, similar to the results of the Heidelbaugh (1999) study, found higher densities in the seagrass habitats (King and Sheridan 2006). These studies and others (Sheridan and Livingston 1983; Stoner 1983; Lewis 1984) conclude that on a per plant biomass basis, *Halodule* provides as much fish and infaunal habitat value as other species with higher above-ground biomass, such as *T. testudinum*.

Halophila johnsonii.
H. johnsonii was documented by at least one survey in all assessment areas except OEC and IEC. In 2006, *H. johnsonii* was not observed in two assessment areas where it was previously observed (#5 and #6), however it returned to these areas in 2009. The expansion and contraction of *H. johnsonii*, also referred to as "pulsating patches" may be a long-term survival strategy (Virnstein *et al*. 2009). The persistent presence of high-density elevated patches of *H. johnsonii* on flood tidal deltas near inlets suggests that it is capable of sediment stabilization (NMFS 2007a). Given the similarities between the morphology of other *Halophila* spp. and *H. johnsonii,* it is reasonable to assume that *H. johnsonii* has the same capabilities as these other species to provide important ecological functions and services to the coastal ecosystem of southeast Florida (NMFS 2007a). (*H. johnsonii* is a threatened species under the Endangered Species Act; see Section 3.7.2.1)

In Heidelbaugh (1999), *H. johnsonii* beds yielded a total of 126 species (69 epifauna and 57 infauna). Three hundred and twenty macrofaunal organisms were collected from *H. johnsonii* beds. NMFS has concluded that the conservation of *H. johnsonii* will not only maintain the diversity of the seagrass communities, but also the important biodiversity and biophysical characteristics of the entire ecosystem (NMFS 2007a). Although *H. johnsonii* serves as hiding and resting habitat for many species, Gabriel and Hirons (2011), in a study specific to the project impact areas in the SAC, stated that "consumers [i.e., marine species] in Port Everglades are not feeding on seagrass", including some of the densest patches of *H. johnsonii* in the project area.

3.6.1.3 Spatial and Temporal Patterns of Study-Area Seagrass Beds

The investigations discussed above in Section 3.6.1.1 allowed for a thorough evaluation of the seagrass community in the harbor and channel-adjacent areas. Seagrass occurrence within Port Everglades consisted of mixed SAV with *H. decipiens* and *H. wrightii*, mixed SAV with *H. decipiens* and *H. johnsonii*, monospecific beds of *H. johnsonii*, and *H. decipiens*. Seagrasses increased in spatial coverage between 1999 and 2009 (Table 10), but increases were not uniform in all areas of the harbor; some beds decreased in size and demonstrated changes in species composition. Table 10 does not include information from the aforementioned joint USACE/Port Everglades 2013 survey of the OEC, which was conducted after the NMFS 2011 summary was provided to USACE.

Table 10 Port Everglades Project Area Seagrass Coverage 1999-2000, 2006, & 2009

Bed Type	1999-2000 (ac)	2006 (ac)	2009 (ac)
Halophila decipiens	3.29	4.47	6.58
*Halophila johnsonii**	2.85	2.80	4.68
Halodule wrightii	0.61	0.00	0.00
Mixed *H. johnsonii*/H. decipiens*	0.00	1.08	0.46
Mixed *H.decipiens/H.johnsoni*i/H. wrightii*	1.96	0.09	0.26
Totals	**8.71**	**8.44**	**11.98**

**Halophila johnsonii* is a threatened species under the Endangered Species Act
Source: NMFS 2011

A spatially oriented (relative to various areas of the Port's harbors and channels) evaluation of the study area was provided in NMFS (2011) (enclosed in Appendix H):

Seagrass Assessment Area #1:
This area is located within the OEC and supported approximately 1.04 acres of *H. decipiens* (DC&A 2001). Videographic surveys by DC&A (2010) were unable to confirm the presence of seagrasses in this area, probably because Broward County dredged the Port Everglades Entrance Channel from November 2005 through February 2006 in association with Broward County Shore Protection Project. This area may have been impacted by that dredging event.

Seagrass Assessment Area #2:
This is the northernmost seagrass area within the proposed Port expansion area and is north of the IEC and main turning basin (MTB) and along the eastern side of the (IWW. In 1999, this area contained 1.54 acres of *H. decipiens, H. johnsonii,* and *H. wrightii* (DC&A 2001). In 2006, the area contained 0.63-acre *H. decipiens* (DC&A 2006). The 2008 interagency verification survey of this area did not reveal any notable changes in seagrass distribution, however a mixed *H. decipiens* and *H. johnsonii* bed along the east slope of the IWW was observed. In 2009, the area contained 0.13-acre of *H. johnsonii*, a decrease in acreage and a notable shift from a mixed seagrass community to a monospecific bed.

Seagrass Assessment Area #3:
This area is located within the IEC and the MTB. In 2001, *H. decipiens* was documented along the northern side of the IEC (DC&A 2001) and in 2001 and 2006 *H. decipiens* was documented along the southern side of the IEC (DC&A 2001; DC&A 2006). In 2008, additional *H. decipiens* was observed along the entire northern side of the IEC and along the south side of the IEC. Although the seagrass bed along the southern side of the IEC extended to the east, additional points were not collected (FDEP 2008). In 2009, *H. decipiens* was documented along the northern and southern sides of the IEC (DC&A 2009). In 2001, the seagrass acreage in this area was 0.68-acre and in 2006 the seagrass acreage was 0.58-acre. In 2009 the seagrass acreage in this area was 0.09-acre.

Seagrass Assessment Area #4:
This area is located south of the IEC. In 2001 this area contained 1.26 acres of monospecific *H. johnsonii* (DC&A 2001) and in 2006 this area contained 3.89 acres of *H. johnsonii* and *H. decipiens* (DC&A 2006). This area was not verified in 2008. In 2009, the area contained 3.87 acres of mixed *H. decipiens* and *H. johnsonii* (DC&A 209b).

Seagrass Assessment Area #5:
This area is located along the southern access channel (SAC). In 2001, the area contained 0.84-acre of *H. johnsonii, H. decipiens,* and *H. wrightii* (DC&A 2001). In 2006, this area contained 0.55-acre of *H. decipiens* (DC&A 2006). In 2009, the area contained 0.05-acre of *H. johnsonii, H. decipiens,* and *H. wrightii.* The 2006 report documents a complete species transition (from *H. wrightii* to *H. decipiens*) within one bed along the SAC [see Figures 49 and 50]. In preparation for the interagency verification survey in 2008, the area was subdivided into three assessment areas, Areas A, B, and C. The 2008 verification survey did not include Area C. However, the 2008 survey documented a notable increase in seagrass locations along Areas A

and B. In 2009, this bed transitioned again to a mixed *H. wrightii, H. decipiens,* and *H. johnsonii* bed (DC&A 2009b).

Seagrass Assessment Area #6:
This area is not within the current footprint of the proposed project. In 2001, the area contained 0.24-acre of *H. decipiens, H. johnsonii,* and *H. wrightii* along the southern side of the DCC. In 2006 the area contained 0.12-acre of monospecific *H. decipiens* along the south side of the DCC. The 2008 verification survey documented a notable increase in seagrass locations along the north and south sides of the DCC. Of particular importance is the documentation of a westward expansion of the *Halophila* species and the expansion of seagrass habitat to the north side of the DCC, in addition to one observation of *Halodule wrightii.* In 2009, *H. johnsonii* and *H. decipiens* were documented along the south side of the channel and *H. johnsonii* along the north side of the channel. In 2009, 0.74-acre of seagrass were documented in this area.

Seagrass Assessment Area #7:
Similar to assessment area #6, this area is not within the current footprint of the proposed project. This area is located along the IWW south of the DCC. This was the only area where seagrass was documented along the western side of the IWW. In 2001 the area contained 4.11 acres of *H. johnsonii, H. decipiens,* and *H. wrightii*, however *H. wrightii* was only observed along the east side of the IWW. In 2006, the area contained 2.67 acres of *H. johnsonii* and *H. decipiens.* Based on the 2008 verification survey, it did not appear that conditions have changed much in this area, except for the channel-ward migration of a *H. johnsonii* bed along the east side of IWW. In 2009, the area contained 7.11 acres of *H. johnsonii, H. decipiens,* and *H. wrightii.* Similar to 2001, the *H. wrightii* was only observed along the east side of the IWW. Another notable change is that the west side of the IWW only contains *H. decipiens* and in all previous years, *H. johnsonii* was also observed along the west side of the IWW.

Seagrasses in the project area comprise both inshore areas where depths are shallow enough for light penetration or in deeper, clearer waters offshore. Following the creation (via dredging) of the federal navigation channel of the IWW during the late 1950s and early 1960s, seagrasses colonized the manmade channel slopes. The IWW is linked to the South and Central Florida Project, a multi-purpose, federally authorized project that provides flood control, water supply for municipal, industrial, and agricultural uses, prevention of saltwater intrusion, water supply for Everglades National Park, and protection of fish and wildlife resources. The primary system includes about 1,000 miles of levees, 720 miles of canals, and almost 200 water control structures. The IWW links the DCC on the southern portion of the port, which is also referred to as Canal C-13. Due to its configuration and purposes (i.e., generally servicing the South Florida population), water quality, and particularly turbidity fluctuations, SAV coverage there is extremely dynamic.

Offshore SAV beds are also dynamic, likely due to both coastal sediment transport processes as well as permitted dredging activities in the Federal channels. Also, water clarity within and near the Federal channel is related to that of the IWW. This may explain why the *H. decipiens* bed found along the south margin of the OEC in 2013 was not previously observed during previous offshore surveys.

3.6.1.4 Algal Species

Various red and green algal species have been documented within the IWW and DCC north and south of the Port project area. Specific species identified include: *Caulerpa sertuloides; Caulerpa verticillate*; *Lyngbya sp.; Polysiponia sp*.; *Seorospora sp.; Dasya sp*. and *Hypnia sp*.(Taylor Engineering 2008). These species are found intermixed with sea grasses in the IWW and while the seagrass surveys conducted for Port Everglades did not specifically enumerate the presence of algal sp., many of these species were noted intermixed with the sea grasses mapped for the project. During the seagrass surveys conducted for the Port Everglades project, biologists recorded and mapped locations where the substrate was bare of all vegetative cover, including algal species. All of the algae coverage in the Port Everglades project area was intermixed with seagrasses (M. Robbart, DC&A, pers comm., 2012). Additionally, the FWRI survey of *H. johnsonii* also documented the presence of *Caulerpa sp*., *Anadyomene s.p* and "other" green algae mixed in transects located in shallow water just north of the USCG station (Julie Christian, FWRI, *pers comm*. 2012).

3.6.1.5 Water Quality and Local Seagrasses

The seagrasses in the SAC and DCC are commonly impacted by cyanobacteria blooms that appear to correlate with periods of warmer water temperatures, freshwater inputs, and increased nutrient inputs (i.e., phosphorus and nitrogen) from upstream of the DCC (Ryan St. George, pers com, BCEPD, 2009 as cited in NMFS, 2011, Appendix H), also known as Canal S-13 and the New River Canal (S-11). Many of the seagrass beds in the vicinity of Port Everglades are also impacted by large amounts of run-off from roads, parking lots, and other impermeable structures since all of that water drains from the upland to the ocean via the Port inlet. Water quality flowing from the land to the ocean via the inlet has been studied by the USGS (Futch et al. 2011). USGS has documented at least 64 organic wastewater compounds, 16 pharmaceutical compounds, *Salmonella* species, one coliphage, and human enteroviruses in the water in the inlet. These compounds may also have adverse impacts on seagrass and the species that use seagrasses as habitats.

3.6.2 Hardbottom and Reef Communities

<u>Geomorphology.</u>
The reefs of southeast Florida (Miami-Dade, Broward, and Palm Beach counties) are established on late-Pleistocene formations that were drowned by sea level rise between 5000 and 7000 years ago (Lighty *et al*. 1978; Banks *et al*. 2007). The reef complex is comprised of a nearshore ridge complex, and a seaward succession of three shore-parallel reefs referred to as the "inner," "middle, and "outer" reefs, or the "first," "second", and "third" reefs, respectively (Goldberg 1973; Moyer *et al*. 2003; Banks *et al*. 2007). The nearshore ridge complex runs parallel to the shore and is made up of carbonate/quartz sandstone and coquina rock (Banks *et al*. 2007). The nearshore ridge complex occurs in 0-12 feet (0-4 m) of water and hosts a hardbottom community of algae, sponges, encrusting octocorals, and hard corals (CSA 2009). These hardbottom communities exist in a dynamic environment, and may be periodically covered and uncovered by sands as a result of storms and/or littoral transport. Seaward of the nearshore ridge complex, the inner reef occurs from approximately 100 to 2,000 feet (30 to 610 m) from shore and crests at 26 feet below MHW (8 m); the middle reef is located 3,000 to 6,000 feet (914 to 1,829 m) from shore in 49 feet (15 m) of water (MHW); and the outer reef is approximately 8,000 feet (2,438 m) or more offshore and crests at 52 feet below MHW (16 m) (USACE 1996; Banks *et al*. 2007). The troughs between

the inner and middle, and middle and outer reefs are characterized by sand and coral rubble with isolated patches of hardbottom and hard corals (USACE 1996).

Offshore benthic fauna diversity.

Southeast Florida reefs are considered high-latitude reefs, existing near the northern limit of reef growth in the continental Unites States (e.g., Goldberg 1973). The reef complex found offshore Port Everglades is highly variable in terms of spatial distribution of its biological communities (Moyer *et al*. 2003) and does not conform to the classic reef zonation described for tropical and sub-tropical reef systems (Goreau 1959; Stoddart 1969; Loya 1972; Goldberg 1973). Numerous factors, such as seasonally cold ocean water, tidal inlet discharge, groundwater seepage, freshwater inputs and high variability of substratum complexity and composition have been proposed to explain why benthic communities of high latitude reefs off Florida differ from typical reefs of the western Atlantic region (Goldberg 1973). Although no longer a growing, or accreting reef system as it once was 5000 to 7000 years ago (Banks *et al*. 2007), the reef complex provides storm protection, hardbottom habitat for invertebrates and fish species, and recreational uses that result in economic benefits to South Florida (Johns *et al*. 2001).

Southeast Florida reefs, including those near Port Everglades, are dominated by fauna typical of the wider-Caribbean basin (Goldberg 1973). These include in order of abundance, octocorals, sponges, and hard corals (DC&A 2009; Moyer *et al*. 2003; Goldberg 1973). These reefs have been characterized as octocoral dominated reefs (Moyer *et al*. 2003; Goldberg 1973). Goldberg (1973) described the rich diversity of octocoral species characteristic of this reef system. Thirty-nine species of octocorals were found to be represented including *Eunicea*, *Plexaura*, and *Pseudopterogorgia,* and twenty-seven species of scleractinian corals were documented. The predominant hard coral genera in S. Florida include *Siderastrea*, *Montastraea, Stephanocoenia,* and *Porites* (DC&A 2009). Recently, 45 hard coral species were documented in Broward County by Banks *et al*. (2008), while, Moyer *et al*. (2003) found thirty across the county. Nineteen hard coral species were found on the middle and outer reefs adjacent to Port Everglades in 2006 (DC&A 2009). Typical sub-tropical sponges are found along the reefs including, but not limited to members of *Ircina, Agelas, Iotrochota, Verongula*, and *Xestospongia* genera (DC&A 2009).

Offshore benthic fauna coverage.

Recent studies have provided information regarding the relative density and coverage of corals in certain areas of the Broward County reefs. The four studies discussed below demonstrated representative results for estimation of coral coverage in reefs near the Port.

The *Calypso Pipeline Project* proposed to directionally drill (HDD) from south of the Port's inner entrance channel northeast across the OEC through the middle and outer reefs into deep water. Baseline benthic surveys were conducted along the pipeline corridor (300 feet in width) as well as in areas of potential indirect impact. (Sampling sites were north of the OEC and close to sites surveyed by Dial Cordy and Associates in 2006, see DC&A 2009). The average coral cover across all sites was lower than 1.5%. Outer reef (the third reef line from shore) coral cover was 1.34% and middle reef coral cover was lower. Density of hard corals was less than 3.0/m^2 on the outer reef. Densities of sponges and soft corals were higher, with the highest density found on the outer reef (Dodge, Gilliam, and Shaul 2001).

The *Broward County Shore Protection Project* (BCSPP) also yielded useful data. That project called for monitoring of hardbottom resources before, during, and after 2005 beach nourishment activities along Broward County beaches; some of the 25 sites have been monitored since 1997 (Gilliam *et al*. 2006). The outer reef site closest to Port Everglades, designated "JUL8" (see DC&A 2009 for precise locations), had low coral cover (1.40%), while JUL7 (middle reef) had 1.10% coral cover (Gilliam *et al*. 2006). Coral densities at these sites were low: 1.3 colonies/m^2 at

JUL7 and 2.03 colonies/m^2 at JUL8 (Gilliam *et al*. 2006). Sponge density was higher than coral and octocoral density on both the middle and outer reef sites (Gilliam *et al*. 2006).

The *Southeast Florida Coral Reef Evaluation and Monitoring Project* (SECREMP) monitoring protocol is used to assess hardbottom habitat from Miami-Dade to Palm Beach counties (FWC et al. 2006). Four sites were surveyed in Broward County and varied substantially in their benthic cover. Nearshore and inner reef hardbottom had high coral cover when compared to middle and outer reefs. In 2005, middle and outer reefs sites had coral coverage below 1%. These values are similar to results reported for 2003 and 2004 (FWC et al. 2006).

Finally, a benthic and fish survey was conducted in the summer of 2007 that documented coverage of benthic organisms and fish populations at sites north of the Port entrance channel for a possible sand by-pass project. Coral cover was lower than 1% at all sites and coral density was less than 1/$m^{2.}$ The threatened scleractinian coral *Acropora cervicornis* was documented at the two northern most sites (NSUOC 2008b).

<u>Fishes associated with offshore hardbottom and reef habitats.</u>
Fish populations within the Broward County reef system vary seasonally and annually, according to surveys (Ferro *et al*. 2005; Gilliam *et al*. 2006). Many visual fish surveys have been conducted in the last decade at nearshore hardbottom and inner, middle, and outer reef sites (see DC&A 2009, DC&A 2001, Ferro *et al*. 2005, NSUOC 2008b, FWC et al. 2006, Gilliam *et al*. 2006, Dodge, Gilliam and Shaul 2001). Of the 110 fish species observed, Table 11 lists only the most frequently observed species documented from a 2006 survey on the middle and outer reefs (DC&A 2009). The most diverse families represented were muraenids (moray eels), serranids (sea basses), pomacanthids (angelfishes), labrids (wrasses), scarids (parrotfishes), gobiids (gobies), blenniids (blennies), balistids (leatherjackets), and haemulids (grunts). The highest number of species was documented on the outer reef (DC&A 2009). The most numerically dominant fish were acanthurids (surgeonfishes), labrids, clupeids (herrings), and ephippids (spadefish) (DC&A 2009).

<u>Fishes and benthic organisms associated with adjacent nearshore hardbottom habitats</u>.
A benthic and fish survey was conducted in the summer of 2007 that documented coverage of benthic organisms and fish populations at sites within the nearshore hardbottom habitat, north of the OEC, for a possible sand by-pass project (NSUOC 2008b). Sixteen hard corals were documented, including the threatened scleractinian coral, *A. cervicornis*. *A. cervicornis* was documented at the two northernmost sites using the NMFS *Acropora* survey method. In addition, during a survey for the Department of Navy (NSUOC 2011), *Acropora cervicornis* colonies were documented south of the entrance channel. In 2011, the closest documented *A. cervicornis* colonies to the entrance channel were 150 m south of the southern jetty in the nearshore hardbottom habitat (NSUOC2011). Additional information regarding these corals is found in Section 3.7.2 of this document. Surveys conducted in the nearshore hardbottom area documented only 10 species of fish, the least of the habitats sampled (Coastal Systems International 1997). Labrids and pomacentrids were the dominant species present, while scarids and acanthurids were also commonly observed. Other species of fish that use this nearshore hardbottom area include yellowtail snapper (*Ocyurus chysurus*), bar jacks (*Caranx ruber*), hogfish *(Lachnolaimus maximus*), and porkfish (*Anistroremus virginicus*), as well as many others (Coastal Systems International 1997).

Table 11 Most frequently observed fish species during baseline ecological surveys conducted on the middle and outer reefs near Port Everglades (DC&A 2009)

Common Name	Scientific Name
Family Sea Basses	**Serranidae**
Tobaccofish	*Serranus tabacarius*
Family: Snappers	**Lutjanidae**
Yellowtail Snapper	*Ocyurus chysurus*
Family: Goatfishes	**Mullidae**
Spotted Goatfish	*Pseudopeneus maculatus*
Family: Butterflyfishes	**Chaetodontidae**
Spotfin Butterfly	*Chaetodon ocellatus*
Reef Butterfly	*Chaetodon sedentarius*
Foureye Butterfly	*Chaetodon capistratus*
Family: Angelfishes	**Pomacanthidae**
Blue Angelfish	*Holocanthus bermundensis*
Rock Beauty	*Holocanthus tricolor*
Gray Angelfish	*Pomocanthus arcuatus*
Family: Damselfishes	**Pomacentridae**
Bicolor Damselfish	*Stegastes paritus*
Family:Wrasses	**Labridae**
Hogfish	*Lachnolaimus maximus*
Spanish Hogfish	*Bodianus rufus*
Creole Wrasse	*Clepticus parrai*
Yellowhead Wrasse	*Halichoeres garnoti*
Bluehead Wrasse	*Thalassoma bifasciatum*
Family: Parrotfishes	**Scaridae**
Princess Parrotfish	*Scarus taenipterus*
Stoplight Parrotfish	*Sparisoma chrospterum*
Redband Parrotfish	*Sparisoma aurofrenatum*
Family: Blennies	**Blenniidae**
Roughhead Blenny	*Acanthemblemaria aspera*
Family: Gobies	**Gobiidae**
Dash Goby	*Ctenogobius saepepallens*
Colon Goby	*Coryphopterus dicrus*
Masked/Glass Goby	*Coryphopterus sp.*
Family: Surgeonfishes	**Acanthuridae**
Ocean Surgeon	*Acanthurus bahianus*
Family: Leatherjackets	**Balistidae**
Gray Trigger	*Balistes carpiscus*
Family: Puffers	**Tetradontidae**
Sharpnose Puffer	*Canthigaster rostrata*
Family: Grunts	**Haemulidae**
French Grunt	*Haemulon flavolineatum*
White Grunt	*Haemulon plumierii*
Porkfish	*Anisotremus virginicus*
Family: Herring	***Clupeidae***
Herring	*Harengula spp.*
Family: Spadefishes	**Ephippidae**
Spadefish	*Chaetodipterus faber*

Adapted from DC&A 2009

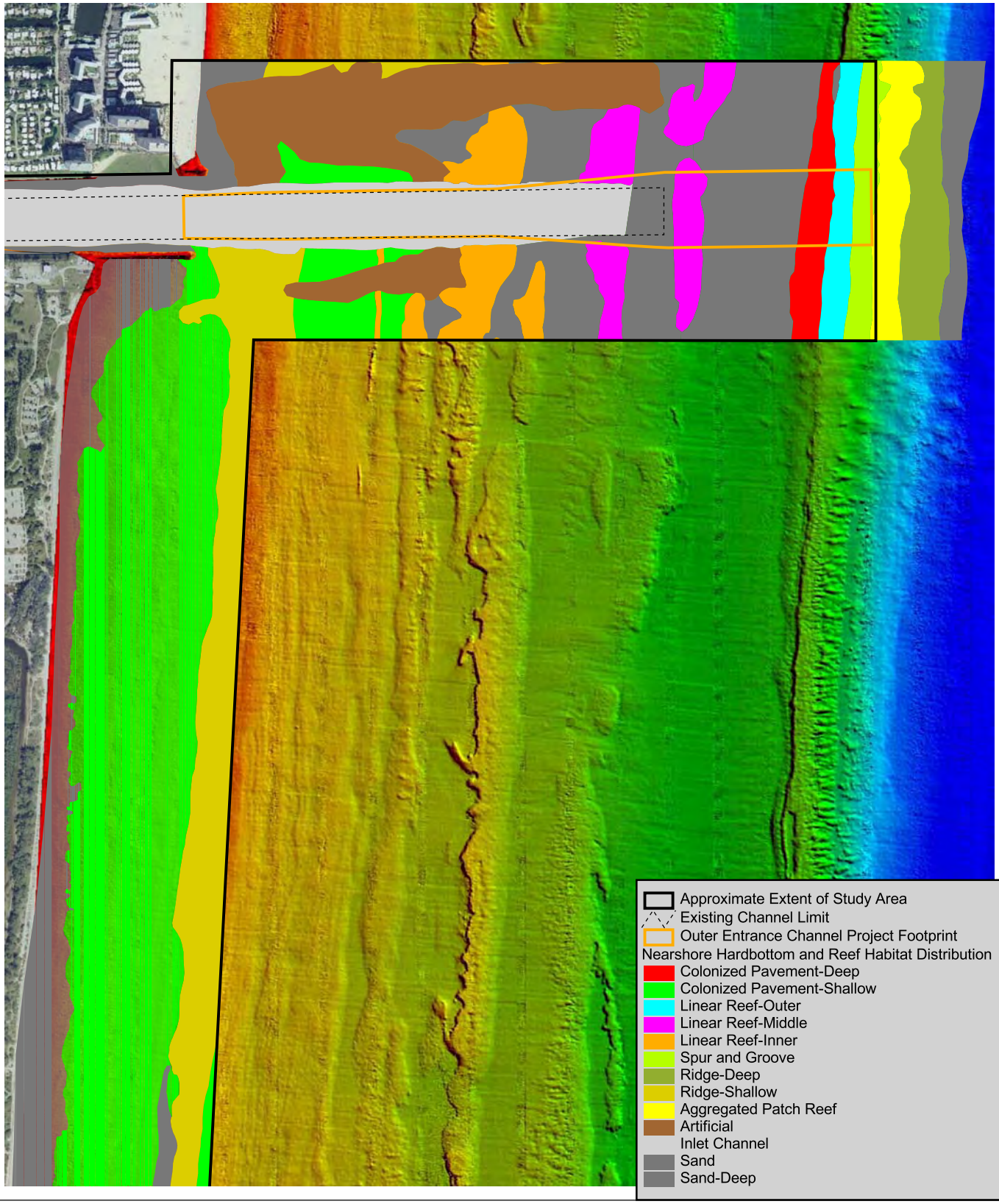
Port Everglades channel habitat.

Little information has been collected on the biota of the channel and adjacent zones due to the hazard of sampling this area (frequent vessel traffic, substantial currents/tides, etc.). Integrated video mapping surveys within the OEC conducted in May 2001, January 2002, and June 2009 resulted in classification of marine resources to create a habitat map of the OEC (Figure 51). Resources within the OEC included sand, low-relief reef, high-relief reef, and scattered rock/rubble. Over 22 species of fish were recorded between the jetties of the entrance channel, the most common of which are listed in Table 12. The area of low-relief hardbottom in water greater than 42 feet is a viable community with both gorgonians and hard corals present. This community is comprised mostly of sponges (e.g. *Ircinia* sp., *Niphates* sp., *Cliona* sp., and *Iotrochota* sp.) and gorgonians (e.g. *Eunicea* sp., *Plexaura* sp. and *Pseudopterogorgia* sp). As demonstrated by the recolonization of the channel walls after the 1980 deepening at Port Everglades, these communities can be expected to recolonize after future dredging events.

Table 12 Most Frequently Observed Fish Species During Baseline Ecological Surveys Conducted in the Port Everglades Harbor Channel

Common Name	Scientific Name
Bluehead Wrasse	*Thalassoma bifasciatum*
Slippery Dick	*Halichoeres bivittatus*
Sergeant Major	*Abudefduf saxatilis*
Cocoa Damselfish	*Pomacanthus variabilis*
Beaugregory	*Pomacanthus partitus*
Dusky Damselfish	*Pomacanthus fuscus*
Spottail Pinfish	*Diplodus holbrooki*
Ocean Surgeon	*Acanthurus bahianus*
Blue Tang	*Acanthurus coeruleus*
Juvenile Grunts	*Haemulon spp.*
Juvenile Snapper	*Lutjanus spp.*

Adapted from DC&A 2001



1500 0 1500 3000 Feet

Nearshore Hardbottom and Reef Habitat Distribution	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1500 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 51

3.6.3 Essential Fish Habitat

3.6.3.1 Overview

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) set forth a new mandate for the NMFS, regional fishery management councils (FMC), and other federal agencies to promote the protection, conservation, and enhancement of Essential Fish Habitat (EFH). The EFH provisions of the Magnuson-Stevens Act support one of the Nation's overall marine resource management goals - maintaining sustainable fisheries. Essential to achieving this goal is the maintenance of the habitat quality and quantity necessary for fishery resources.

EFH is defined in the Magnuson-Stevens Act as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The rules promulgated by the NMFS in 1997 (draft) and 2002 (final) further clarify EFH with the following definitions: waters - aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate - sediment, hardbottom, structures underlying the waters, and associated biological communities; necessary - the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and spawning, breeding, feeding, or growth to maturity - stages representing a species' full life cycle. EFH may be a subset of all areas occupied by a species. Acknowledging that the amount of information available for EFH determinations will vary for the different life stages of each species, the rules direct the FMCs to use the best information available, to take a risk-averse approach to designations, and to be increasingly specific and narrow in the delineations as more refined information becomes available.

Much of the information summarized in this *Existing Conditions- Essential Fish Habitat* section was provided pursuant to NEPA regulations §1501.6 *Cooperating Agencies* in the detailed planning document, "Characterization of Essential Fish Habitats in the Port Everglades Expansion Area" (June 3, 2011), which is enclosed in Appendix H, authored by NOAA's National Marine Fisheries Service, Habitat Conservation Division at the Southeast Regional Office.

The rule also directs FMCs to consider more limited designations for each species. Habitat Areas of Particular Concern (HAPCs) are subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially important ecologically, or located in an environmentally stressed area. In general, HAPCs include habitats highly important for the migration, spawning, and rearing of fish and/or shellfish. Federal actions with the potential to adversely impact HAPCs will be more carefully scrutinized during the consultation process and subject to more stringent conservation recommendations.

The SAFMC (1998a and 1998b) habitats within the study area that are designated as EFH and/or HAPC are shown in Table 13. These habitats have been shown to be important for species of the snapper-grouper complex, penaeid shrimp, spiny lobster, coastal migratory pelagic species, corals, and highly migratory species (Table 1 of NMFS 2011). Also listed is the Mid-Atlantic FMC designation of coastal inlets as EFH for bluefish and the NMFS designation of coastal inlets as EFH for a variety of sharks.

Table 13 Essential Fish Habitat Areas in Study Area

Project Area	EFH and/or **HAPC (in bold)**
Dania Cut-off Canal, Southport Access Channel, Turning Notch, Widener, and Main and North Turning Basins	Estuarine emergent vegetation
	Estuarine shrub/scrub (including mangrove fringe)
	Mangrove wetlands
	Seagrass
	Intertidal flats
	Shallow subtidal bottom
	Estuarine water column
	Unconsolidated bottom
Inner Entrance Channel	**Coastal inlet**
Outer Entrance Channel	**Med-high profile live-/hardbottom**
	Nearshore hardbottom
	Coral and coral reef (**hermatypic habitats**)
	Artificial reefs
	Sargassum
	Attached macroalgae
	Sponges
	Water column
	Shallow subtidal bottom
	Unconsolidated bottom
	Unvegetated softbottom (Sand)

Source: South Atlantic Fisheries Management Council, 1998b

3.6.3.2 Managed Species

Managed species that commonly inhabit the study area include pink shrimp (*Farfantepenaeus duorarum*); spiny lobster (*Panularis argus*); and members of the 73-species snapper-grouper complex, including blue stripe grunts (*Haemulon sciurus*), French grunts (*Haemulon flavolineatum*), mahogany snapper (*Lutjanus mahogoni*), yellowtail snapper (*Ocyurus chysurus*), and red grouper (*Epinephelus morio*). These species use inshore habitats as juveniles and sub-adults and hardbottom and reef communities offshore as adults. Other species of the snapper-grouper complex commonly seen offshore in the study area include gray triggerfish (*Balistes capriscus*) and hogfish (*Lachnolaimus maximus*). Coastal migratory pelagic species also commonly utilize the offshore area adjacent to the study area, including king mackerel (*Scomberomorus cavalla*) and Spanish mackerel (*Scomberomorus maculatus*). As many as 60 corals can occur off the coast of Florida (SAFMC 1998b) and these resources fall under the protection of the SAFMC Coral Fishery Management Plan. A more detailed list of managed species in the project area is found in Table 1 of NOAA (2011).

3.6.3.3 EFH Characteristics

This EIS focuses on habitats in the study area, and specifically those that will be impacted and will require compensatory mitigation. Those EFHs, such as hardbottoms/reefs, seagrass beds, and jurisdictional wetlands are discussed in detail in sections above. However, two additional EFH/HAPCs (unvegetated unconsolidated bottom and inlet channel) also comprise large portions of the study/impact area and therefore warrant specific discussion. Furthermore, a discussion of

the importance of habitat linkages is necessary in order to underscore that various EFHs found in conjunction with others offer additional functional resource value. These descriptions presented below comprise mostly excerpts from NMFS (2011), *Characterization of Essential Fish Habitat in the Port Everglades Expansion Area* found in Appendix H, including material cited therein:

Unvegetated, unconsolidated bottom.

> "Soft bottom habitat is the area with unconsolidated sediment that lacks vascular plants (i.e., no seagrass is present, but macroalgae may be present). Within the interior portions of Port Everglades, the unconsolidated sediments are usually sand, silty sand, or mud with sandy material occurring more commonly in shallow waters and near the inlet and muddy sediments occurring in deepwater waters and towards the Dania Cutoff Canal. Although soft bottom habitat lacks visible structural features, many microscopic plants occur at the sediment surface and burrowing animals commonly occur below the surface (Peterson and Peterson 1979; Alongi 1990); the dominant taxa of macro-infauna are usually polychaetes, crustaceans, mollusks, and echinoderms. One of the more interesting features of soft bottom communities is that the species within this habitat can significantly structure the habitat through processes, such as bioturbation, enhancing water flow through sediments, and tube building, that affect community as a whole. Similarly, soft bottom habitat provides important ecological services to coastal ecosystems (Peterson and Lubchenco 1997). For example, soft bottom areas serve as a storage reservoir of chemicals and microbes. Intense biogeochemical processing and recycling establish a filter to trap and reprocess watershed-derived natural and human-induced nutrients and toxic substances" (NMFS 2011).
>
> "One of the more important services provided by soft bottom habitat [outside the port] is foraging habitat for fishery species and their prey. For example, adult white grunts, which are a federally managed fishery species as well as an important food source for species managed within the snapper-grouper complex, are generalized carnivores that feed mainly on benthic invertebrates (Bowman *et al*. 2000; Potts and Manooch 2001). The high forage value of soft bottom habitat results from the high concentrations of organic matter transported to and produced on soft bottom and the numerically abundant, diverse invertebrate fauna associated with this habitat. While the forage value of soft bottom habitat can vary greatly with position in the landscape, proximity to physical disturbance (such as dredging and wave scour) and chemical disturbances (such as stormwater runoff and low concentrations of dissolved oxygen) can be overriding factors (Pearson and Rosenberg 1978; Diaz and Rosenberg 1995)" NOAA (2011).
>
> "The high availability of food coupled with the refuge for predators make soft bottom habitats, especially those in shallow waters and those close to mangroves, seagrass, live/hardbottom, or inlets, important nursery areas for many species of juvenile fish" (NMFS 2011). Rudolph (1986) and Messing and Dodge (1997) identified 370 species of invertebrates within the shallow-water benthic community, including polychaetes, oligochaetes, mollusks, sipunculids, peracarid crustaceans, platyhelminthes, and nemertina. While these studies did not sample the deeper areas (i.e., the federal navigation channel or turning basins) it is likely the deeper areas have lower abundances and diversity than the shallower areas. The offshore soft bottom communities located within the study area include polychaete and other worms. In an infaunal study conducted offshore of Hollywood Beach, Dodge *et al*. (1991) found dominant taxa were polychaetes (52%), nematodes (14%), and crustaceans (9%). Macroalgal growth is also associated with these communities with the most abundant species being from the green algae genera *Caulerpa* sp., *Halimeda* sp., and *Codium* sp. during the summer months. This is

in contrast to the winter months where *Dictyota* sp. and *Sargassum* sp. are more common (USACE 1996). Invertebrate fauna also utilize this softbottom area and these can include the Florida fighting conch (*Strombus alatus*), milk conch (*Strombus costatus*), king helmet (*Cassia tuberosa*), and the queen helmet (*Cassia madagascariensis*) (USACE 1996). Offshore soft bottom habitats within the study area, in particular between the Middle and Outer Reefs, may provide a corridor for reef species to travel between reef lines and also be an important foraging area for some fish species (Jones *et al*. 1991). See Table 1 of NMFS (2011), located in Appendix H, for a list of species associated with soft bottom habitat and documented in or near the project area. Unvegetated, unconsolidated benthic habitats within the existing channel undergo dredging, i.e., a direct removal of biota and substrates, approximately every 3-5 years to maintain navigation channels and basins. The inner entrance channel was last dredged in 2005 and 2006 for maintenance of necessary navigational depths and is expected to be dredged again in late 2014 or early 2015.

Inlet channel.

"Tidal inlets are HAPCs because of the unique role they play as migratory corridors connecting ocean and estuarine waters that serve as spawning and nursery areas for shrimp, red drum, mackerels, and other species (Hettler and Chester 1990; Lindeman *et al*. 2000; Faunce and Serafy 2007; Serafy *et al*. 2007). It should be noted that habitats, such as seagrass beds, mangroves, hardbottom, coral, and coral reefs, also are HAPCs, and this close proximity emphasizes this important linkage role for this particular inlet. Movement of larval and juvenile fish and shrimp through inlets can vary greatly between inlets and over time with some species migrating nocturnally, within portions of the tidal stream, phases of the lunar cycle or interaction of these factors (Forward *et al*. 1999). The SAFMC designated coastal inlets as EFH for species managed under the snapper-grouper and shrimp FMPs. Additionally, the Mid-Atlantic Fishery Management Council designated coastal inlets as EFH in the bluefish (*Pomatomus saltatrix*) FMP" (NMFS 2011).

Habitat Linkages.

NMFS (2011) states that "…many exploited coral reef fishes occupy inshore regions as juveniles before migrating offshore to reproduce thereby undergoing an ontogenetic pattern of habitat utilization... As described in the section above, coastal inlets are migratory corridors for fishery resources that utilize oceanic and estuarine habitats. Although not well studied, the biogeography of the Port Everglades area provides for a unique landscape and ecological linkages between coral reef, mangrove, and seagrass habitats..."

"Mangrove and seagrass beds are essential habitats for fishes, including species commonly found on reefs. Life history stages that utilize these habitats include the critical early stages (egg, larval, settling, postlarvae, and developing juveniles). Mangrove and seagrass habitats intercept large numbers of larvae and provide abundant food resources and protection from predators (Parrish 1989)…The turbid waters in these areas may decrease the foraging efficiency of predators (Blaber and Blaber 1980)" (NMFS 2011).

"Coral reef fishes often use shallower habitats as juveniles (Lindeman *et al* 2000) and various combinations of these habitats may be used during adult diurnal feeding

migrations or seasonal shifts in cross-shelf distributions (SAFMC 2009). Nagelkerken *et al*. (2000) document that Lutjanidae and Haemulidae settle in seagrass beds rather than on reefs. Other species represented in seagrass beds and mangrove estuaries include juvenile mutton, gray, dog, lane (*Lutjanus synagris*), and yellowtail snappers; and goliath, red, and gag groupers; and hogfish (SAFMC 2009). In addition, early juvenile Nassau grouper (*Epinephelus striatus*) have also been found to use macroalgal habitats along mangrove-lined channels (Eggleston 1995). Habitats within Port Everglades may provide EFH for newly settled stages of mutton snapper, which are known to occur in seagrass habitats (Gilmore, unpubl. data) and generally use mangrove prop roots or adjacent shallow rock and coral reef formations as larger juveniles (Gilmore, unpubl. data). Similarly, Mumby *et al*. (2004) found that the community structure of coral reefs was influenced by the presence of mangroves in the vicinity, and the total adult biomass of several species was higher" (NMFS 2011).

"Collections in both seagrass beds and mangroves suggest that there is an integral link between these habitats with tripletail, snook, gray snapper, red drum, and goliath grouper, for example, occurring over seagrass beds or other adjacent bottoms as adults or large juveniles, but using the mangrove prop-roots as habitat during juvenile stages. Spotted seatrout, striped and white mullets (*M. curema*) and great barracuda (*Sphyraena barracuda*) juveniles are also common inhabitants (SAFMC 2009). There are also recognizable and predictable interactions where different life stages of fish move between reefs and seagrass beds on a diurnal basis. The best known examples in Florida are species of grunts which utilize reefs by day and seagrass beds by night" (NMFS 2011).

"Two species known to be present within coral reef habitats within the Port Everglades expansion area, gray snapper and bluestriped grunt, use vegetated habitats during their ontogeny (Faunce and Serafy 2007). In this study, both species exhibited a three-stage ontogenetic strategy, including settlement and grow-out within seagrass beds, expansion to mangrove habitats, and increasing utilization of inland mangroves during the dry season and with increasing body size. They also observed that for fishes inhabiting mangroves, the distance from an oceanic inlet and water depth were stronger predictors of reef fish utilization than factors like latitude, temperature, or habitat width. These findings highlight that the nursery function of mangrove shorelines is likely limited to the area of immediately accessible habitat, and that more expansive mangrove wetlands may contain a substantial number of larger adult individuals. It has also been suggested that the presence of mangroves and seagrass beds serve as extra "waiting room" habitats for juvenile coral reef fishes, and that adopting such a life-history strategy may buffer against poor recruitment years (Parrish 1989)" (NMFS 2011).

Further information on other EFH in the project area (channel wall habitats, inner reef habitats, etc.) may be reviewed in NMFS (2011), attached in Appendix H as previously indicated.

3.6.4 Other Fishery Resources

3.6.4.1 Introduction

To date, USACE was unable to locate any fishery or non-fishery dependant surveys of fishes or invertebrates within the boundaries of the inner harbor, and Florida FWC has confirmed that it has not conducted fishery independent sampling at Port Everglades. Given that, other sources of data were sought.

Data collection activities at power plants in/near the project area are useful for determining which species frequent the area as well as for an appreciation of ongoing mortality in/near the project area. Data are acquired due to the use of the plants' water cooling systems, which incidentally trap or take fishes and macroinvertebrates. According to an *Experimental Fish Guidance Devices Position Statement* (NMFS 1994), the three main causes of delay, injury, and loss of fish at water intakes are entrainment, impingement, and predation. *Entrainment* occurs when the fish is pulled into the diversion and passes into a canal or turbine. *Impingement* is where a fish comes in contact with a screen, a trashrack, or debris at the intake. This causes bruising, descaling, and other injuries. Impingement, if prolonged, repeated, or occurs at high velocities also causes direct mortality. Intakes increase predation by stressing or disorienting fish and/or by providing habitat for fish and bird predators.

A 2008 report prepared for Florida Power and Light recorded impingement mortality and entrainment at the Port Everglades Power Plant (PPE) based on data collected between April 2006 and 2007. The study was conducted in response to Section 316(b) of the Clean Water Act (69 FR 41567) which included numeric performance standards for reductions to impingement and entrainment mortality (I&ME). Using this data allows USACE to characterize the species inhabiting or migrating to the inside of the Port Everglades inlet. The report included fish eggs and larvae in the analysis. The intake for the power plant is located at the mouth of Slip No 3 in the harbor. The slip is similar to a small cove or embayment that could potentially affect the composition and abundance of species. This location is subject to substantial natural variability resulting from alternating tidal and wind-driven flows along the Intracoastal Waterway (i.e., the SAC in the project area) and the harbor's proximity to the OEC and Atlantic Ocean.

3.6.4.2 Impingement Data

A total 5,577 individual organisms consisting of 102 fish and 47 invertebrate taxa were collected from PPE. The two most common species found during the study were the big-eye anchovy (*Anchoa lamprogrotaenia*) and the broad-striped anchovy (*Anchoa hepsetus*), representing 67% of all the fish that were entrained or impinged during the calendar year of data collection. Other dominant species include bandtail puffer, checkered puffer, spotfin mojarra, and the tidewater mojarra, which when added to the anchovy species previously mentioned, comprise 85% of the impinged fish. This impingement biomass was dominated by checkered puffer (33.8%), followed by lookdown (16.45%) and bandtail puffer (12.1%). Blue crab was the dominant invertebrate species on a biomass basis with 4.2 kg collected.

Pink shrimp represented 23% of the annual invertebrate impingement and 4% of the total impingement. Other dominant invertebrate species included Atlantic brief squid, sargassum crab, caridean shrimp, mud crabs, penaeid shrimp, roughneck shrimp, portunid crabs, and blue crabs, together comprising 76% of impinged invertebrate species. An estimated total of 63.2 kg of fish and invertebrates was impinged during the study period.

The highest impingement rates were observed from mid-July to September due to the presence of big-eye anchovy. Peak abundance of impinged fish occurred during the first week of September when impingement of big-eye anchovy comprised approximately 25% of the overall annual impingement rate. Pink shrimp were the dominant shellfish species impinged, with an early season peak during late April through June and throughout September. Impingement rates of small invertebrates such as non-commercial crabs, shrimp, and squid species varied throughout the year, with peaks in December to January, March, June, and September. Of the 5,557 individuals collected during the 26 sampling events, 78% were taken at night.

3.6.4.3 Entrainment Data

A total of 72,052 fish and 197,988 invertebrates were collected by entrainment sampling at PPE during the 2006-07 sampling program, consisting of 84 fish and 38 invertebrate taxa. Of the invertebrates, 2,223 individuals (0.79% of the total) were recreational or commercially important shellfish, with the bulk of invertebrates consisting of non-commercial crab and shrimp species (e.g., mud crabs, grass shrimp, mole crabs).

Fish entrainment was dominated by organisms of unidentifiable taxonomy (83.4%, primarily unidentified eggs), followed by a complex comprised of Carangidae, Labridae, and Sciaenidae (4.46%). Unidentifiable eggs were predominately undeveloped with no differential characteristics that would allow further taxonomic differentiation. Some may have been spawned shortly before collection and thus and cell division was not yet evident, while others were unfertilized and not viable. Fish eggs accounted for 25% of the total entrainment and 93% of the annualized fish entrainment. Fish larvae comprised 7% of the fish entrainment count and two percent of annual entrainment. Invertebrates were dominated by decapod zoea (88%), comprised mostly of brachyuran crabs (mud crabs, sargassum crabs, 47 percent), caridean shrimp (grass shrimp, 29%), and anomuran crabs (hermit crabs, mole crabs and porcelain crabs; 12%).

Entrainment exhibited an initial peak in January followed by a gradual decline through May, a slight upward trend in the summer, and an annual peak during the fall. There was little day to night variation in total entrained organisms, with entrainment rates at night approximately 7% higher than the daytime rates.

Total annual entrainment for the study based on actual flows was 38.7 billion organisms, including an estimated 10.3 billion fish and 28.4 billion invertebrates. Total entrainment on an annualized basis based on design flow was 46 billion organisms. Annualized fish entrainment was estimated to be 12.5 billion, while annualized entrainment of invertebrates was estimated at 33.5 billion. Maximum design flow entrainment by life stage included approximately 11.6 billion eggs, 34 billion larvae and 435 million juveniles, adults and unidentifiable life stages.

3.7 Protected Species

3.7.1 Terrestrial Species

Utilization of the terrestrial habitats within the project area by protected species is limited due to the highly urbanized nature of the region. However, the recent discovery of the re-appearance of the federally endangered beach clustervine (*Jacquemontia reclinata*) is an encouraging sign of the value of JUL habitats (Wright 2011) and the effectiveness of recent habitat restoration measures. Other flora in the project area includes state-protected golden leather fern (*Acrostichum aureum*) in the fringing areas of mangrove swamps and along various watercourses. Other listed plant species such as sea lavender (*Argusia gnaphalodes*) and beach peanut (*Okenia hypogaea*) occur in the dune areas and estuarine habitats on JUL. These plants are listed by the Florida Department of Agriculture, but have no federal status. A number of listed and migratory bird species utilize the area and surrounding waters for feeding, loafing, and roosting.

A detailed discussion of the biological status of each species and the effects of the proposed action is included in the ESA consultation documents (prepared by USACE, USFWS and NMFS), which are located in Appendix F of the EIS.

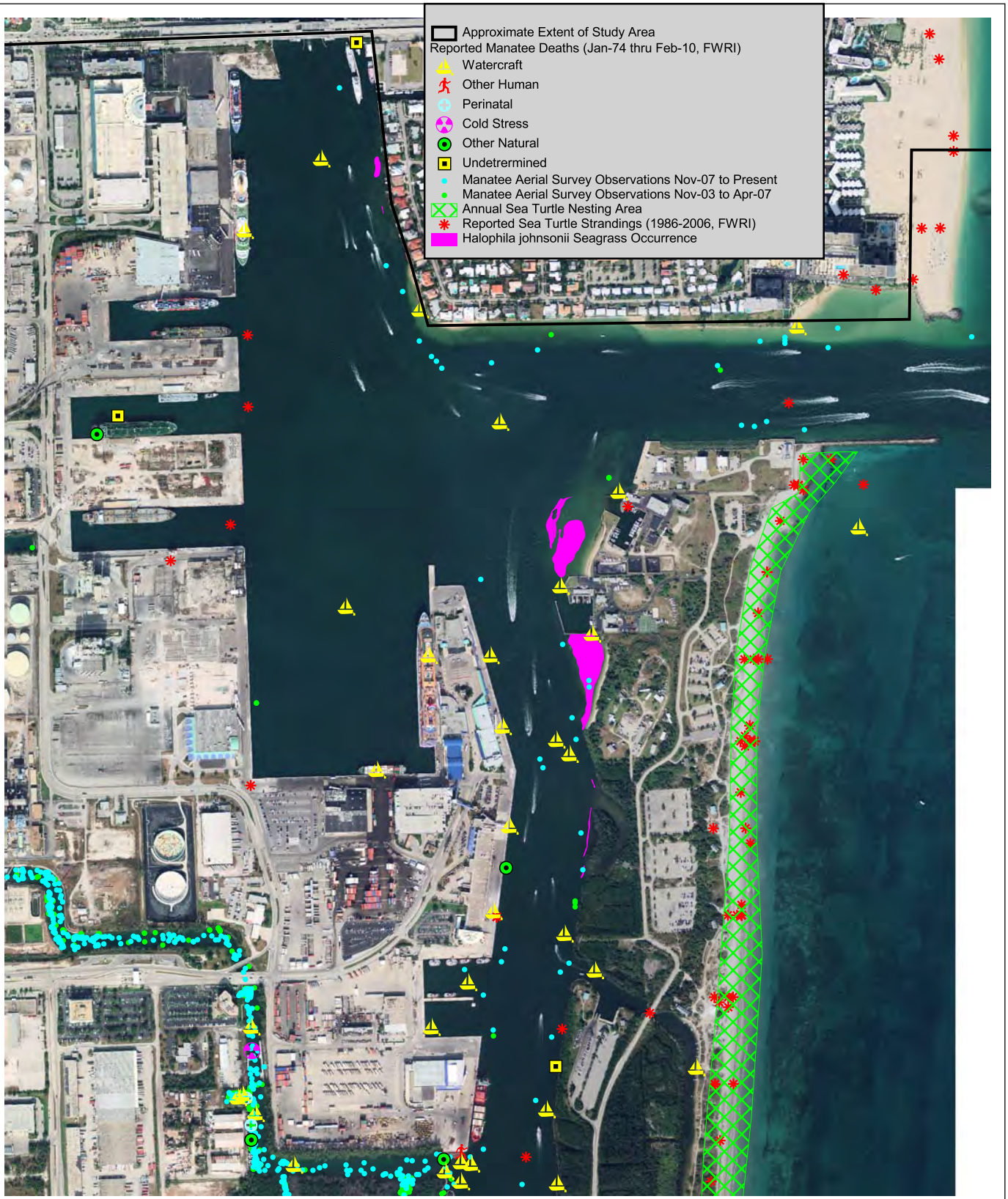
The piping plover (*Charadrius melodus*), a migratory shorebird known from Broward County, is protected as a threatened species under the ESA and the State of Florida, and is also protected under the Migratory Bird Treaty Act. The species breeds in the northern Great Plains of the U.S. and along beaches of Lake Michigan and Lake Superior. Individuals of the species winter along the Atlantic Gulf Coast from North Carolina to Texas (American Ornithologists' Union, 1998). Piping plovers migrate to Florida's coast in September and are found there through March, often on the accreting ends of barrier islands and along coastal inlets (USFWS 1995). Foraging areas include intertidal beaches, mudflats, sandflats, lagoons, and salt marshes, where they feed on invertebrates such as marine worms, insect larvae, crustaceans, and mollusks. There has not been documented nesting of the species in Florida.

The least tern (*Sterna antillarum*) is a small member of the gull family (Laridae) listed by Florida as a threatened species (FWC 1997) and federally protected under the Migratory Bird Treaty Act (but not ESA). The eastern least tern population breeds primarily from coastal Maine through Florida (American Ornithologists' Union 1998), including Broward County. Florida populations arrive each year in April, and typically choose open sandy substrates to form breeding colonies. Although typically nesting on open, sandy beach areas, an increasing number of colonies are located on open, flat, artificial surfaces (e.g., warehouse roof tops). Breeding and nesting occur through August. Least terns forage along coastal areas feeding on small fishes, as well as some crustaceans and insects.

3.7.2 Marine Species

3.7.2.1 Johnson's Seagrass

Halophilia johnsonii was listed as a threatened species by NMFS on September 14, 1998 (63 FR 49035) and the final rule for critical habitat designation for *H. johnsonii* was published 5 April 2000 (Federal Register, vol. 65, No. 66). Although NMFS has listed *H. johnsonii* as a threatened species under Section 4 of the ESA, it has not promulgated a 4d rule under the Act, and as a result, there is no prohibition on take. *H. johnsonii* has the most limited geographic ranges of all seagrass species. It is known to occur only from 21.5 km north of Sebastian Inlet (i.e., near Palm Bay in Brevard County) south to northern Biscayne Bay (i.e., near North Miami) on the east coast of Florida (Kenworthy 1997; Virnstein and Hall 2009). Results from seagrass surveys conducted for the project (DC&A 2000, 2001, and 2006) demonstrated that *H. johnsonii* occurs within the SAC and DCC (see Figures 52 and 53). There is not any designated critical habitat in the project area. An assessment of the biology and ecology of Johnson's seagrass, *H. johnsonii* is found in Section 3.6.1.2.



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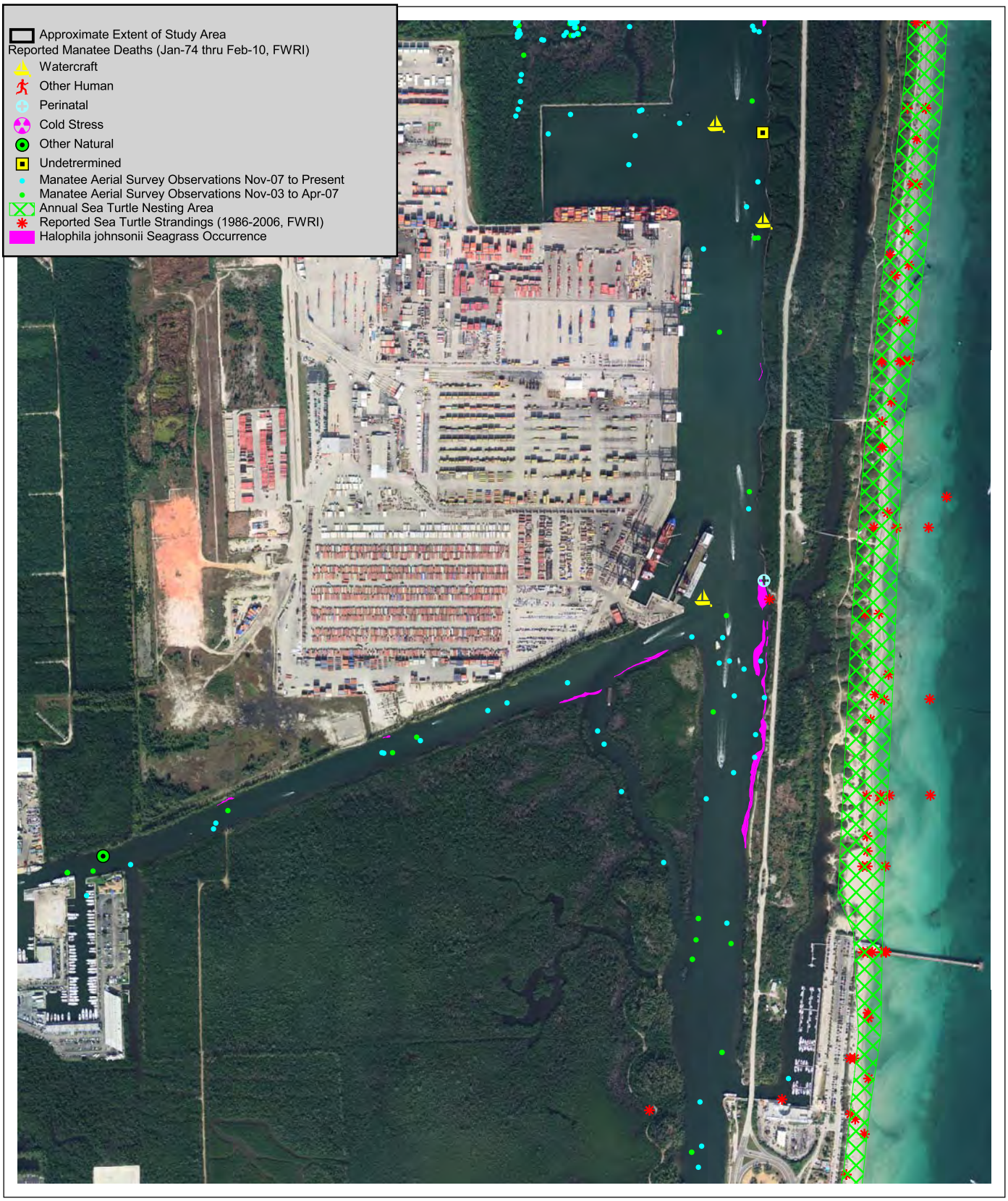
Overview of Threatened and Endangered Species Data - North	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 52



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Overview of Threatened and Endangered Species Data - South	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 53

3.7.2.2 Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*) has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, *P. pectinata* historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish *P. perotteti* (west and south of Port Arthur, TX) (Adams and Wilson, 1995). Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months. It also was an occasional visitor to waters as far north as New York.

Smalltooth sawfish, *P. pectinata,* were once common in Florida as detailed by the Final Smalltooth Sawfish Recovery Plan (NMFS 2009b) and are very rarely reported in southeast Florida. Their core range extends along the Everglades coast from the Ten Thousand Islands to Florida Bay, with moderate occurrence in the Florida Keys and at the mouth of the Caloosahatchee River. Outside of these areas, sawfish are rarely encountered and appear to be relatively rare (Simpfendorfer 2006). It does not appear to be a coincidence that the core range of smalltooth sawfish corresponds to the section of Florida with the smallest amount of coastal habitat modification.

USACE requested sighting information from the FWC smalltooth sawfish sighting database on January 16, 2008 for the "area in and around Port Everglades, Broward County". In an email dated January 16, 2008 FWC sawfish Biologist, Gregg Poulakis referred USACE to the FWC sawfish database previously provided to USACE in October 2007. A search of that database found a total of seven sightings of *P. pectinata* in Broward County between 1993 and 2007 ranging in size from 2.4 to 4.1 meters in length (pers com, Gregg Poulakis, FWC, Port Charlotte, FL, email dated 16 January 2008). The locations of these sightings ranged from Pompano Beach through Lauderdale-By-the-Sea, including three sightings in the vicinity of the Port. In July 2011, USACE contacted FWC again, and was referred to NMFS-OPR, who has taken over management of the database. NMFS (via S. Norton, pers com) provided a figure of all of the smalltooth sawfish sightings throughout Broward County, which is shown below (Figure 54). NMFS provided data pertaining to a total of 15 individuals documented in Broward County between 2003 and 2011. Possibly the most notable sighting of a *P. pectinata* in Broward County, in the vicinity of the Port, took place at the Florida Power & Light (FP&L) Port Everglades power plant discharge canal on March 17, 2006 during an effort to capture an injured manatee in the canal (Figure 55). Based on data from FWC, the sawfish was approximately 10 to 12 feet (120 to 144 inches) in length and was released from the manatee capture net without harm.

Habitat use by sawfish appears to be divided by animal size. Small sawfish (0-79 inches/0-200 cm) use shallow water areas as nursery areas often dominated by red mangrove habitats. The mangrove prop roots help serve as shelter against predation (NMFS 2009b and Simpfendorfer 2006). There is limited data available on habitat usage for large juvenile sawfish (>79 inches/201 cm). One tagged individual was recorded in water depths of less than 17 feet for 120-days (NMFS 2009b). Simpfendorfer found that a large percentage of animals greater than 300 cm (3 meters) in size were found in deeper water. Adult smalltooth sawfish use shallow coastal waters to deep shelf waters of up to 400 feet (NMFS 2009b). They may use navigation channels as a transit corridor between the shallow coastal and deeper water habitats. Mote Marine Laboratory (Simpfendorfer 2006) prepared a Habitat Suitability Index (HSI) for sawfish under contract to NOAA, for the entire state of Florida and found, that on a scale of 0 to 9 (with 9 being the best possible habitat for smalltooth sawfish), the water habitats in Broward County ranked between 2 and 3 on the HSI. This finding was based on the water depths adjacent to mangroves, distances to mangrove buffer, and salinity. It should also be noted that Broward County's tidal waterways are unique compared to other Florida coastal counties. Characterized as predominately linear, the marine waterways rarely exceed 1,000 feet in width and most shorelines are stabilized with a

seawall, rip-rap or other erosion control system (Broward County 2007). This determination by Simpfendorfer supports USACE's determination that the Port's existing habitats are not optimal for sawfish; the area is extremely limited for use by juveniles due to the lack of shallow water (less than one meter in depth) directly adjacent to large areas of mangroves. However, this does not mean that the areas near Port Everglades cannot support sawfish. This is also shown in the history of sawfish sightings in Broward County. A review of the NOAA sawfish database provided one record of a sawfish smaller than two meters (168 cm), located offshore of Broward County near Pompano Beach, approximately 15 miles north of Port Everglades (Amanda Frick, NOAA, pers com, 25 July 2011). To date, no sawfish smaller than 2 meters (the size at which sawfish attain sexual maturity) has been documented within five miles of Port Everglades or within the boundaries of the Port.

NMFS released the final recovery plan for the smalltooth sawfish in January 2009 (NMFS 2009b), and designated critical habitat for the species in September 2009 (74 FR 45353).

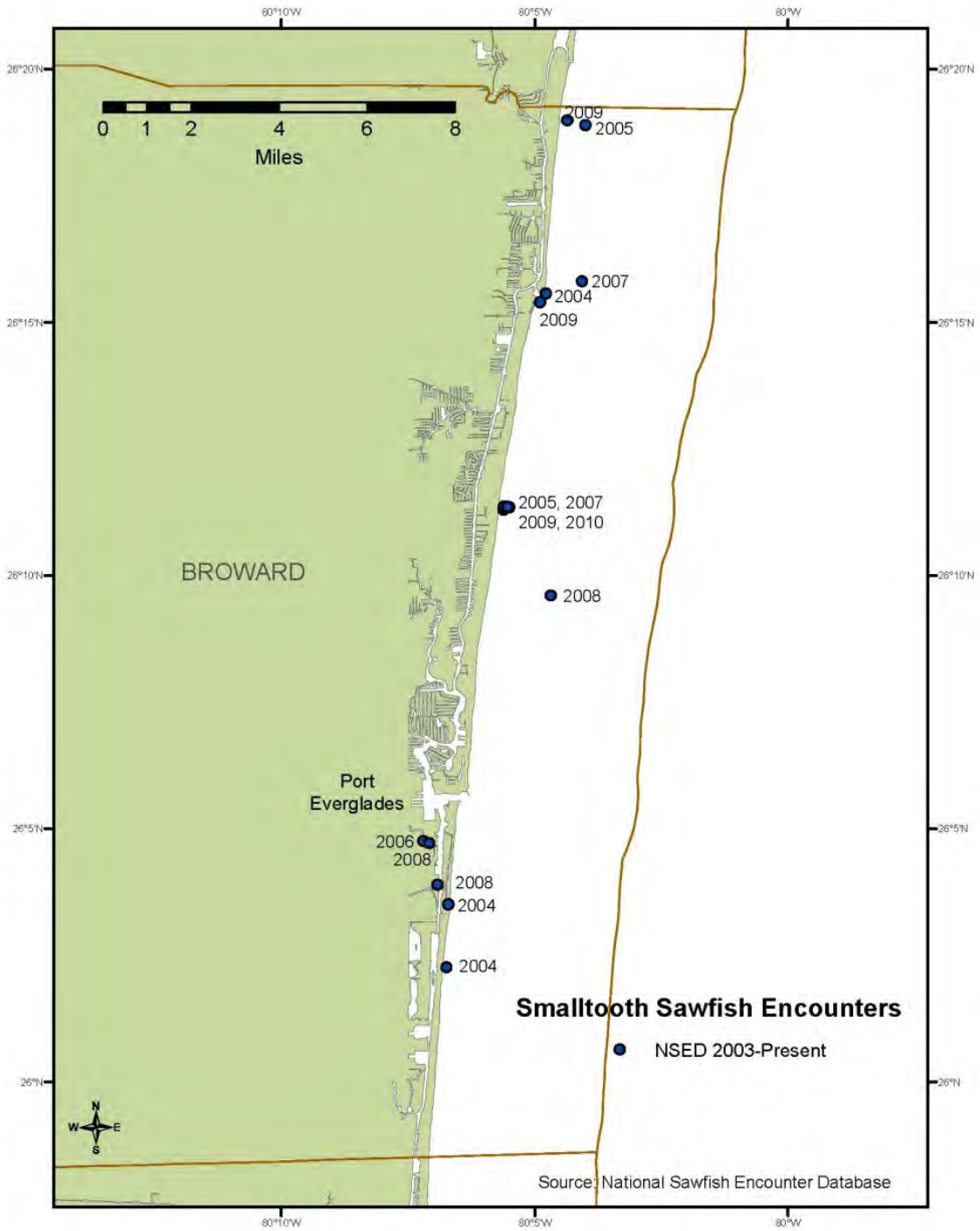


Figure 54 Smalltooth sawfish observations, Broward County, Florida (2003-2011)

Figure 55 Adult smalltooth sawfish incidentally captured in the FP&L power plant discharge canal

Source: FWC (March 2006)

3.7.2.3 Sea Turtles

Broward County is within the normal nesting range of three species of sea turtles: the threatened loggerhead (*Caretta caretta*), the endangered green turtle (*Chelonia mydas*), and the endangered leatherback (*Dermochelys coriacea*). The endangered hawksbill sea turtle (*Eretmochelys imbricata)* has also been recorded nesting in the County on rare occurrences (Table 14). The majority of sea turtle nesting activity in Broward County occurs during the summer months of June, July, and August, with nesting activity occurring as early as February 28 (as observed at Deerfield and Hillsboro Beaches) and as late as September (Burney and Margolis 1999). The waters and habitats offshore of Broward County are also used for foraging and shelter for the three species listed above and possibly the hawksbill turtle and the Kemp's ridley turtle (*Lepidochelys kempii*) (USACE 2000). In May 2014, NMFS finalized a designation of critical habitat offshore which includes shallow nearshore waters as nearshore reproductive habitat and offshore breeding habitat in designated unit LOGG-N-19 (NMFS, 2014). Due to the heavily developed nature of the Broward County coastline, the relative location of Highway A1A to the beach, and extensive beach front lighting, all of which have the potential to negatively impact nesting sea turtles and their hatchlings, Broward County has relocated all discovered nests at Pompano Beach, Deerfield Beach, Hollywood-Hallandale, and Fort Lauderdale since the inception of its sea turtle conservation program in 1978 (Burney and Margolis, 1998). In 2005, the State of Florida changed its policy regarding relocation of nests, and decreasing the number of nests relocated in Broward County to approximately 65-70% of the deposited nests countywide and then to about 28-30% of the nests in 2006 and 2007 (pers com, Lou Fisher, Broward County, 2007). Sea turtle nests located within the boundaries of JUL are not typically moved unless their location is in jeopardy from storm surge, tidal inundation, or erosion (pers com, S. Leve and E. Cowan, FDEP 2011). If nests are relocated, they are typically moved south to a natural area with slightly higher elevation.

Table 14 Sea Turtle Nesting in Broward County: Number of Nests by Year and Species

Year	Green	Loggerhead	Leatherback	Hawksbill
2012	209	3,284	46	0
2011	261	2,126	5	0
2010	268	2,283	14	0
2009	71	1,808	45	0
2008	276	1,929	14	0
2007	233	1,593	41	0
2006	138	1,740	15	0
2005	208	1,819	25	2
2004	153	1,826	4	0
2003	78	2,335	12	0
2002	216	2,070	18	0
2001	26	2,321	39	0
2000	255	2,674	13	0
1999	24	2,584	12	0
1998	200	2,643	14	0
1997	29	2,216	42	0
1996	130	2,902	2	0
1995	52	2,567	15	0
1994	123	2,180	9	1

Data source: FWRI 2013

Between 1991 and 2012, 36 stranded sea turtles have been reported within or near Port boundaries (see Figures 52 and 53): 20 loggerheads, 9 green turtles, 4 hawksbill turtles, and 3 unidentified species. Of these 36, 16 were documented as incidental captures. One green turtle was caught on hook and line at John U Lloyd Beach State Park, and 15 (11 loggerheads, 3 green turtles, and one unknown) were caught in the FP&L power plant at Port Everglades (A. Foley, FWRI, pers com, March 21, 2013).

3.7.2.4 American Crocodile

The distinct population segment of American crocodile (*Crocodylus acutus)* found in Florida is a federally listed threatened species under the ESA (FR 72 13027). Nesting for the crocodile begins in March and extends until late April or early May until the eggs are laid. They build their nests in well-drained soil at sites adjacent to deep-water. Adult crocodiles feed at night on schooling fish in creeks, open water, and deep channels. Crocodiles are shy animals and prefer quiet, inland ponds and creeks and protected coves (Figure 56). They also prefer natural, undisturbed areas for nesting, resting, and feeding (USFWS 1999).

The species is distributed along coastal and estuarine shores of the extreme southern Florida peninsula. Crocodiles primarily nest from Florida Bay to Turkey Point and on northern Key Largo. In Broward County, crocodiles have been confirmed as being present in West Lake Park (M. Cherkiss, USFWS; and F. Mazotti, University of Florida; pers com, August 1, 2011). However, nesting has not been confirmed in West Lake Park.

Source: A. Sosnow – Port Everglades.2005

Figure 56 American crocodile observed in Port Everglades

3.7.2.5 West Indian Manatee

The West Indian manatee (*Trichechus manatus*) has been listed as a protected mammal in Florida since 1893, when the state legislature made it illegal to kill or capture a manatee without a permit. The manatee is federally protected under the MMPA as a depleted species and was listed as an endangered species throughout its range in 1967 (32 FR 4061) and received federal protection with the passage of the ESA. Although critical habitat was designated in 1976 for the Florida subspecies (*Trichechus manatus latirostris*) (50 CFR 19.95(a)), there is no federally designated critical habitat in the project area (Broward county is the only coastal county in Florida that lacks designated critical habitat). Florida provided further protection in 1978 by passing the Florida Marine Sanctuary Act designating the state as a manatee sanctuary and providing signage and speed zones in Florida's waterways. Broward County also provided county-wide protections to the manatee with the passage of the Broward County Manatee Protection Plan (Broward County 2007).

Port Everglades has been actively involved in manatee protection and public awareness efforts with its tenants, users, and the public at large. Their efforts have included the following:

(1) posting manatee warning and speed zone signs throughout the Port;
(2) posting the former "EPA slip" in the FP&L discharge canal as a "Manatee Nursery Area" to restrict boaters and the general public;
(3) developing and implementing a manatee protection plan for dredging activities;
(4) developing and implementing a manatee protection plan for blasting activities;
(5) deepening Manatee Lagoon to allow manatees to utilize the area during all tidal stages and increase the flow of warm water;
(6) installing floating barricades and signs to prevent access to the manatee nursery area;
(7) providing Lagoon Protection at the John U. Lloyd SRA;
(8) funding harbor manatee research by the Service, the Miami Seaquarium conducted by Dr. Jesse White, and other researchers including Wilcox, Reynolds, and Fletemeyer;
(9) participating in law enforcement to prevent harassment of manatees by swimmers;
(10) sending letters to all tug captains prior to manatee season (November 15 – March 31) to remind them of the upcoming season and manatee protection measures;
(11) developing a manatee protection plan that includes the placement of four-foot-wide bumpers throughout the port, along the slips, to hold ships four feet away from the bulkheads, thus reducing the potential for a manatee to be crushed between a ship and the bulkhead;
(12) developing outreach programs and materials such as brochures, seminars and public presentations;
(13) donating a satellite tag to manatee researchers at the USFWS; and
(14) monitoring manatee movements within the Port as ships are being moved, and maintaining logs of these manatee sightings.

Surveys show that during the winter months when temperatures drop, manatees from north Florida and Miami-Dade County will migrate to the FP&L power plants (Port Everglades and Fort Lauderdale) (Deutsch 2000). Both of these warm water refuge areas are designated as Manatee Essential Habitat by Broward County (Broward 2007), although not as designated critical habitat under the ESA by USFWS. A variety of survey efforts have documented that the FP&L plants at Port Everglades and Fort Lauderdale can serve as warm water refugia for manatees during cold

weather (Figures 57 and 58). Mezich 2001 reported as many as 276 manatees; while the maximum one-day count of manatees reported by Laist and Reynolds (2005) at the Port Everglades and Fort Lauderdale power plants were 290 and 221 animals, respectively, and Reynolds (2007) reported a one-day count of 273 animals at the Fort Lauderdale power plant on January 8, 2006 (Reynolds 2006). A review of annual reports to FP&L by Dr. Reynolds of Mote Marine Lab provided manatee population information associated with the Port Everglades and Fort Lauderdale Power Plants (Reynolds 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002 and 2001). Winter survey data for the two plants are shown in Figures 57 and 58. Surveys were not conducted in the winter of 2007/2008 because Florida did not experience any extreme cold fronts that winter.

Mezich (2001) hypothesizes that manatee preference for the Port Everglades plant may be changing as recent years have shown a decrease in the number of animals using the Port Everglades plant and an increase in the number of animals using the Fort Lauderdale plant located west of the Port. A review of the data from Reynolds' reports to FP&L (2011, 2010, 2009, 2008, 2007, 2006, 2005) would seem to support this belief. The growth in usage of this plant may also be attributable to its more consistent releases of warm water and isolated location with less human disturbance than the Port Everglades plant site (Laist and Reynolds 2005). Due to the scarcity of forage material in Broward County, Mezich (2001) stated the following:

> "Manatees that winter at the Broward County power plants are foraging primarily on aquatic vegetation in Dade County. Distribution and abundance of freshwater aquatic vegetation in the area of the Broward county power plants is relatively limited and relegates to vegetation growing in the canals on the shoreline…The most significant estuarine foraging are located in Dumfounding Bay, North Biscayne Bay (between 79th street and Julia Tuttle Causeways), South Biscayne Bay primarily along the west side of the bay and the northwest shore of Virginia Key."

Deutsch *et al.* (2003) noted that the manatees that utilize the Port Everglades power plant during winter cold spells exhibit three trends in movement to access forage. As previously stated, some move south into Biscayne Bay, some move north into Lake Worth Lagoon and some move further west toward the Fort Lauderdale FP&L plant to access freshwater forage and mangroves. Manatees typically demonstrate a diurnal feeding pattern when at the power plants. They spend the mornings into the early afternoons in the warm discharge waters at the plant, and then move away from the plant to forage since the sun has warmed the surrounding waters. As air temperatures (and subsequently water temperatures) drop, they return to the power plant discharges' thermal refuges.

During the summer months when the water warms, manatees return to the counties to the north and south to forage and reproduce. However, telemetry and aerial surveys confirm manatees are present within Broward County all year (Deutsch 2000). Broward County conducts aerial surveys by helicopter flights throughout the year. Recent surveys conducted between 2004 and April 2011 have documented between 8 and 455 manatees in all waterways of Broward County (Broward County 2011).

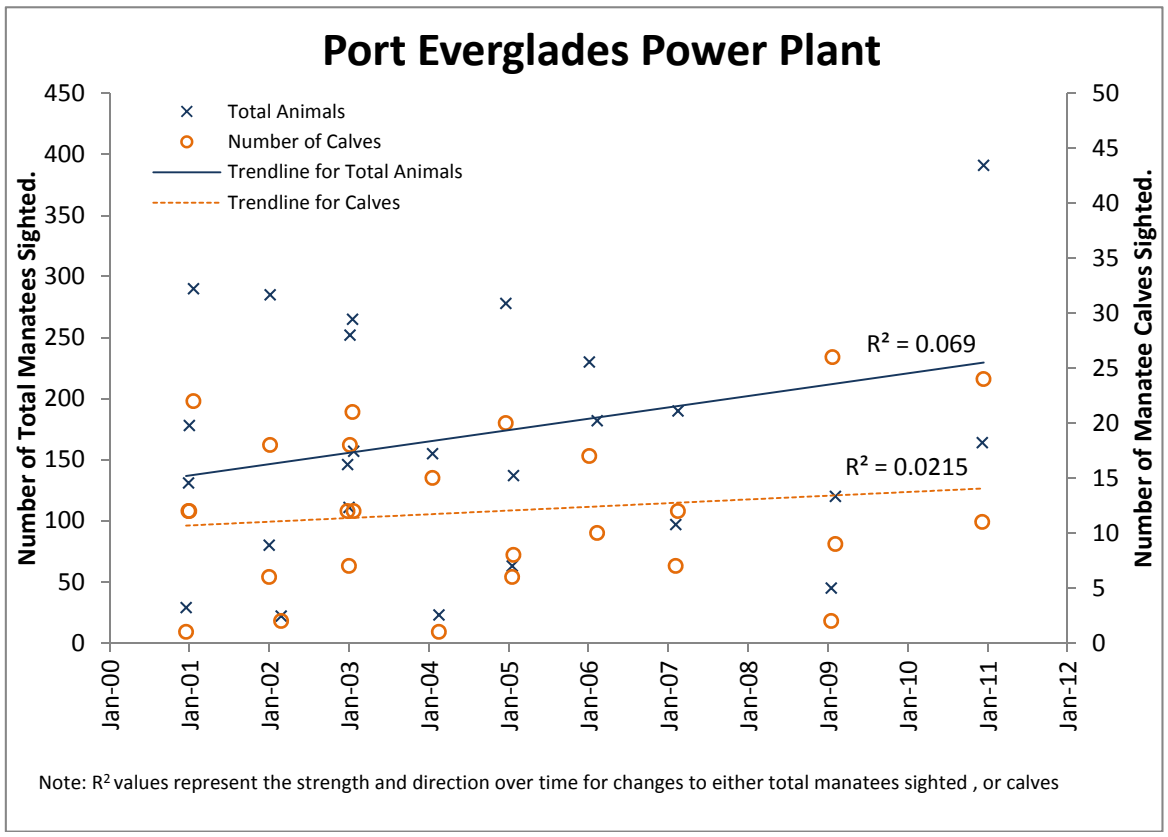


Figure 57 Aerial Sightings of Manatees at Port Everglades Power Plant (2000-2011)

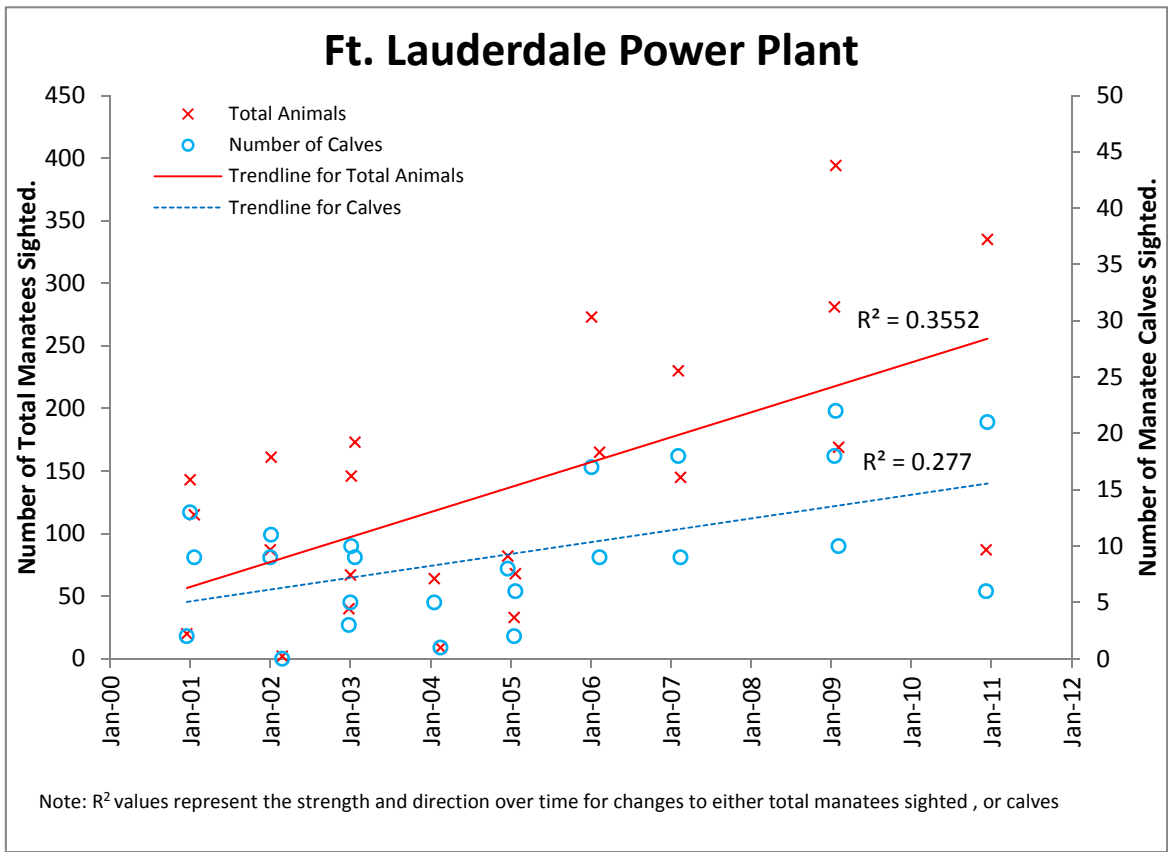


Figure 58 Aerial Sightings of Manatees at Fort Lauderdale Power Plant (2000-2011)

FP&L has temporarily ceased operations at the current Port Everglades location. Demolition of the current plant was completed in 2013 and construction of the new plant is expected between 2014-2016 with the plant online and operational in 2016 (based on information provided on the FP&L website: http://www.fpl.com/environment/plant/port_everglades.shtml, accessed 3/13/2013). FP&L has been preparing, with USFWS and FWC, an environmental monitoring plan and a biological monitoring plan. During construction, FP&L will maintain an "Interim Warm-Water Refuge" (IWWR), using the current warm-water discharge system, during the winter months beginning with the discontinuation of operations at the existing Port Everglades plant and continuing until the new units are operational (Golder Associates 2012). The implementation of the IWWR should result in continued manatee use of the Port Everglades plant and potentially no decrease in protection measures associated with the Port Everglades expansion project (i.e. standard manatee protection measures and cessation of confined underwater rock blasting during manatee congregation periods).

3.7.2.6 Bottlenose Dolphin

Although bottlenose dolphins are occasionally spotted within the boundaries of the Port, as of January 14, 2008, Dr. Edward O. Keith of NSU, who has been collecting data on bottlenose dolphins in the county since 2000, had not documented any resident dolphins in Broward County (pers com, Edward Keith, NSU, 2008). The NSU surveys conducted by Dr. Keith have recorded only three bottlenose dolphins in the Port since 2002. Although Dr. Keith has not documented any resident dolphins, USACE concludes that the Intracoastal Waterway (IWW) that runs through the project area may serve as a migration route by inshore dolphins transiting to the north (Indian River Lagoon) and south (Biscayne Bay). USACE requested that NMFS Southeast Fisheries Science Center (SEFSC) Marine Mammal Stranding Program in Miami, Florida provide data for the last 18 years (1992-2010) for any stranded marine mammals in Broward County recorded by the program (this would exclude manatees as they are not covered by this program). Five bottlenose dolphins have been reported as stranded in Broward County since 1992. None of these were reported within the Port boundaries (NMFS 2008b).

There is not currently a stock assessment available from NMFS concerning the status of bottlenose dolphins in the inshore and nearshore waters off of south Florida (Lance Garrison, pers com, 2011). The stocks of bottlenose dolphins that reside closest to the project area, that have a completed stock assessment report available for review, are the western North Atlantic central Florida coastal stock; the offshore stock, and the resident stock found in Biscayne Bay. The assessments for these groups were completed in 2008, 2009, and 2010, respectively (Waring *et al.* 2010).

3.7.2.7 North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) (NARW) is a federally listed endangered species and is also listed as a depleted stock under the MMPA. The minimum estimated population within the north Atlantic Region is 346 animals (NARWC 2012). This estimate is based solely on the whales cataloged as alive in 2011 in the New England Aquarium's (NEA) right whale identification catalog. The conservative middle estimate of population is 509 individual whales. This is based on the 2011 survey data which is the sum of the 476 cataloged whales presumed alive in 2011, the 13 "intermatch" whales that were likely to be added to the catalog, and the 20 calves from 2010 to 2011 that were also likely to be added to the catalog. The high estimate of the current population of north Atlantic right whales is 672 individuals. This is a sum, based on 2011 survey data, of the 627 cataloged whales, minus known dead individuals; 22 active

intermatch animals without calves and 23 calves (2010 and 2011 calves) minus the known dead. These numbers are based on completed analysis of 2011 survey data as of October 31, 2012 and were presented at the annual Right Whale Consortium meeting held in New Bedford, MA during November 2012 (http://www.narwc.org/pdf/2012_Report_Card.pdf). In 2011, a total of 7 calves were documented, resulting in an average calving interval for the 2011 calving mothers of 5.4 years. There were also two new mothers.

NARWs are highly migratory, summering in feeding and nursery grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf (NMFS 2005b). They migrate southward in winter to the northeastern coast of Florida. The breeding and calving grounds for the right whale occur off of the coast of southern Georgia and north Florida and have been designated as critical habitat under the ESA in 1994 (59 FR 28793). During these winter months, NARWs are routinely seen close to shore in the critical habitat area. There have been two recent sightings of NARWs that must have transited along the east coast of Florida past Port Everglades. The first was a mother/calf pair (#2360 and calf – New England Aquarium Right Whale Database) sighted north of the Port of Miami on January 30, 2004 swimming toward the south and was later seen on several occasions between March 19 and April 9, 2004 in the Gulf of Mexico off of Panama City, Florida. These two animals were re-sighted in the Great South Channel near Massachusetts in May 2004. In December 2005, a mother/calf pair right whale that was seen off central Florida and later documented in the Corpus Christi ship channel, Corpus Christi, Texas in January 2006. This animal was also confirmed as being a member of the north Atlantic stock, NARW # 2503 and her calf. These two animals were re-sighted in the Bay of Fundy in the summer of 2006 (Amy Knowlton, New England Aquarium, 2008 pers. Comm.) These sightings mean that these two right whales and their calves passed by Port Everglades not once, but twice during their transit to and from the Gulf of Mexico. While NARWs have been historically reported in south Florida and the Gulf of Mexico, these sightings are extremely rare (Dan O'Dell, Hubbs-Sea World Research Institute, 2002, personal communication; North Atlantic Right Whale Consortium database, University of Rhode Island, accessed January 2008). Since 2004, three additional sightings of NARW have occurred off of Palm Beach and Broward counties, all north of Port Everglades: One reported by the hopper dredge *RN Weeks* in the Jupiter Inlet/West Palm Beach area in January 2010; one in West Palm Beach, FL (Early January 2011); and the third, spotted and filmed by divers off West Palm Beach in January 20, 2011. An entangled female NARW (confirmed as whale #3911 in the NEA NARW catalog) was documented in the Fort Lauderdale area. Attempts were made to disentangle this animal, and this whale died a couple of weeks after the disentanglement (Audra Livergood, pers comm., 2011).

Pursuant to the NMFS 2011 Stock Assessment (NOAA 2012) report on the NARW, the minimum population size is currently estimated at approximately 396 animals known alive in 2007 (based on the NE Aquarium sighting catalog). No estimate of abundance with an associated coefficient of variability is available. Potential Biological Removal (PBR) for the western Atlantic right whale is calculated to be zero whales. A review of the “Large Whale Ship Strike Database” (Jensen and Silber, 2003) found five recorded ship strikes of NARWs from 1975 through 2002 offshore of Florida, all occurring between Fernandina Beach and Jacksonville. There have been at least two additional ship strikes (one in 2003 and one in 2006) in that same area since 2002. No records of ship strike of any right whales have been reported in southeast Florida (Jensen and Silber 2003).

A complete assessment of NARW recovery efforts and activities is reviewed in the Recovery Plan for the “North Atlantic Right Whale (*Eubalaena glacialis*)” (NMFS 2005b) http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_right_northatlantic.pdf.

3.7.2.8 Sperm Whale

Currently, resource agencies do not possess a robust estimate for the total number of sperm whales (*Physeter macrocephalus*) worldwide. The best estimate, i.e., that there are between 200,000 and 1,500,000 sperm whales, is based on extrapolations from only a few areas that have useful counts. In the western North Atlantic they range from Greenland to the Gulf of Mexico and the Caribbean. The sperm whales that occur in the eastern U.S. Atlantic Exclusive Economic Zone (U.S. EEZ) are believed to represent only a portion of the total stock (Blaylock *et al*. 1995). Sperm whales generally occur in waters greater than 180 meters in depth. While they may be encountered almost anywhere on the high seas their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves 1983). Waring, *et al*. (1993) suggest sperm whale distribution is closely correlated with the Gulf Stream edge. Like swordfish, which feed on similar prey, sperm whales migrate to higher latitudes during summer months, when they are concentrated east and northeast of Cape Hatteras. Bull sperm whales migrate much farther poleward than the cows, calves, and young males. Because most of the breeding herds are confined almost exclusively to warmer waters many of the larger mature males return in the winter to the lower latitudes to breed.

As of the NMFS October 2007 Stock Assessment report on the North Atlantic Stock of sperm whales, the population is currently estimated at approximately 4,804 (CV=0.38), a combination of the north U.S. Atlantic stock (2,607) and the south U.S. Atlantic stock (2,197). According to the stock assessment, there is insufficient data to determine the population trend for the species. PBR for the western North Atlantic sperm whale is calculated to be 7.1 whales. A review of the "Large Whale Ship Strike Database" (Jensen and Silber 2003) found no recorded ship strikes of sperm whales in Florida.

More detailed information on sperm whales can be located in NMFS Stock Assessment reports (http://www.nmfs.noaa.gov/pr/sars/species.htm) and the *Recovery Plan for Sperm Whale* at the following website address: http://www.nmfs.noaa.gov/pr/pdfs/recovery/ final_sperm_whale_recovery_plan_21dec.pdf.

3.7.2.9 Humpback Whale

Humpback whales (*Megaptera novaeangliae)* feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Five separate feeding areas are utilized in northern waters after their return; one of which, the Gulf of Maine feeding population, lies within U.S. waters and is the stock of humpback whales that are in the project area. Most of the humpbacks that forage in the Gulf of Maine visit Stellwagen Bank and the waters of Massachusetts and Cape Cod bays. Sightings are most frequent from mid-March through November between 41degrees N and 43 degrees N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge (CeTAP 1982), and peak in May and August. Small numbers of individuals may be present in this area year-round, including the waters of Stellwagen Bank. Humpback whales pass close to the south Florida coast while migrating from northern feeding waters to mating and calving locations in the Caribbean in the fall and on the return to the north in the spring.

Pursuant to the NMFS December 2012 Stock Assessment report on the Gulf of Maine stock (formerly the North Atlantic population) of humpback whales, the stock is currently estimated to be 4,894 males (95% CI=3,374-7,123) and 2,804 females (95% CI=1,776-4,463). According to the stock assessment, current data suggests that the Gulf of Maine stock is steadily increasing in

size. PBR for the Gulf of Maine humpback whale is calculated to be 1.3 whales. A review of the "Large Whale Ship Strike Database" (Jensen and Silber, 2003) found no recorded ship strikes of humpback whales in Florida.

More detailed information on humpback whales can be located in the NMFS Stock Assessment reports (http://www.nmfs.noaa.gov/pr/sars/species.htm) and the Recovery Plan for Humpback Whale (http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_humpback.pdf).

3.7.2.10 Fin Whale

The fin whale is ubiquitous in the North Atlantic and occurs from the Gulf of Mexico (GOM) and Mediterranean Sea northward to the edges of the Arctic ice pack (Waring *et al*. 1999). The International Whaling Commission (IWC) has proposed a stock boundary for the north Atlantic fin whale, currently all fin whales in the north Atlantic are believed to constitute one stock. This may change with future study. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward "flow pattern" of fin whales in the fall from the Labrador/Newfoundland region, south past Bermuda, and into the West Indies. The overall distribution may be based on prey availability. This species preys opportunistically on both invertebrates and fish. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments. Due to these traits, fin whales are less prone to entanglements than are right and humpback whales, but because they do occur in many of the same areas, the potential exists.

Pursuant to the NMFS 2012 Stock Assessment report on the north Atlantic stock of fin whales, The best abundance estimate available for the western North Atlantic fin whale stock is 3,985 (CV= 0.24). Per the stock assessment report, this estimate must be considered extremely conservative in view of the incomplete coverage of the known habitat of the stock and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas. The abundance estimates of fin whales include a percentage of the estimate of animals identified as fin/sei whales (the two species being sometimes hard to distinguish). The percentage used is the ratio of positively identified fin whales to the total number of positively identified fin whales and positively identified sei whales. According to the stock assessment, there are insufficient data to determine population trends for this species. PBR for the Gulf of Maine humpback whale is calculated to be 6.5 whales. A review of the "Large Whale Ship Strike Database" (Jensen and Silber, 2003) found no recorded ship strikes of fin whales in Florida.

More detailed information on fin whales can be located in the NMFS Stock Assessment reports under the MMPA (http://www.nmfs.noaa.gov/pr/sars/species.htm) and the "Final Recovery Plan for Fin Whale (*Balaenoptera physalus*) July 2010" (http://www.nmfs.noaa.gov/pr/pdfs/recovery/finwhale.pdf).

3.7.2.11 Sei Whale

The sei whale has a global distribution. In the U.S. Atlantic, the whale is seen primarily on Georges Bank in the spring and may migrate to lower-latitude wintering areas from the Gulf of Mexico south. Indications are that, at least during the feeding season, a major portion of the sei whale population is centered in Northerly waters, perhaps on the Scotian Shelf (Mitchell and Chapman 1977). The southern portion of the species' range during spring and summer includes the northern portions of the U.S. EEZ; the Gulf of Maine and Georges Bank. The period of greatest abundance there is in spring, with sightings concentrated along the eastern margin of

Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (CETAP 1982). The sei whale is generally found in the deeper waters characteristic of the continental shelf edge region. Mitchell (1975) similarly reported that sei whales off Nova Scotia were often distributed closer to the 2,000 m depth contour than were fin whales.

This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters. The sei whale, like the right whale, is largely planktivorous, feeding primarily on euphausiids and copepods. In years of reduced predation on copepods by other predators, and thus greater abundance of this prey source, sei whales are reported in more inshore locations, such as the Great South Channel (in 1987 and 1989) and Stellwagen Bank (in 1986) areas (R.D. Kenney, pers. comm.; Payne, *et al*. 1990). An influx of sei whales into the southern Gulf of Maine occurred in the summer of 1986 (Schilling, *et al*. 1993). Such episodes, often punctuated by years or even decades of absence from an area, have been reported for sei whales from various places worldwide.

The NMFS December 2012 Stock Assessment report for Nova Scotia indicated that the size of the population of sei whales in the U.S. EEZ is unknown. However, five abundance estimates are available for portions of the sei whale habitat: from Nova Scotia during the 1970's, in the U.S. EEZ during the springs of 1979-1981, and in the U.S. and Canadian Atlantic EEZ during the summers of 2002, 2004, and 2006. The August 2004 abundance estimate (386) is considered the best available for the Nova Scotia stock of sei whales. However, this estimate must be considered conservative in view of the known range of the sei whale in the entire western North Atlantic, and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas. The abundance estimates of sei whales include a percentage of the estimate of animals identified as fin/sei whales (the two species being sometimes hard to distinguish). The percentage used is the ratio of positively identified sei whales to the total of positively identified fin whales and positively identified sei whales. PBR for the Nova Scotia stock of the sei whale is 0.4. A review of the “Large Whale Ship Strike Database” (Jensen and Silber 2003) found no recorded ship strikes of sei whales in Florida.

More detailed information on sei whales can be located in the NMFS Stock Assessment reports under the MMPA (http://www.nmfs.noaa.gov/pr/sars/species.htm). NMFS published a recovery plan for Sei whale in December 2011 (http://www.nmfs.noaa.gov/pr/pdfs/recovery/seiwhale.pdf).

3.7.2.12 Blue Whale

The blue whale is best considered as an occasional visitor in the U.S. EEZ waters, which may represent the current southern limit of its feeding range (CETAP 1982; Wenzel, *et al*. 1988). Yochem and Leatherwood (1985) summarized records suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species’ range is unknown.

Using the U.S. Navy’s Sound Surveillance System (SOSUS) program, blue whales have been detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the U.S. EEZ (Clark 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Sigurjónsson and Gunnlaugsson (1990) note that North Atlantic blue whales appear to have been depleted by commercial whaling to such an extent that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic.

Pursuant to the NMFS (2010) Stock Assessment report on the western north Atlantic stock of blue whales, the catalog count of 440 recognizable individuals from the Gulf of St. Lawrence is considered to be a minimum population estimate for the western North Atlantic stock.. According to the stock assessment, there are insufficient data to determine population trends for this species. PBR for the Western North Atlantic stock of blue whale is 0.9 whales. A review of the "Large Whale Ship Strike Database" (Jensen and Silber 2003) found no recorded ship strikes of blue whales in Florida.

More detailed information on blue whales can be located in the NMFS Stock Assessment reports under the MMPA (http://www.nmfs.noaa.gov/pr/sars/species.htm) and the "Final Recovery Plan for Blue Whale (*Balaenoptera musculus*) July 1998" (http://www.nmfs.noaa.gov /pr/pdfs/recovery/whale_blue.pdf). In April 2012, NMFS published a notice of intent to update the Blue Whale Recovery Plan (77 FR 22760).

3.7.2.13 Staghorn and Elkhorn Corals

During the Late Quaternary period, two coral species of the genus *Acropora* have been the most important reef-builders in the Caribbean (Aronson and Precht 2001a). *Acropora palmata* and *A. cervicornis* were dominant space occupants of fore-reef habitats on most reefs throughout the Caribbean region (*sensu lato*) for thousands of years until the recent past (Aronson and Precht 2001b). A regional outbreak of white-band disease (WBD) was the primary cause of the regional mass mortality of acroporid corals—*Acropora palmata* and *A. cervicornis*—from the late 1970s to the early 1990s. *A. palmata* dominated the reef-crest and shallow fore-reef habitats at 0–5 m depth on windward-facing Caribbean reefs, whereas *A. cervicornis* dominated intermediate, fore-reef depths of 5–25 m and some back-reef and lagoonal habitats. WBD is an infectious, bacterial syndrome that appears only to affect the acroporids (Vollmer and Kline 2008; Kline and Vollmer 2011).

Because *A. cervicornis* and *A. palmata* were the dominant occupants of reef substratum and the dominant constructors of framework, Aronson and Precht (2001a, 2001b,) concluded that WBD had been the most important cause of coral mortality in the Caribbean in recent decades. Hurricanes, coral bleaching from anomalously high sea temperatures, and additional factors such as corallivory had played subsidiary roles in killing the acroporids (ABRT 2005). These threats have resulted in their listing as Threatened on the US Endangered Species List and critically endangered on the IUCN Red List (Aronson et al. 2009a, 2009b).

In addition, the acroporids are among the most sensitive Caribbean corals to cold-temperature stress and generally do not occur in areas where wintertime sea-surface temperatures (SSTs) drop below 18°C (Precht and Miller 2007). Based on presence/absence data from the northernmost portions of the Florida reef tract, it appears that *A. palmata* may be more cold-sensitive than *A. cervicornis* (Goldberg 1973; Jaap 1984, Burns 1985; Porter 1987; Precht and Aronson 2004).

In the early to middle Holocene (10,000–6,000 years ago), when average sea temperatures were warmer than today, *Acropora*-dominated reefs were common along the east coast of Florida as far north as Palm Beach County. The fossil record shows that the northern limits of these two cold-sensitive species subsequently contracted to Biscayne Bay, south of Miami, apparently as a result of climatic cooling (Precht and Aronson 2004).

As previously mentioned, staghorn coral (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*) were listed as Threatened under the ESA on May 9, 2006, (71 FR 26852) based on a

status review completed by NMFS in March 2005 (70 FR13151). NMFS published a "4D" rule for these *Acropora* species on October 29, 2008 (73 FR 64264) providing a list of activities that would result in "take" as defined by the ESA. NMFS published a final rule to designate critical habitat for these species on November 26, 2008 (73 FR 72210). NOAA has not yet prepared a recovery plan for either *Acropora* species. However, a recovery plan development team completed a draft and provided this to NMFS for revisions and publication. On December 7, 2012, NMFS proposed that the two species of *Acropora* already listed under the ESA be reclassified from threatened to endangered (77- FR 73219).

The Atlantic *Acropora* Status Review (ARBT 2005) presents a summary of published literature and other currently available scientific information regarding the biology and status of both elkhorn and staghorn corals (http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/corals.pdf).

Based on the status review, NMFS has determined that any hardground habitat located in Florida south of the Martin/Palm Beach County line in waters less than 25 meters deep has the potential to support either of the *Acropora* species (NMFS 2005a). The final critical habitat determination identifies that the primary constituent elements for the continued survival of acroporid species may be found in waters less than 30 meters in depth (NMFS 2007b).

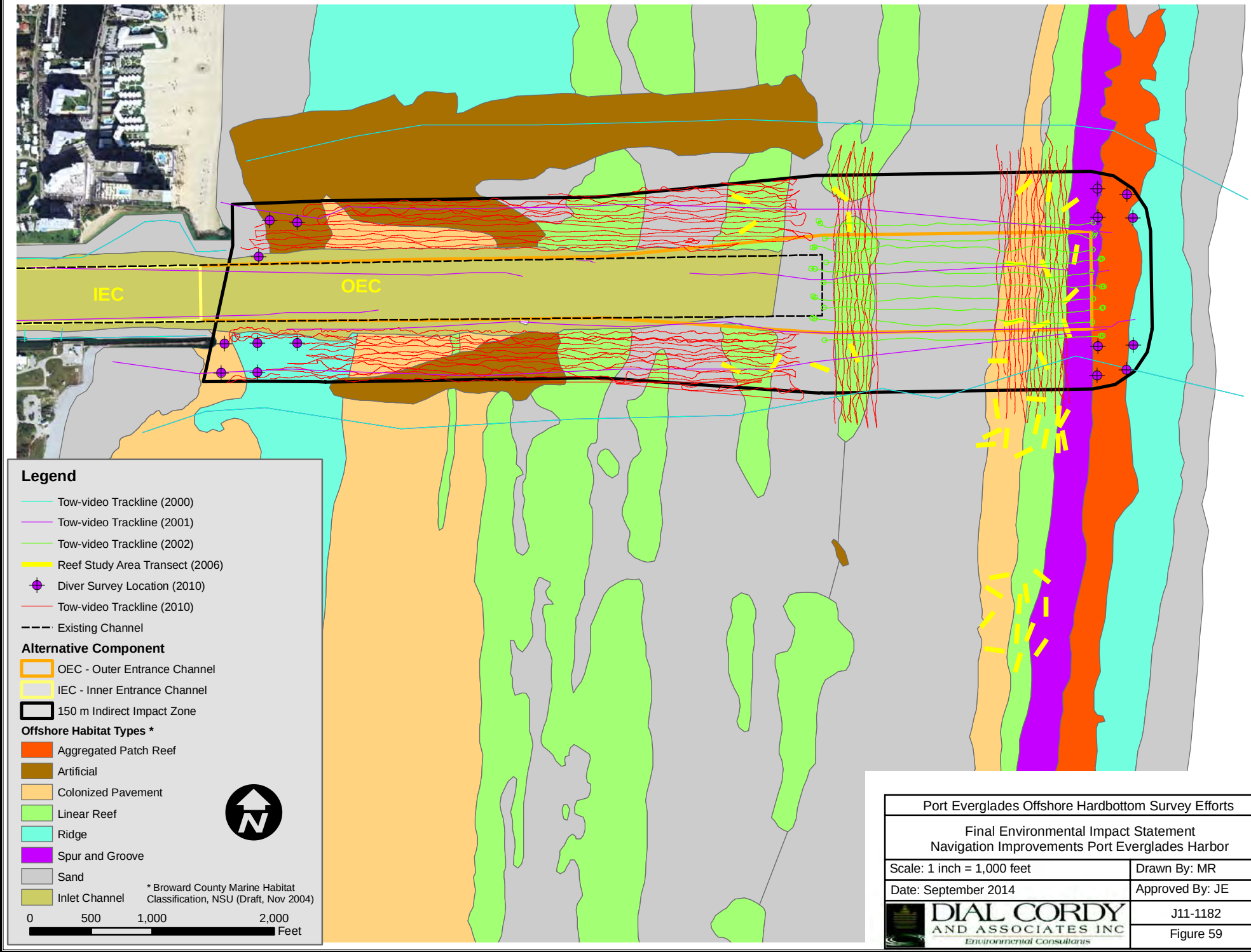
USACE has conducted four surveys of the project area between 2001 and 2010 (survey effort is shown in Figure 59), using a combination of towed video and divers and has not documented the presence of either species in the project area. *A. cervicornis* colonies are known to exist in the vicinity of Port Everglades, 2,780 feet (848m) to the south of the Port entrance channel, on the near shore hardbottom, and 1,400 feet (427m) north on the inner reef (NSUOC 2008: see Figure 60; DC&A 2010b: see Figure 61). These locations are outside the indirect impact assessment area for the Port Everglades expansion project. As of the writing of this document, no colonies of *A. palmata* have been documented within the vicinity of the existing channel. In addition, to date, no *A. cervicornis* have been identified within the direct or indirect impact areas within the proposed project area (DC&A 2010b).

In October 2007, NMFS released the revised *Interim Acropora Survey Protocol for Section 7 Consultation*, a protocol for surveys to be conducted for projects within the known habitat of *Acropora* sp. USACE staff met with NMFS leadership in April 2008 to discuss the applicability of this interim protocol in high traffic federal navigation channels where safety of scientific divers was a major concern. NMFS-OPR leadership agreed that human health, safety and welfare was an important component of the protocol and a modified methodology for surveying for *Acropora* in 13 federal navigation channels within *Acropora* critical habitat was warranted. Working under this agreement, USACE developed a two-tiered survey approach. The two-tiered method includes integrated towed video survey, with a built in altimeter, that would allow the flyer and viewer to know the distance to the bottom, follow-up ground-truthing diver surveys, and diver surveys following the NMFS protocol.

In total, towed video transects covered more than 40% of the entire direct and indirect impact area. The added value of the towed video survey methodology is that significantly more area would be covered than if the diver-only protocol would have been employed to survey for *Acropora spp.* in the project area. Twenty-one dives were made to identify organisms that were designated as "potential" *Acropora* colonies in post-processed video. No *Acropora* colonies were documented within the direct or indirect impact areas of the Port Everglades expansion area during this survey. Full results of this survey are found in the "Port Everglades Feasibility Study *Acropora* Coral Survey Final Report October 2010" included in Appendix D. Based on the results of all of the surveys conducted specific to the project, as well as all of the other data from other agencies and academia that were provided to USACE, currently, it is presumed that the colonies

located 2,780 feet (848m) to the south (DC&A 2010b) and 1,400 feet (427m) north (NSUOC 2008) of the entrance channel are the nearest colonies to the project area. In addition to the work performed on this project by the USACE, additional coral species surveys have been contracted by the US Navy within the South Florida Ocean Measurement Facility Restricted Operating Area (OPAREA) located immediately south of the OEC (USN 2011).

These surveys have also revealed the presence of *Acropora cervcornis* on the inner, middle, and outer (i.e., first, second, and third reefs away from shore, respectively). *Acropora palmata* was not documented during the Navy survey. The closest documented *Acropora cerviconis* to the expansion project was located on the inner reef, south of the margin of the 150-meter-wide indirect impact zone surrounding the project footprint, approximately 450 feet south of the channel. Although the Navy survey did document *Acropora cervicornis* on the outer reef, the closest documented colonies (1-5 colonies in density) were located more than a mile south of the 150-meter-wide indirect impact zone.



Port Everglades Offshore Hardbottom Survey Efforts	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1,000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 59

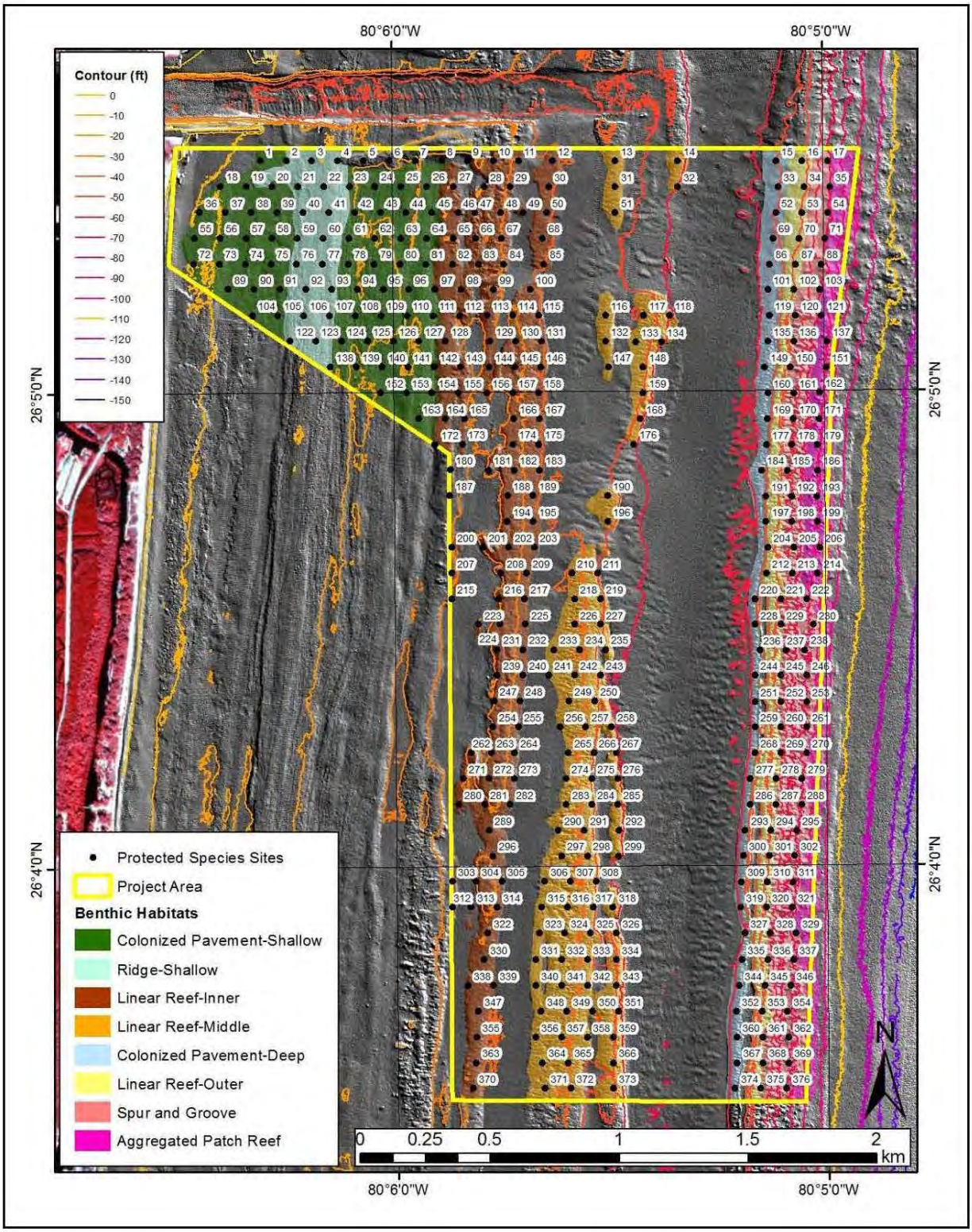
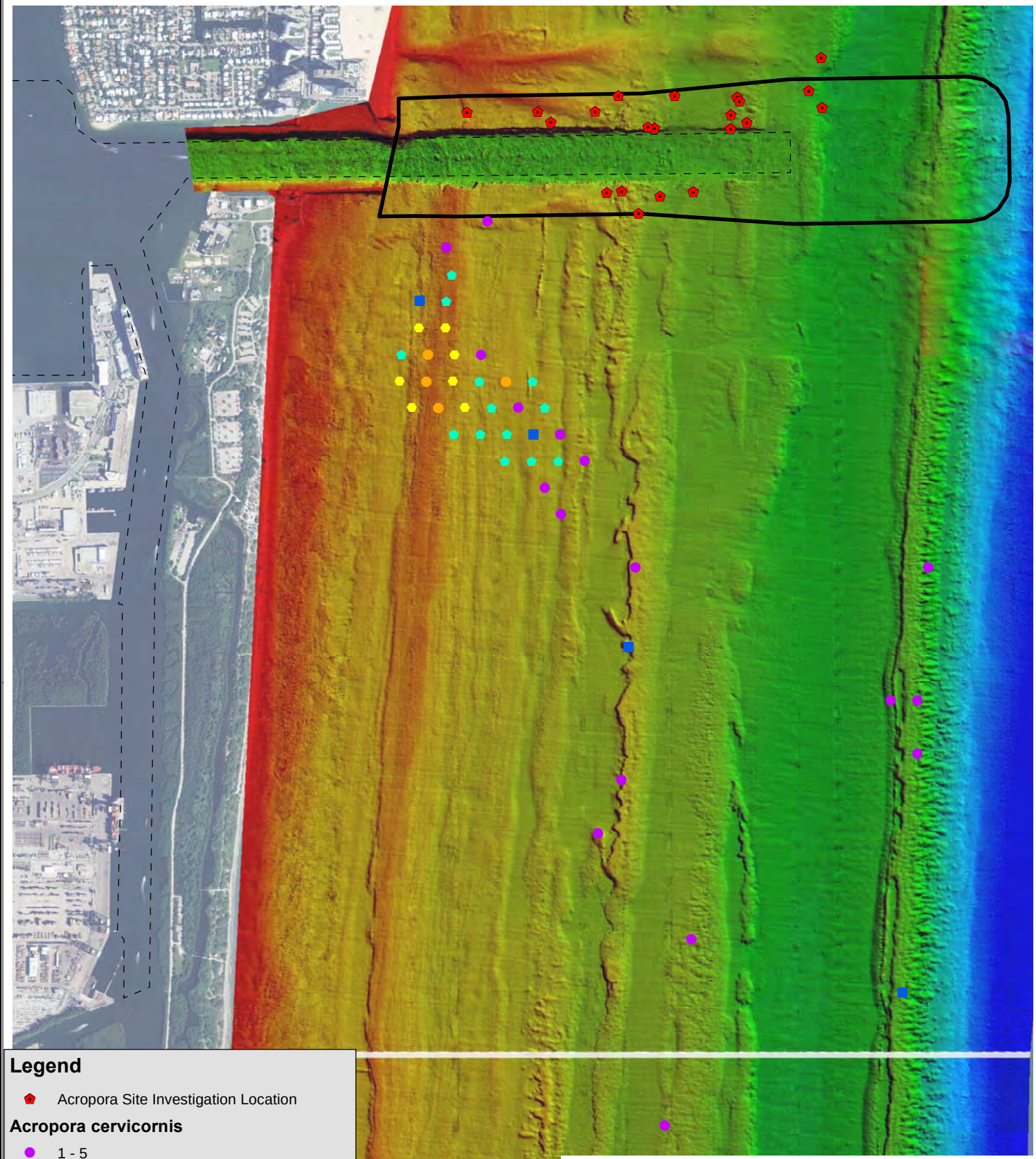


Figure 60 Locations of 376 coral survey locations used for NSUOC (2011)



Legend

Acropora Site Investigation Location

Acropora cervicornis

- 1 - 5
- 6 - 10
- 11 - 50
- 51 - 100
- Over 100

150 m Indirect Impact Zone

Existing Channel

0 250 500 1,000 Meters

USACE-Sponsored Acropora cervicornis Survey: Sample and Colony Locations		
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor		
Date: Sept. 2014	Scale: 1 in = 500 m	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants		J11-1182
		Figure 61

3.7.2.14 Other Corals

On October 20, 2009, the Center for Biological Diversity petitioned NMFS to list 83 coral species as threatened or endangered under the U.S. Endangered Species Act. NMFS identified 82 of the corals as candidate species and established a Biological Review Team (BRT) to prepare a Status Review Report that examines those 82 candidate coral species and evaluates extinction risks for each of them. Of those 82 species, NMFS proposed listing for 66 coral species: 59 in the Pacific (seven as endangered, 52 as threatened) and seven in the Caribbean (five as endangered, two as threatened). The seven Caribbean species include *Orbicella annularis (= Montastraea annularis), Orbicella faveolata (= Montastraea faveolata), Orbicella franksi (= Montastraea franks)i, Dendrogyra cylindrus, Mycetophyllia ferox, Agaricia lamarcki,* and *Dichocoenia stokes* (see Budd et al. 2012 for reclassification of *Montrastraea annularis* species complex). Of the seven species proposed for listing, NMFS found that five warranted listing as threatened. The two species determined not to warrant listing were *A. lamarcki* and *D. stokesi* (*Endangered and Threatened Wildlife and Plants: Final Listing Determinations on Proposal to List 66 Reef-building Coral Species and to Reclassify Elkhorn and Staghorn Corals*, National Oceanic and Atmospheric Administration 50 CFR Part 223, 14 September 2014).

The following biological information on the five Caribbean coral species biology recently listed under the ESA was transcribed from Brainard *et al.* (2011) unless otherwise cited:

> ***Orbicella annularis* complex.** The nominal *Orbicella annularis* has historically been one of the primary reef framework builders of the western Atlantic and Caribbean. Its depth range is from 1 m to over 30 m and has multiple growth forms ranging from columnar to massive to platy. These growth forms were partitioned into three separate species in the early 1990s based on their morphology, depth range, ecology and behavior with subsequent support from reproductive and genetic studies - *Orbicella annularis, Orbicella faveolata* and *Orbicella franksi* [each is discussed below]. All three species are hermaphroditic broadcast spawners. Reproduction is characterized by small eggs and larvae and very slow post-settlement growth rates, which may contribute to extremely low post-settlement survivorship. It is thought that only *O. annularis* is capable of some degree of fragmentation/fission and clonal reproduction.
>
> The *O. annularis* complex characterize the “buttress zone” and “annularis zone” in the classical descriptions of Caribbean reefs and have been described as very abundant in these zones. Declines became obvious in the 1990s and 2000s and were most often associated with combined disease and bleaching events. They exhibit dramatically low productivity (low growth and extremely low recruitment), which puts them at high extinction risk due to any substantial declines in adult populations. In Florida, several studies spanning nearly 30 years imply extreme declines in the Florida Keys (80% to 90%) between the late 1970s and 2003. Parameters measured revealed declines in absolute cover, colony shrinkage, and virtually no recruitment. Additionally, further dramatic losses occurred in this region during the cold weather event in January 2010. Similar declines have been documented in the U.S. Virgin Islands, Belize, and Colombia as well as on relatively remote Caribbean reefs such as Navassa Island National Wildlife Refuge and offshore islands in Puerto Rico. The *M. annularis* complex has been shown to be highly-to-moderately susceptible to bleaching, which was highlighted during the well-documented mortalities in these species following severe mass-bleaching in 2005 due to thermal stress. Disease outbreaks of white-plague and yellow-band have also resulted in population declines to these species. Degraded water quality (increased nutrients and/or toxins) and increased turbidity and sedimentation associated with land-based sources of

pollution has resulted in decreased growth rates and increase susceptibility to bleaching and disease.

Orbicella annularis. Boulder star coral, *O. annularis*, is restricted to the west Atlantic and occurs throughout the Caribbean, including Florida, the Bahamas, and Flower Garden Banks but may be absent in Bermuda. It has been reported in water depths ranging from 0.5 to 20 m and is generally described with a shallower distribution. *O. annularis* colonies grow in columns that exhibit rapid and regular upward growth. Based on the Status Review, very low productivity (growth and recruitment), dramatic recent declines and its restriction to the highly disturbed/degraded wider Caribbean region, and its preference for shallow habitats (yielding greater exposure to surface-based threats) are the main factors that increase the extinction risk for *O. annularis.*

Orbicella faveolata. Mountainous star coral, *Orbicella faveolata*, is restricted to the west Atlantic and occurs throughout the Caribbean, including Florida, the Bahamas, Flower Garden Banks and the entire Caribbean coastline. It is documented on most reef habitats ranging in water depths from 0.5 to 40 m. It has been reported as the most abundant coral in forereef environments between 10 and 20 m. In many life history characteristics, including growth rates, tissue regeneration, and egg size, *O. faveolata* is considered to be intermediate between its two sister species. Based on the Status Review, extremely low productivity (growth and recruitment), dramatic recent declines and its restriction to the highly disturbed/degraded wider Caribbean region are the main factors that increase the extinction risk for *O. faveolata.*

Orbicella franksi. Star coral, *Orbicella franksi*, is restricted to the west Atlantic and found throughout the Caribbean, including Florida, the Bahamas, Bermuda, Flower Garden Banks and the entire Caribbean coastline. It has been reported in water depths from 5 to 50 m and is often a dominant component of Caribbean mesophotic reefs. *O. franksi* tends to have a deeper distribution that it's two sister species. Based on the Status Review, extremely low productivity (growth and recruitment), dramatic recent declines and its restriction to the highly disturbed/degraded wider Caribbean region are the main factors that increase the extinction risk for *O. faveolata.*

Dendrogyra cylindrus. Pillar coral, *Dendrogyra cylindrus*, is restricted to the west Atlantic and is present throughout the greater Caribbean, including Florida, but is one of the Caribbean genera absent from the southwest Gulf of Mexico. A single colony (in poor condition) is known in Bermuda. It is reported in most reef environments but is more common on forereef spur-and-groove habitats in the Florida Keys rather than in nearshore hardbottom and reef habitats. It has been documented in water depths between 2 and 25 m. *D. cylindrus* is reported as uncommon but conspicuous with isolated colonies scattered across a range of habitat types. In Florida, the overall density is estimated at approximately 0.6 colonies per 10 m^2. They are described as gonochoric spawning but their low density does not support successful reproduction; however, they are effective in propagation through fragmentation. Annual growth rates range from 12-20 mm in the Keys up to 0.8 cm yr^{-1} elsewhere in the Caribbean. Conflicting reports and low density make understanding the susceptibility of *D. cylindrus* to elevated temperatures difficult; however, it is known to be sensitive to cold shock. Based on the Status Review, the overall low population density and low population size combined with a gonochoric spawning mode, corresponding lack of observed sexual recruitment, and susceptibility to observed disease mortality are the main factors that increase the extinction risk for *D. cylindrus.*

Mycetophyllia ferox. Rough cactus coral, *Mycetophyllia ferox,* is restricted to the west Atlantic with reports throughout most of the Caribbean, including Florida, although it has not been documented in the Flower Garden Banks or in Bermuda. It has been reported to occur in shallow reef habitats ranging from 5 to 30 m water depths. It is described as uncommon or rare contributing less than 0.1% species contribution and occurs at densities less than 0.8 colonies per 10 m^2 in Florida. Studies conducted in the Florida Keys show a dramatic decline since the mid-1990 sand Dustan (1977) suggested that *M. ferox* was much more abundant in the upper Florida Keys in the early mid-1970s compared to current observations, but that it was highly affected by disease. *M. ferox* has been reported as susceptible to acute and sub-acute white plague disease, which was positively correlated with water temperature. Based on the Status Review, disease, rare abundance, and observed declines in abundance are the main factors that increase the extinction risk for *M. ferox.*

In coral surveys conducted for the proposed navigation improvements (most recently, DC&A 2009a), colonies in the *M. annularis* complex comprised almost exclusively *M. faveolata* and *M. franksi*, but uncertainty in underwater video identification resulted in small colonies being pooled into the general complex. *M. annularis sensu stricto* is extremely rare in Broward County. Overall, *M. annularis* complex species colonies were relatively common and conspicuous but never abundant. No colonies of *D. cylindrus* were encountered in any of the USACE-contracted surveys in the vicinity of the project. This coral is exceedingly rare in Broward County (FWS personal communication). *M. ferox* was extremely rare; only three individual colonies were observed in the project area. Even more rare was *A. lamarcki,* (not selected to be listed under ESA) which was observed only once. Finally, surveys demonstrated that *D. stokesi* (also not selected to be listed under ESA) was relatively common and conspicuous but never abundant.

3.8 Coastal Barrier Resources

According to USFWS's *Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service* (available online at http://www.fws.gov/laws/lawsdigest/coasbar.html), the Coastal Barrier Resources Act (CBRA), Public Law 97-348 (96 Stat. 1653; 16 U.S.C. 3501 et seq.), enacted October 18, 1982, designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System (System). Areas so designated were made ineligible for direct or indirect federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and National Wildlife Refuges and other, otherwise protected areas are excluded from the System.

There are no CBRA units in or near the project area. However, Lloyd Beach (the coastal feature on which JUL exists) is designated as "Otherwise Protected Area" (OPA) FL-20P. Under this act, it is restricted only from receiving federal funding for flood insurance on buildings within the unit boundary. "The northern boundary of Unit FL-20P follows the southern edge of the Turning Basin Inlet/north edge of JUL. The eastern boundary follows the approximate center of a channel [i.e., SAC] behind the barrier. The southern boundary cuts across the barrier roughly at the southern tip of the State park and a small adjacent parcel belonging to the City of Hollywood recently acquired for conservation purposes. The unit includes the state park and also lands belonging to the USCG, the U.S. Navy, Nova University, the City of Dania Beach, and a private company. The remaining private and military properties listed above are proposed for removal from the coastal barrier resources system (CBRS) because they are not held for conservation or recreation purposes, are not in holdings within the conservation or recreation areas, and were developed at

the time they were included within Unit FL-20P in 1990" (Appendix D of *Report to Congress: John H. Chafee Coastal Barrier Resources System Digital Mapping Pilot Project*, USFWS, undated).

While the Navy, Nova Southeastern University, and Dania Beach properties noted above are developed, JUL remains the only undeveloped parcel in the management unit. JUL is located on a barrier island, which is a dominant geographic feature along much of Florida's coastline. The soils of the park are geologically rather immature due to its recent formation as a barrier island and the action of wind and rain on the soil and relic, underlying coral formations. JUL has 2.25 miles and 0.26-mile of beachfront coastline and inlet shoreline, respectively, within its boundaries. The hydrological features of the park include the Atlantic Ocean, Intracoastal Waterway, New River Sound and mangrove wetlands. Though much of the rain (over 60 inches per year) infiltrates into the shallow, unconfined Biscayne Aquifer, a great deal runs off or remains on the surface, adding to the prominent surrounding surface waters. These beneficial rains, however, can also cause water quality degradation within the Park through urban runoff. (The above paragraph was adapted from a CBRA and CBIA 2003 determination provided to USACE and Broward County from the USFWS as part of the Broward County Shore Protection Project.)

3.9 Water Quality

3.9.1 Surface Waters

Southeast Florida –including Miami-Dade, Broward, and Palm Beach Counties- is one of the more heavily urbanized areas in the State of Florida. In 1990, the total population of the three counties combined was approximately 4.06 million (1.26 million in Broward County). In 2000, the total combined population was approximately 5.01 million (1.62 million in Broward County). By 2010, the population in Broward County increased 7.7% to 1.75 million, and the overall tri-county population reached 5.6 million (U.S. Census Bureau 2012). The rapid population growth is a suspected contributor to the degradation of water quality along the coast, mainly through the discharge of nutrient-laden sewage and stormwater runoff into canals (FDEP 2003).

Drainage of Broward County is facilitated by more than 266 miles of natural and dredged canals that traverse the county's urban corridor (Broward County Planning Council 1989). Overall, the hydrology of Broward County is highly manipulated by these water control structures, which have altered the natural hydroperiods and flows of the South Florida watershed. The primary drainage system is managed by the South Florida Water Management District and consists of nine major canals and their corresponding drainage basins. These nine major canals, along with secondary and tertiary canals, eventually drain to estuarine areas (e.g., Intracoastal Waterway and associated bays and swamps). From the Intracoastal Waterway, inlets provide discharge access to the Atlantic Ocean. Runoff can carry bacteria, viruses, oil and grease, toxic metals, and pesticides (FDEP 2003). In addition to contributions from canals, nutrients and coliform bacteria can be introduced via septic tanks and disposal well discharges on Florida's east coast (USGS 1992, see below).

The waters within the Port are designated Class III (acceptable for recreation, fish, and wildlife) by the FDEP. The waters adjacent to JUL, within the Atlantic Ocean, are designated as Outstanding Waters of the State. Water that passes through the Port area is conveyed from the New River System to the north, the IWW from the south, and the DCC (south of the Port), which collects water from areas west of the Port. In addition, there are storm water collection systems both within the Port and in areas west and north of the Port that discharge into the North Turning Basin as well as into several other areas within the Port itself.

Port staff examined Broward County water quality data collections sites immediately north and south of the Port for 2002-2011 and found no DO readings less than the state surface water quality minimum standard of 4 mg/L and the average was 6.025 mg/L. Typically, water quality in south Florida estuaries varies on a seasonal basis, and physical and chemical parameters are influenced by freshwater run-off, which increases during summer months when precipitation is more abundant.

Historical chemical analysis has indicated that some pesticides have been found in trace amounts in the project area. However, the Port does not handle fertilizers or pesticides as a bulk cargo and the Port has indicated that the minor presence of these compounds may be associated with the urban run-off surrounding the Port or agricultural run-off from farther inland.

Free-floating petroleum product has been found in various concentrations behind the bulkheads within the Midport area (i.e., STB) from Berth 5 to Berth 15. BCEPD conducted sampling of the bulkhead and found that no product was leaching from behind the bulkhead into the slips. In addition, the FDEP conducted a risk assessment of the area in association with the Port Everglades Environmental Corporation adjacent to the FP&L intake area and found that there was no harm to fish, wildlife, or human kind as a result of the product escaping from the bulkhead into the slips.

There are no public drinking water supply wells within the jurisdictional boundaries of the Port and none within several miles of the Port. The Port has prohibited the construction of any irrigation system within the jurisdictional area of the Port.

The USGS conducted studies at various inlets and outfalls in Broward County in 2007 and 2008 to determine if the reefs off of Broward County are exposed to microbial constituents of human sewage and determine the sources of the contamination (inlets vs outfalls), and is in the process of publishing the findings of those studies. The results (Figure 62) show that the reefs off Broward County are exposed to microbial constituents of human sewage, with Port Everglades Inlet being an important source of these constituents. Samples collected from corals (25%) and sponges (40%) show exposure to these constituents. Additionally, 64 organic wastewater compounds; 16 pharmaceutical compounds; *Salmonella* species, coliphage, and human enteroviruses; nutrients; radon and methane were all found in water samples collected from the study (Futch *et al.* 2011).

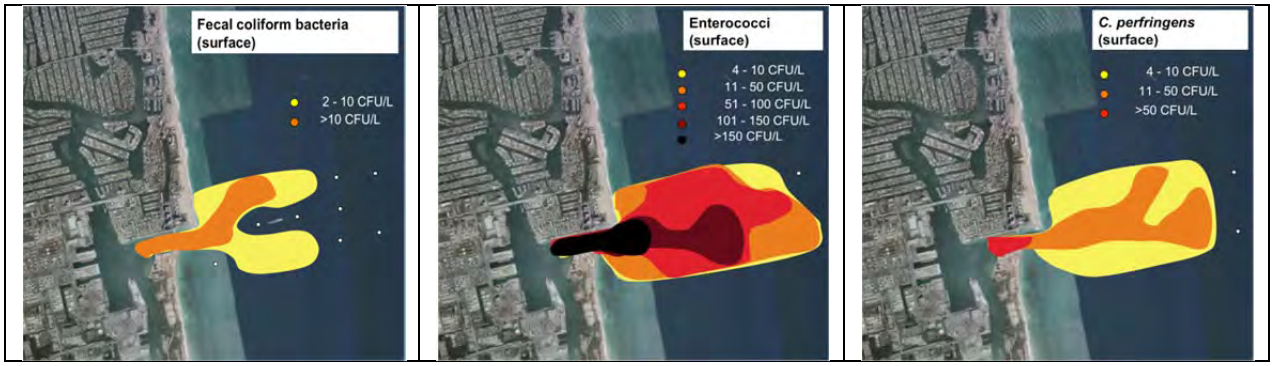


Figure 62 Concentrations of fecal coliforms, enterococci, and *Clostridium perfringens* from samples collected at Port Everglades in 2007-2008

3.9.2 Ground Water

The Biscayne Aquifer is the primary water supply source for Broward and Miami-Dade Counties and this aquifer is classified as a "Sole Source Aquifer" under the Safe Drinking Water Act. The groundwater surface elevation of the Biscayne is typically just below the ground surface and it usually follows the topography. The vertical profile of the Biscayne Aquifer is that of a wedge with a thickness of less than 20 feet at the western edge of Miami-Dade and Broward counties and a thickness of more than 200 feet along the ocean shoreline of Broward County (Schroeder, *et al.* 1958). The construction and operation of the east coast canal system over the last century has resulted in a lowering of the groundwater elevation along the coastal ridge. Municipal and industrial water use has further depressed the groundwater table in Biscayne Aquifer and has resulted in saltwater intrusion in the lower depths of the Biscayne Aquifer all along the Miami-Dade and Broward coastline. Figure 63, taken from Sonenshein (1995) shows the relationship between freshwater and saline water zones (bounded by "isochlor" lines) in the Biscayne Aquifer in the vicinity of Biscayne Bay. This general relationship with less dense freshwater overlying heavier saline water holds for the Biscayne Aquifer along the entire coastline of Miami-Dade and Broward Counties. The location of the saltwater interface along the coast moves east and west depending upon season and significance of wet and dry hydrologic periods as well as water management actions such as canal operations and groundwater withdrawals.

Broward County Department of Planning has prepared the map below, which shows saltwater intrusion in Broward County (Broward County Planning Division 2000). From this map, it is evident that saltwater intrusion in the Biscayne Aquifer has traveled approximately three miles west of the Port Everglades inlet as of February of 1994. Dausman and Langevin (2005) indicate that the westward bulge of the salinity impact zone in the area of Port Everglades is due to the density of east-west drainage canals and rivers as well as the relatively westward locations of the salinity control structures (S-36, S-33, G-54, and S13). East of these water control structures, the elevation of the water surface is controlled by tides and the salinity of the water in the tidal portion of the canals varies from 3,000 mg/L to 30,000 mg/L depending upon the location of measurement and how much freshwater is released from the upstream control structures. In the immediate vicinity of Port Everglades there are three municipal well fields (Dixie, 3A, and Dania). The Dixie and 3A well fields are located five miles west of Port Everglades and they are west of the saltwater intrusion zone shown in Figure 64. The Dania well field is located four miles south-southwest of Port Everglades and it is located along the western edge of the saltwater intrusion zone.

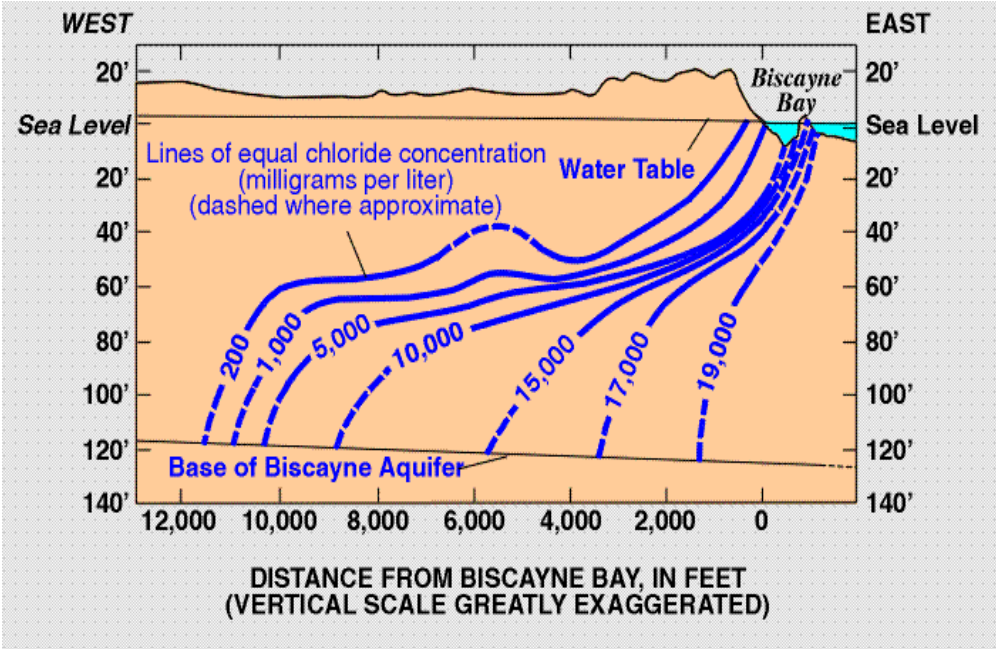


Figure 63 Relationship Between Freshwater and Saline Water Zones in Biscayne Aquifer

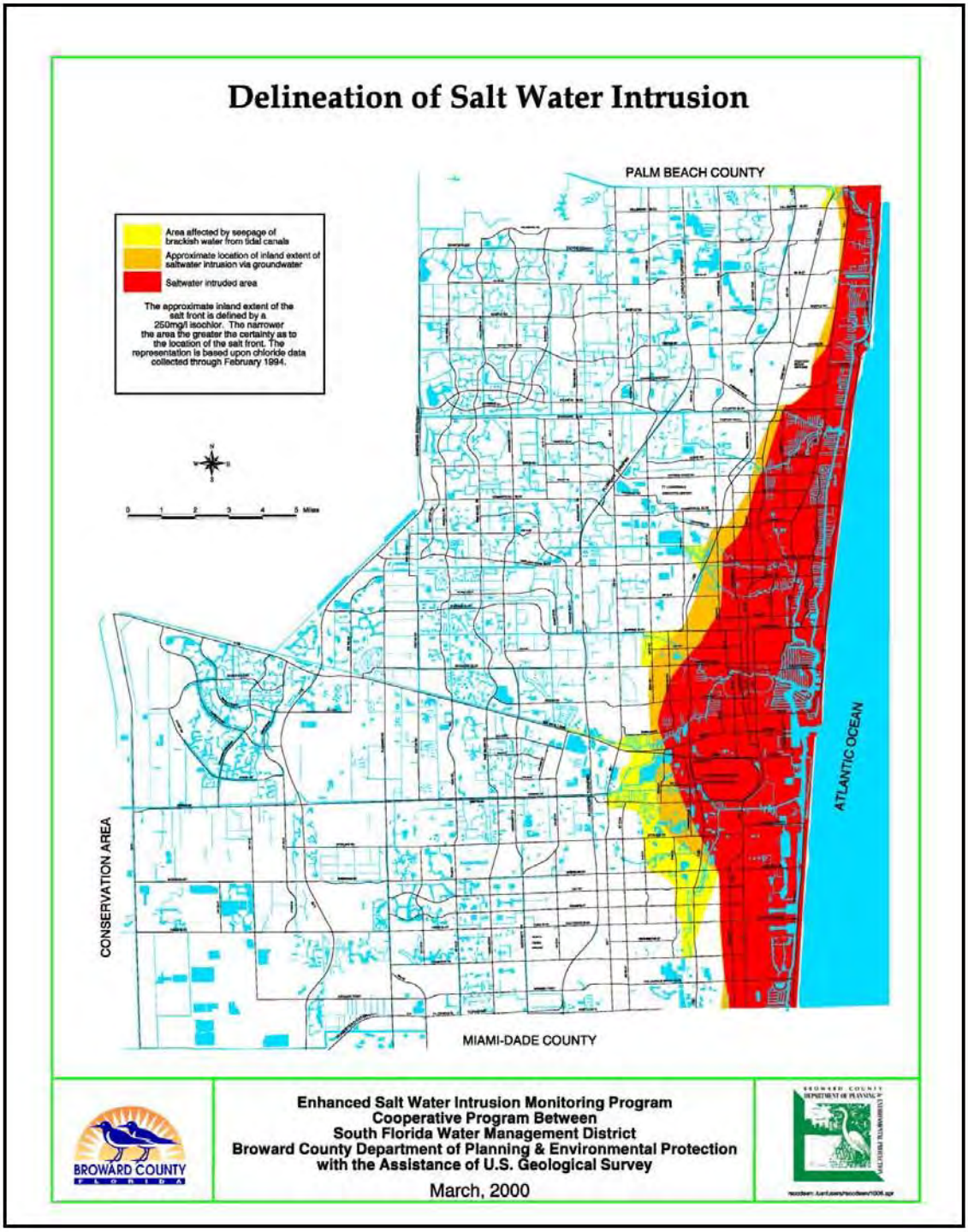


Figure 64 Broward County Saltwater Intrusion

3.10 Hazardous, Toxic, and Radioactive Waste

No active Comprehensive Environmental Response Compensation Liability Act (CERCLA) sites were found in the immediate vicinity of the Port. Although industrial facilities exist in the area that may have a potential for release of toxic materials, the materials most likely to be discharged are petroleum hydrocarbons; small, undocumented chemical spills; and stormwater runoff from large container and freight yards. A Phase I report is included in Appendix J.

Sediment sampling of material that may be dredged in the federal reaches is required prior to construction activities. Based on past sampling of dredge material, no hazardous substances are anticipated to be present above applicable action thresholds. Furthermore, dredge material that is subject to requirements issued under CWA Section 404 or Section 103 of the MPRSA is not classified as hazardous waste based on 40 CFR 261.4(g).Therefore, discussions pertaining to sediments that may be dredged and disposed are provided above in Section 3.4.2.

3.11 Air Quality

The Clean Air Act (CAA) of 1990 delineates the USEPA's responsibilities for improving and protecting the nation's air quality. The last significant amendments occurred in 1990 substantially enhancing the responsibility and authority of the Federal Government. The authority enhancements were through expanded regulatory authorizations, emphasizing implementation and enforcement while also considering a benefit-cost approach. USEPA is authorized to set air pollutant limits ensuring environmental and basic health protection standards for the United States; however, individual states have the option to enforce more stringent air pollution laws, if desired.

The study area's "region of influence" for air quality is defined by the administrative/regulatory boundary of Broward County, in the Southeast Florida Air-shed, part of the greater Miami-Fort Lauderdale-West Palm Beach Air Quality Control Region (AQCR). Air quality in a given location is described by the concentration of various pollutants in the atmosphere and is influenced by many factors including the type and amount of pollutants emitted the size and topography of the air basin, and the prevailing meteorological conditions. The significance of the pollutant concentration is determined by comparing it to the federal and state ambient air quality standards. The CAA requires EPA to establish the National Ambient Air Quality Standards (NAAQS) for six "criteria" pollutants.

Primary descriptors of the affected area's air quality may include the following:

- Criteria pollutants and standards;
- Ambient air monitoring
- Monitored ambient concentrations
- Emission source types and locations
- Existing conditions (or affected environment)
- General conformity
- Class 1 areas

Criteria Pollutants and Standards

The USEPA has set national ambient air quality standards for six common or "criteria pollutants". Ambient air is that portion of the atmosphere, external to buildings, which the general public has access. USEPA uses the term criteria because the allowable concentration levels of these six pollutants are human health-based and/or environmentally based limits. The human health-based limits are the primary standards and the environmental or property damage limits are the secondary standards. Currently, the seven criteria air pollutants are: Ozone (O_3), Particulate Matter (PM_{10}), and ($PM_{2.5}$) particles with aerodynamic diameters of 10 or 2.5 microns or less, Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2), and Lead (Pb) (USEPA 2010b).

Pollutants considered in this EIS are CO; PM_{10}; $PM_{2.5}$; sulfur oxides (SO_x); nitrogen oxides (NO_x); and volatile organic compounds (VOCs), which are precursors to ozone (O_3). Ozone is a photo-chemically produced pollutant created over time by a chemical reaction between $SO_{x,}$ NO_x and VOCs in the presence of heat and sunlight. Locally monitored concentrations reflect offsite or distant emission sources; in that, winds carry ozone and ozone precursors hundreds of miles from the original emission source. (http://www.miamidade.gov/development/pollution/ozone.asp).

The state and national ambient air quality standards presented in Table 15 represent the maximum allowable atmospheric concentrations that may occur while ensuring protection of public health and welfare, with a reasonable margin of safety. Short-term standards (1-, 8-, and 24-hour periods) are established for pollutants contributing to acute health effects, while long-term standards (quarterly and annual averages) are established for pollutants contributing to chronic health effects. The FDEP, Division of Air Resource Management (DARM) has adopted the NAAQS, with some exceptions and additions. In particular, the Florida sulfur dioxide standards are more stringent than the NAAQS.

Ambient Air Monitoring

Broward County has a network of air quality monitoring stations located throughout the county. Station #25 is located within the immediate vicinity of Port Everglades and monitors ozone and $NO_{2.}$ This site is the closest air quality monitoring site to the Port and the entrance channel (Figure 65).

Monitored Ambient Concentrations

DARM publishes the requisite Broward County Air Quality Maintenance Plan. This plan is in response to Section 110 requirements for attainment areas in association with the 1997 8-hour ozone standard under the CAA and does not . entail any conformity obligations. Table 16 provides 2007 local air monitoring results.

Table 15 Florida and National Ambient Air Quality Standards

Pollutant	Averaging Time	Florida Standard	National Primary NAAQS	National Secondary NAAQS
Carbon Monoxide	8-hour; 1-hour	9 ppm; 35 ppm	9 ppm; 35 ppm	NA NA
Lead	Quarterly[a]	1.5 µg/m^3	1.5 µg/m^3	1.5 µg/m^3
Nitrogen Dioxide	Annual[a]	100 µg/m^3 (0.05 ppm)	100 µg/m^3 (0.053 ppm)	100 µg/m^3 (0.053 ppm)
Ozone	1-hour[b] 8-hour[d]	0.12 ppm --	0.12 ppm 0.08 ppm	0.12 ppm 0.08 ppm
PM_{10}	Annual[a] 24-hour[b]	50 µg/m^3 150 µg/m3	50 µg/m^3 150 µg/m3	50 µg/m^3 150 µg/m3
$PM_{2.5}$	Annual[a] 24-hour[b]	----	15 µg/m^3 35 µg/m3	15 µg/m^3 35 µg/m3
	Annual[a]	60 µg/m^3	0.030 ppm	0.5 ppm
		(0.02 ppm)	0.14 ppm	
Sulfur Dioxide	24-hour[c]	260 µg/m^3 (0.10 ppm)	NA	NA
	3-hour[c]	1300 µg/m^3	NA	NA
		(0.5 ppm)		

[a]Arithmetic mean.bNot to be exceeded on more than an
[b]Average of one day per year over a 3-year period.
[c]Not to be exceeded more than once per year.
[d]Not to be exceeded by the 3-year average of the 4th highest daily maximum.
NA – Not applicable

Source: USEPA 2008a

Figure 65 Broward County Air Quality Monitoring Stations

Table 16 Broward County Air Quality Report: Criteria Air Pollutants for 2007

CO (ppm)		NO_2 (ppm)	O_3 (ppm)		SO_2 (ppm)		$PM_{2.5}$ (ug/m3)		PM_{10} (ug/m^3)		PB (ug/m^3)
2nd Max 1-hr	2nd Max 8-hr	Annual Mean	2nd Max 1-hr	4th Max 8-hr	2nd Max 24-hr	Annual Mean	98th%ile	Annual Mean	2nd Max 24-hr	Annual Mean	Quarterly Mean
3.2	2.1	0.007	0.084	0.064	0.011	0.001	41	9	106	22	

Source: USEPA 2008b

Emission Source Types and Locations

The applicable criteria pollutants are generated by various activities (e.g., construction and mobile source operations) associated with the proposed action alternatives. Airborne emissions of lead are not included because there are no known significant lead emissions sources in the region or associated with the proposed action alternatives or the No-Action Alternative.

The Port is located in a highly urbanized area with an International Airport within two miles of the port. Additionally, an east/west Interstate (I-595), a north/south Interstate (I-95), and the Florida Turnpike are less than five miles from the Port. As such, there is heavy vehicular traffic within the Port area resulting from these roadways. There are trucks leaving and entering the Port on a daily basis associated with the delivery of petroleum products as well as the transport of containerized and bulk cargos. These cargo transports produce emissions that affect local air quality. Three other factors also contribute to the air quality surrounding the Port: the presence of FP&L's fossil fuel plant, associated airport emissions, and Port vessel activity associated with international commerce.

The Port is working with its tenants to develop a "Green Port Program", a component of which addresses air quality in the Port and associated Port activities. Some of the steps taken by the Port to improve air quality include: (1) converting diesel gantry cranes to electric (Currently seven of the nine gantry cranes in the Port are electric.); (2) converting Port vehicles from regular diesel fuel to biodiesel; (3) investigating alternative fuels such as biodiesel (B-20), which contains 20% biodiesel and 80% petroleum diesel by 2015; (4) converting Port vehicles to alternative fuel vehicles that are 100% diesel free; (5) conducting an energy audit throughout the Port; and (6) replacing aging inefficient equipment with newer, more fuel efficient equipment. The benefits of this audit are expected to be an annual reduction in emissions of 9.8 million pounds of CO_2; 61,101 pounds of SO_2 and 17,091 pounds of NO_2 (Port Everglades 2007a).

Existing Conditions (or Affected Environment)

A locality's air quality status and the stringency of air pollution standards and regulations depend on whether monitored pollutant concentrations attain the levels defined by the NAAQS. Ambient air quality concentrations are expressed in parts per million or micrograms per cubic meter. Existing and proposed air emissions are expressed in tons of pollutant per year. To ensure the NAAQS are achieved and/or maintained, the CAA requires each state to develop a State Implementation Plan (SIP). According to the plans outlined in the SIP, designated state and local agencies implement regulations to control sources of criteria pollutants. The SIP must also include a plan to maintain acceptable air quality in areas that do not exceed the NAAQS.

Broward County including the metropolitan Fort Lauderdale area is part of the affected environment for air quality from Port Everglades activities. As was mentioned earlier, Broward County is included in the air-shed along with Miami-Dade and Palm Beach counties. These counties encompass portions of the Southeast Florida Intrastate Air Quality Control Region (USEPA, 2006). Currently, the air-shed is in attainment for all federally regulated criteria pollutants. These would include the standards for ambient concentrations of CO, SO_2, NO_2, PM, Pb and the 8-hr standard for ozone.

However, emissions of NO_x and VOCs which are precursors to ozone formation and are caused primarily by motor vehicle traffic and other mobile sources such as aircraft are of continuing interest in Broward County. The county was previously operating under a maintenance plan for 1-hour ozone emissions, but as of June 15, 2005, is no longer subject to the 1-hour Standard (USEPA). Since Broward County is in attainment for all criteria pollutants including ozone, the estimated emissions for the proposed project (see Section 4.0 where air quality is addressed) were calculated for CO, NO_x, SO_x, PM_{10}, $PM_{2.5}$ and VOCs for planning purposes only. Broward County (and all the counties in the air-shed) is considered by USEPA to be in attainment for all criteria pollutants, including ozone under the June 15, 2005 8-hour ozone standard and as such, are exempt from the CAA Conformity Determination requirements.

As previously discussed in Section 2.4 (No Action Alternative) based on 2012 vessel call data (most recent data available, which were analyzed and detailed in the Economics Appendix to the Feasibility Study), approximately 4,000 vessels call annually at Port Everglades. These vessels contribute to the emissions currently ongoing in the county air-shed.

General Conformity

The CAA include provisions to ensure that emissions from federal actions will comply with the goals of the SIP through a Conformity Determination Analysis. The analysis confirms the proposed action will not cause new air quality violations, worsen existing violations, or delay timely attainment of the relevant national ambient air quality standards in areas of nonattainment or within maintenance areas.

USEPA published *Determining Conformity of General Federal Actions to State or Federal Implementation Plans; Final Rule* in the 30 November 1993, Federal Register (40 Code of Federal Regulations [CFR] Parts 6, 51, and 93). This publication provides implementing guidance to document the CAA Conformity Determination requirements. Subsequent to the 1993 rule, USEPA collected information from other federal agencies on how to maintain the same environmental protections while streamlining the general conformity implementation process. This information was used to develop and propose regions to the general conformity rule. After soliciting comments on these revisions from the public, USEPA issued a final rule revision on April 5, 2010. Federal regulations state that no department, agency, or instrument of the Federal Government shall engage in, support in any way or provide financial assistance for, license to permit, or approve any activity that does not conform to an applicable implementation plan. It is the responsibility of the federal agency to determine whether a federal action conforms to the applicable implementation plan before the action is taken.

Table 17 Clean Air Act de *minimus* Thresholds

Pollutant	Nonattainment Area Threshold Emissions (Tons Per Year)	Maintenance Area Threshold Emissions (Tons Per Year)
Carbon Monoxide(CO)	100	100
Particulate Matter(PM_{10})		100
Moderate Nonattainment Area	100	
Serious Nonattainment Area	70	
Particulate Matter ($PM_{2.5}$)	100	100
Precursor pollutants SO_2, NOx, VOC, & NH_4	100	100
Sulfur Dioxide(SO_2)	100	100
Nitrogen Dioxide(NO_2)	100	100
Lead(Pb)	25	25
Ozone2(O_3)	VOC/NO_x	VOC/NO_x
Serious Nonattainment Area	50/50	
Severe Nonattainment Area	25/25	
Extreme Nonattainment Area	10/10	
Inside an ozone transport region 3:		50/100
Marginal Nonattainment Area	50/100	
Moderate Nonattainment Area	50/100	
Outside an ozone transport region 3**:**		100/100
Marginal Nonattainment Area	100/100	
Moderate Nonattainment Area	100/100	

Note: The *de minimus* levels for all criteria and precursor pollutants provided in this table are effective as of 2009.

1 NH_4 is the chemical formula for ammonium (ammonia), a precursor to the development of $PM_{2.5}$. Net emissions of pollutants determined by USEPA as precursors or contributors to $PM_{2.5}$ emissions include SO_2, NO_x, VOC, and NH_4, and are each limited to net emissions of 100 tons per year in a $PM_{2.5}$ nonattainment or maintenance area.

2 The rate of increase of ozone emissions is not usually evaluated in an environmental review because the formation of ozone occurs on a regional level and is the result of the photochemical reaction of NO_x and VOC in the presence of abundant sunlight. Therefore, USEPA considers the rates of increase of NO_x and VOC emissions to reflect the likelihood of ozone formation on a project level.

3 An ozone transport region (OTR) is a single transport region for ozone, comprised of the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and the Consolidated Metropolitan Statistical Area that includes the District of Columbia.

Sources: 40 CFR 93.153(b)(1)&(2), July 1, 2006; *Florida Administrative Code (FAC)*, October 1, 2004, Chapter 62-204 *Air Pollution Control-General Provisions*; and Section 62-204.800 *Federal Regulations*, 71 FR 17003, April 5, 2006, *PM2.5 De Minimus Emission Levels for General Conformity Applicability*.

The general conformity rule applies to federal actions proposed within areas which are designated as either nonattainment or maintenance areas for the NAAQS for any of the criteria pollutants. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Emissions of pollutants for which an area is in attainment are exempt from conformity analyses. Broward County (and all the counties in the air-shed) is considered by USEPA to be in attainment for all criteria pollutants and as such are exempt from the CAA's Conformity Determination requirements.

Class 1 Areas

The CAA also establishes a national goal of preventing degradation or impairment in any federally designated Class I Area. As part of the Prevention of Significant Deterioration (PSD) program, mandatory Class I status was assigned by Congress to all international parks, national wilderness areas, memorial parks greater than 5,000 acres and national parks greater than 6,000 acres. In Class I Areas, visibility impairment is defined as a reduction in visual range and atmospheric discoloration. Stationary sources such as industrial complexes are typically an issue for visibility within a Class I PSD Area. There are three Class I Areas designated in Florida: (1) Chassahowitzka Wilderness Area, (2) St. Marks Wilderness Area, and (3) Everglades National Park. The closest Class I Area to Port Everglades is the Everglades National Park, which is located on the southwest tip of the Florida peninsula west of Homestead, a distance of approximately 75 miles. This is well in excess of the 50 km (31 mile) limit typically used by federal land managers to define a "near" Class I Area and the types of visibility impacts analyses applicable to those areas.

Sensitive Receptors

Sensitive receptors include, but are not limited to, hospitals, schools, daycare facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants. Extra care must be taken when dealing with contaminants and pollutants in close proximity to areas recognized as sensitive receptors. There are no known sensitive receptors within 1,500 feet of the project area; the nearest sensitive receptors are a school one mile to the northwest of the project footprint, and Broward General and Westside Regional Medical Center, which are located approximately 1.5 miles west of Port Everglades Harbor (see Figure 66).

3.12 Noise

The urban setting of the Port produces noise not necessarily related to the operation of the Port. One of the major contributors to noise on an intermittent basis is the Fort Lauderdale/Hollywood International Airport. Other sources of noise within the jurisdictional boundaries of the Port are related to the transportation sector, such as trucks associated with the movement of petroleum product, containerized cargo, and private vehicles.

There is little to no noise produced as a result of vessel traffic except for the engine and propeller noise associated with vessel transit and tug operations, as well as recreational vessels transiting through the Port. Port tariff restricts the blowing of whistles and horns by vessels while in Port and the only intermittent whistle blowing are signals between tugs while assisting vessels in their movement within the Port.

Figure 66 Sensitive Air Quality Receptors Near Project Area

3.13 Aesthetic Resources

The Port is situated in an urban setting. East of the Port is JUL which is dedicated for recreational use. This area is vegetated with mangroves and coastal hardwood hammocks, and areas of exotics such as Australian pine and Brazilian pepper. South of the Port across the DCC is West Lake Park. That portion of the Park is not intended for heavy public use; it comprises areas of mangroves, sloughs, and canals. To the northwest of the West Lake are several public marinas, Port Laudania (island-hopping maritime commerce), and several yacht repair facilities. To the north and west of the Port, there is a mixture of residential homes and condominiums. To the northwest of the Port is a Regional Sewage Treatment Plant; commercial establishments such as hotels, restaurants; and a mixture of various other commercial enterprises. The Southport area is partially developed with container yards and six low-profile gantry cranes.

Adjacent to the Port is a major roadway network that includes two interstate highway systems, the Florida Turnpike, U.S. Highway 1, and an International Airport. Port property, excluding the Southport area is developed for purposes of Port activities such as cruise terminals, warehousing, cement silos, container yards, petroleum berths, bulk cargo berths, parking garages, etc.

In summary, the majority of the Port is associated with nearby urban areas. The aesthetic resources of the area comprise JUL including beaches and forests, West Lake Park including its mangrove swamps, the federal waterways themselves, submerged offshore reefs, and perhaps even the massive vessels that transit the Port and entrance channel.

3.14 Recreation Resources

John U. Lloyd Beach State Park is a major recreational feature of the project area (see also Section 3.17 *Adjacent Properties* below). It offers visitors to its facilities many opportunities to enjoy themselves. These activities include swimming, sunbathing, hiking, bicycle riding, fishing from the shoreline or the south fishing jetty, canoeing, kayaking, and boating, nature study and photography, use of nature trails, and picnicking. The park has one of the easiest and most interesting shore dives in the area. The park has two boat ramps with easy access to the ocean through the Port Everglades Inlet, a popular inlet for those who prefer to fish in open water. Concessions exist on premises.

Use of ocean cruises (local or international) for recreation is a growing industry. The Port Everglades Master/Vision plan (2009, “Cruise Assessment” section) noted, “Port Everglades is a significant homeport option for the worldwide cruise fleet, offering a platform for cruise operations to the largest cruise region worldwide (the Caribbean) while also catering to diverse cruise vessel types and brands.” During FY 2009, 508,000 revenue passengers boarded cruises at Port Everglades, while 394 cruise vessels called at the Port.

As of 2011, Broward County had 42,687 registered watercraft. (http://www.flhsmv.gov/dmv/TaxCollDocs/vesselstats2011.pdf). Ninety-six percent of these are classified as pleasure craft. Pleasure craft enter the Port area from the west along the DCC, or from north or south on the IWW; they generally converge in the IEC, along with commercial shipping and cruise vessels (Figure 67). There are several marinas adjacent to the Port that service all types of pleasure craft during the entire year. Some of these marinas are associated with hotels in the northern portion of the Port so that they can accommodate guests and their vessels. There are also several public and private marinas within the DCC and the IWW south of the Port as well as a public boat ramp in John U Lloyd State Park.

Diving and fishing in offshore areas adjacent to the Port's outer channels via use of private or commercial craft are common recreational pursuits near the project area, though neither is allowed within the channel itself. However, fishing from the docks within the Port is prohibited, and no private craft can drop anchor within the harbor or channels to fish due to Port security regulations.

There are many businesses that cater to the fishing industry, diving industry, and tourist industry through dinner cruises and boat tours of the area. Nearby West Lake Park to the south of the Port provides recreational opportunities for shallow water boating, bird watching, etc. Along the IWW adjacent to West Lake Park is a jet-ski area.

Figure 67 Aerial Photograph of Port and Recreational Boat Traffic at Port Everglades

3.15 Cultural Resources and Historic Properties

The earliest widely accepted date of occupation by aboriginal inhabitants of Florida dates from around 12,000 years ago. This earliest cultural period, called the Paleo-Indian period, lasted until about 10,000 YBP (years before present). Sea level was lower and the continental shelves were exposed - an area almost twice the width of the current size of the state. Few Paleo-Indian archeological sites are recorded in south Florida.

During the Archaic period (ca. 10,000 YBP - ca. 2500 YBP), a wider range of resources was exploited and may have led to a more sedentary existence. Sea level rose to its present position. Few Archaic-period archeological sites are recorded in south Florida. Known sites are clustered along the Atlantic and Gulf coasts and inland waterways.

Two, different regional cultural traditions within Broward County, known as the Glades and the Okeechobee cultures, developed from the Archaic period in south Florida around 2500 YBP. Occurring within the eastern part of the County, the Glades culture sequence (ca. 2500 YBP - A.D. 1513) produced a large number of sites, predominantly along the coasts, but also on tree islands in the interior wetlands. Glades site types recorded by the Florida Master Site File (FMSF) include shell and earth middens and low sand mounds and many are recorded near the project area.

During the early historic period, beginning with the first Spanish colonial period (A.D. 1513 - 1763), the Ais, Tequesta, and Calusa were the main tribal groups that controlled southern Florida. Other native tribes, the Jeaga and the Hobe, inhabited the Atlantic coast as well. Their population was decimated by European-introduced diseases, warfare, enslavement, and migration out of Florida.

The Miccosukee and the Seminole migrated into Florida in the 18th and 19th centuries from Georgia and Alabama. Throughout the mid 1800s, the U.S. relentlessly pursued a policy of Indian removal in Florida. The Seminole Indian Wars (1835-1842) were the result. The Seminole and Miccosukee, resisting removal, eventually established themselves in the Everglades, Big Cypress Swamp, and the Ten Thousand Islands.

American settlement in south Florida began in earnest in the late 19th century. In the late 19th and early 20th centuries, the Florida East Coast railway brought new settlers and tourists to Broward County towns and beaches. Land and agriculture were the economic backbone of south Florida for these decades.

In 1926 and 1928, hurricanes demolished the region and recovery from the after effects only began around World War II. By the 1950s, the population of the region had exploded and today Broward County's industry includes cattle, agriculture, commercial and sport fishing, and tourism.

In 1927, construction started within the current Port Everglades project area on Port Mabel. Port Mabel originally served as a military facility. During the 1930s, it steadily grew based on the growing trade business. In the 1940's the Port was again heavily utilized by the military and experienced steady growth with expansion of the Port and creation of additional land based infrastructure. This growth continues today as the Port use continues into the 21st century.

All of Broward County, both inland, along the coast, and offshore have the potential to contain cultural resources. Within the proposed project areas, the FMSF recorded four archeological sites

in the immediate vicinity of the project area. All four are maritime resources located outside of the current project area. In addition, five historic structures are located adjacent to the project area. Finally, the Port itself is considered a resource. The resource group is composed of both archeological sites and the historic structure and Port itself. Its significance lies within its importance to the commerce, community planning and development, engineering, and military history. Adjacent John U. Lloyd Beach State Park is also a registered historical landmark (i.e., Black Beach) (pers com, Dan Hughes, USACE Jacksonville District).

In 2002, the USACE conducted a submerged cultural resources survey of portions of the proposed project area. The resulting report, Historic Assessment and Remote Sensing Survey at Port Everglades, Broward County, Florida, (Hall 2002) identified four possible targets that were determined by archeological diver identification not to represent potential historic properties. This survey was coordinated with the Florida State Historic Preservation Officer (SHPO) and the Florida SHPO concurred with the report's findings on April 25, 2002 (DHR File No. 2002-03860).

An updated submerged cultural resources survey of the expanded outer channel project area (OEC) was conducted in 2011 (Lydecker, et al. 2012) and identified two potentially significant magnetic anomalies. Subsequent archeological diver identification of the two magnetic anomalies in 2012 (Lydecker, et al. 2013) indicated that both anomalies were modern ferrous debris. USACE determined no historic properties affected for the outer channel expansion project area and the Florida SHPO concurred on February 4, 2013 (DHR File No. 2013-00187).

3.16 Native Americans

No portion of the proposed project exists within or adjacent to any Native American properties.

3.17 Adjacent Properties

Located north of the Port are residential and commercial developments including an extensive array of private vessel marinas and docks. The federal IWW project transits through the Port from north to south, along the Southport Channel. East of the Port is a barrier island that contains the John U. Lloyd Beach State Park (JUL), a U.S. Navy facility, Nova Southeastern University Oceanographic Center (NSUOC), and a USCG Facility. On the east side of the barrier island is a sandy beach/offshore reef system. West Lake Park, is a 1,500-acre nature preserve, considered one of the largest and last remaining protected parks in South Florida, and is located south of the port. Major transportation infrastructure is located west of the port. This includes: the Fort Lauderdale/ Hollywood International Airport, two interstate highways, and Florida's turnpike. The Port has adequate access to FEC Railway links, with future plans for an intermodal container transfer facility and railway lines.

John U. Lloyd Beach State Park. JUL is located approximately two miles east of Dania, three miles north of Hollywood, and five miles south of Fort Lauderdale, in one of the most densely populated areas of Florida. The park is situated on a peninsula that separates Port Everglades from the Atlantic Ocean, and comprises one of the most heavily used beach areas in the Florida state park system. Access to the unit is from State Road A1A (North Ocean Drive) off Dania Beach Boulevard. JUL comprises 158.75 upland acres and 151.97 wetland/submerged acres, for a total of 310.72 acres, and has 2.25 and 0.26 miles of beachfront coastline and inlet shoreline, respectively, within its boundaries. The park contains the following ecological communities (Figure 68): beach (an active nesting area for sea turtles) and beach dune, estuarine tidal swamp (mangroves), estuarine and marine unconsolidated substrates, marine consolidated substrates,

and a rare, tropical coastal hammock ecosystem (maritime hammock). It is covered with a diverse assemblage of tropical trees (mastic and paradise tree) as well as tropical understory (wild coffee and Spanish stopper). Generally, because of the cooler weather, tropical species rapidly decline northward from South Florida along the coast to Cape Canaveral. This unit is near the northernmost range of many tropical species. Because of the near total loss of this type of plant community in this part of the state, the maritime hammock sites within JUL have become increasingly valuable for their ability to act as "refugia." The examples seen in South Florida today are remnants of a once extensive system. Because of the likelihood for development to occur on the remaining privately held coastal property in South Florida, it is certain that the remaining examples of this community will become even more endangered. The hydrological features of the park include the Atlantic Ocean, Intracoastal Waterway, New River Sound and mangrove wetlands.

U.S. Coast Guard Facility (USCG). USCG Station Fort Lauderdale is part of District 7, consists of 8.3 acres, and is located at the northern end of the peninsula that separates Port Everglades from the Atlantic Ocean (Figure 69). It is located north of the NSU Oceanographic Center and north and west of JUL. The Station was commissioned in 1975 its primary missions are search, rescue and drug interdiction. Their area of responsibility extends over Palm Beach, Broward, and Dade counties. This area encompasses 1,891 square miles of ocean and over 300 miles of inland waterways. Missions include search and rescue, maritime law enforcement, marine safety and marine environmental protection. To fulfill mission requirements, two 41' utility boats, one 24' utility launch, and one 21' rigid hull inflatable boat are maintained at the station. Two immediate response boats and crews are on duty 24 hours a day. In addition, a communication watch is maintained in the modern communications center.

Nova Southeastern University Oceanographic Center. The Nova Southeastern University Oceanographic Center NSUOC property consists of 10 acres located on the northwestern shore of the barrier island and is immediately south of the Navy facility and north of the USCG facility (Figure 69). The facilities include three permanent buildings encompassing almost 27,000 square feet of office, classroom, library, and laboratory space. NSUOC also provides space for the National Coral Reef Institute, the Guy Harvey Research Institute in the newly constructed Center of Excellence for Coral Reef Ecosystems Science Research Facility, and the Save Our Seas Shark Center.

U.S. Navy Facility. The Naval Surface Warfare Center Carderock Division's *South Florida Ocean Measurement Facility* (SFOMF) consists of 10 acres located on the northwestern portion of the barrier island, south along the IEC and immediately north of NSUOC (Figure 69). The Navy leases the property from the State of Florida's Board of Trustees of the Internal Improvement Trust Fund (TIITF) (pers com, William Venezia, US Navy, email dated 4 October 2012 to Dial Cordy and Associates). This site has housed an active, continuously operating Navy range for more than 50 years. According to the information on the SFOMF website (http://www.navsea.navy.mil/nswc/carderock/pub/who/sites/south_fl.aspx, the main mission of SFOMF is "to perform electromagnetic signature tests of Navy assets by providing the ability to monitor surface ship, submarine, and remote vehicle signatures in the near shore environment. Multiple fixed, in-water electromagnetic and acoustic measurement sites at various depths are controlled from a secure range house. The range encompasses the Navy's only shallow and deep water magnetic research and development ranges, and accommodates both surface and submerged operations."

Figure 68 On-site habitats at John U. Lloyd Beach State Park

Legend

Broward County Parcel Boundary

0 200 400 800 Feet

Selected Properties Adjacent to the Project Area	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 400 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 69

3.18 Economics and Logistics

Section 2.4.2 of the Feasibility Study details Cargo Movements at the Port. That section and the Economics Appendix to the Feasibility Study provide information regarding the existing economic conditions and their relevance to logistics. Much of the text below is summarized from the Feasibility Study.

Port Everglades handles liquid bulk, dry bulk, general cargo, ro/ro cargo, neobulk, breakbulk, cruise ship passengers, and containerized cargo. The Port documented 4,000 vessel calls in 2012.

Containerized Cargo. Port tenants include more than 30 shipping lines calling on over 150 ports in 70 countries. Of these, 26 carriers serve 33 countries and 101 ports in Latin America and the Caribbean. Cargo transiting to and from Port Everglades comes from all over the world including countries in the Far East, South America, northern Europe, the Mediterranean and South Africa. The Port's location at this global crossroads for trade also makes it extremely attractive for imports and exports - more than $11 billion worth in 2006. One key draw is Florida's first and largest Foreign-Trade Zone, conveniently situated in the heart of Port Everglades (Port Everglades 2006).

Container tonnage has been resilient over the past decade despite the economic recession causing an average 20% decline across all major domestic container ports. The growth in cargo tons is indicative of south Florida population growth over this temporal period of analysis.

There is a trend for container vessels calling at deeper sailing drafts inbound and outbound. For example, container vessels calling with 35-foot sailing draft or greater increased from 35 inbound in 2004 to 104 inbound in 2008. The increase in deeper drafting vessels correlates with the increase in number of larger Panamax container vessels calling the port. The liquid bulk fleet (tanker) is primarily Handymax in size (less than 60,000dwt), with a few Aframax vessels (120,000dwt with post-Panamax beams) and Panamax vessels (<80,000dwt). The bulk fleet is currently sailing at or near 37-foot average drafts. The dry bulk fleet ranges between 40,000 and 60,000 dwt. The dry bulk is typically all cement. Section 4.2 of the Economic Appendix (Feasibility Study) discusses the fleet composition in more detail.

Economies of scale (declining cost per unit as volume increases) in shipping emerge for a variety of different reasons. Having a large local market share is an important driver of economies of scale in terminal operations. When a high share of the volume originates in and/or is destined for a local market, this lowers container terminal costs per unit thereby enabling larger, more efficient and more intensively utilized facilities. This enables carriers to operate larger vessels that naturally optimize at lower per slot costs than smaller ships. With the continued long term population growth in south Florida, Port Everglades will continue to be a busy port-of call.

Bulk Cargo. As the lead bulk cargo seaport in Florida, Port Everglades continues to supply Florida's population growth demands. Port Everglades imports and exports more than three million tons of raw materials each year in bulk, break bulk, floating, and rolling cargoes. Steel and steel rebar, lumber, and plywood are major break bulk cargoes. Dry bulk, which includes cement and aggregate, are also important. The majority of cement and its byproducts are imported to South Florida from Sweden (Port Everglades 2006). The Port also is a designated point of entry for coffee, sugar, and cocoa to be traded in the coffee futures market with two certified waterside warehouses at the Port.

Petroleum. Port Everglades is the main entry and delivery center for petroleum, gasoline and jet fuel for all of South Florida. More than a dozen major petroleum corporations store and distribute gasoline through Port Everglades to thousands of gas stations in 12 counties, including communities on the east and west coasts of Florida and the Florida Keys. Port Everglades originally started as a petroleum port. Currently, nearly one-fifth of Florida's energy requirements (and one-fifth of Port Everglades' total revenues) comes from petroleum and its byproducts stored at and distributed through Port Everglades. The Port is South Florida's primary seaport for delivery of refined petroleum with annual petroleum throughput in the vicinity of 128.8 million barrels (42 U.S. gallons per barrel) of which 55% is gasoline and 21% jet fuel. Based on current energy demands in South Florida, this number is expected to increase approximately 30% by 2015 (FDEP 2005). Port Everglades is the regional seaport for 11 petroleum terminal operators who supply gasoline, jet fuel, fuel oil, diesel fuel, propane, aviation gasoline, and asphalt to 12 counties in South Florida, serving a market of 6.8 million people. Petroleum products moving through Port Everglades' docks account for nearly 40% of all Florida's transportation fuels. In addition, jet fuel moving through the Port is supplied to three international airports in the region (Fort Lauderdale, Miami and Palm Beach) and military jet operations in SE Florida from Homestead Air Reserve Base. Approximately 65% of petroleum products moving through Port Everglades come from refineries in the U.S. Gulf States (Louisiana, Texas, and Mississippi). Foreign imports, which account for approximately 35% of the region's supplies, come from the Caribbean, Europe, South America, Canada, and Mexico (Port Everglades 2006).

Cruise. In addition to the cargo traffic, Port Everglades is a major homeport/destination Port for major cruise ship lines. Multi-day cruises include *Balearia Bahamas Express, Hapag-Lloyd Cruises, Princess Cruises, Carnival Cruise Lines, Holland America Line, Royal Caribbean International, Celebrity Cruises, MSC Cruises, Silversea Cruises, Cunard Line, P&O Cruises*, and *Seabourn*. Daily cruises include *Discovery Cruises*.

The Port is also one of the world's busiest cruise ports in terms of passengers. Several recent developments are projected to boost cruise numbers and are expected to favorably impact the Port's bottom line in 2007 including relocation of larger ships and expansion of existing ships to carry more passengers. Traditionally the port's cruise vessels have been smaller day-cruises accommodating 1,200 passengers or so. Cruise ship trends at Port Everglades are changing and are trending towards larger capacity vessels accommodating on the order of 3,000 passengers. Total annual cruise calls is projected to remain around 2,000 annually.

Military. The Port is home to U.S. Coast Guard Station, Fort Lauderdale, commissioned in 1975. Its primary missions are search and rescue operations and drug interdiction as part of their mission in support of the U.S. Department of Homeland Security. Historically, Port Everglades has long had a reputation as a favorite U.S. Navy liberty port. It is an ideal location for operational exercises in conjunction with the Port-located U.S. Navy's South Florida testing facility. Each year, as part of the air and sea show, the Port welcomes numerous Naval ships and thousands of sailors. In 2007 Port Everglades was host to more than 6,000 sailors during liberty associated with the air and sea show.

Employment. Cargo and cruise operations at the Port generate substantial economic benefits for Broward County and the South Florida region. More than 29,000 jobs are directly or indirectly attributable to Port operations. Jobs created by Port and trade activity tend to be good jobs: they pay significantly more than other job sectors in the local economy, have better long-term opportunities for employees, and offer better training programs (particularly for minorities). In the year 2007, Port related jobs have estimated average, per capita, annual wages of $44,326 (Port Everglades 2007b).

3.19 Infrastructure

The Port's principal shipping channels and turning basins provide access to berthing areas at the Port, roll-on/roll-off ramps, gantry cranes and other associated yard equipment, staging and storage areas, transit sheds, and marshalling yards. There is direct access to multi-modal inland links through Florida's interstate and highway systems; an FEC rail hub within two miles, and a major international airport (FLL) across U.S. Highway 1.

Port Everglades' infrastructure is divided into three Port terminal areas, each with individual characteristics and use: Northport, Midport, and Southport. The Port's 32 berths are divided amongst the three terminal areas. Total berthing space measures 24,522 linear feet (R. Flint email to R. Musser, Port Everglades, 9 January 2015).

The Port Everglades Northport region is a multi-use facility, primarily handling cruise operations and liquid bulk unloading (petroleum), but with additional capabilities for container vessels, neobulk cargos, roll-on/roll-off ("ro/ro") cargos, military berthing, and some smaller lay-in spaces. The Northport region covers Berths 1-13. Northport has nine acres of open yard facilities for containers. The Northport area has oil product storage tanks, cement silos, railroad spur access, road access, and airport access nearby. There is also one daily cruise vessel that berths in this area.

Port Everglades' Midport, like Northport, is a mulit-use facility. Midport berthing serves cruise industries, lift-on/lift-off ("lo/lo") cargo, ro/ro cargo, naval ships, harbor tugboats, and smaller lay-in vessels. Primary cargos handled in this area of the Port include containers, bulk cement, lumber, and steel. The Midport region covers Berths 14-29. Along with berthing, Midport provides: one Panamax gantry crane, a refrigerated wharehouse, 77 acres of open yard area for containers and neobulk storage, and nine dockside terminal buildings that provide additional cargo storage as well as passenger facilities. Terminals 16 and 29 are dedicated to cargo operations. Terminals 18, 19, and 26 are dual-use passenger/cargo terminals. Terminals 21, 22, 24, and 25 operate passenger facilities only.

Port Everglades Southport region is dedicated to cargo traffic and maintains both lo/lo and ro/ro operations. The Southport terminal has 215 acres of open yard facilities for contianers/trailer storage and operations. Southport extends from Berths 30 to 33C. Along with berthing, Southport offers seven low-profile post-Panamax gantry cranes. These cranes are mounted on a rail which extends from Berth 30 at the TN to Berth 33 just north of the DCC.

Future growth in cargo business at the Port is dependent in large part on the Port's ability to accommodate container ships and petroleum tankers. The number and size of new container ships delivered or on order from shipyards increased significantly during the past decade. Container ship capacities and dimensions have increased substantially since the 1970s and 1980s. Principal deep-sea shipping routes to and from Asia, Europe, and the United States are currently serviced through use of Panamax (3,000 TEUs and over) and post-Panamax (4,000 TEUs and over) vessels. First- and second-generation vessels, once the mainstay of the container shipping industry, today operate as feeder vessels from larger, regional hubs to smaller ports. Shipping lines are planning the future development of even larger container vessels (post-Panamax Plus), which will be able to transport between 6,000 and 8,000 TEUs. The drafts of modern-day vessels are also significantly deeper than in the past. Modern container ships, on average, require drafts of between 30 and 35 feet. Some of the larger container ships require even deeper drafts, ranging from 40 to 45 feet. These larger ships want to call on the Port, but have been unable to access berths due to channel depth constraints.

3.20 Navigation Safety

Navigation safety issues regarding the Port are complex, involving offshore conditions as well as issues involving transit and turning inside the Port. During plan formulation, representatives from the Port, the Port Everglades Pilots Association, and USACE met several times to discuss problems to be investigated by this study. "Navigation problems occurring under existing conditions with risk to safety" was one of the two major problems identified. Specifically, the risk was due to (1) not having adequate width and depth of the channel to accommodate *future* vessel fleets leading to collisions, allisions, and groundings, and (2) safe maneuverability and routine operation of the Port in its current configuration. "Groundings" refer to contact between a vessel and a submerged object resulting in loss of vessel control. "Allision" is the contact between a moving vessel and a stationary object, including another vessel. "Collision" is the contact between two moving vessels. The existing problems that warrant study are expanded in more detail below:

i Outer Entrance Channel (OEC) existing dimensions and strong unpredictable cross currents (see NOS 2010) combine to make entrance transit difficult under such conditions of increased winds, waves, and currents. Pilots must increase vessel speed to negotiate the currents and compensate under crabbed conditions to remain aligned within the channel (Figure 70);

ii The Knuckle area restricts maneuverability and passing operations, especially when vessels are at Berths 25 and 26;

iii The shoal in the area of the USCG facility restricts maneuverability and passing operations for transit down the Southport Access Channel (SAC), especially when vessels are at Berths 24 and 25;

iv The existing SAC width restricts two-way traffic;

v Turning Notch (TN) dimensions limit the size of vessels that can be turned and berthed;

vi Depth of channels and basins constrains fully loaded vessel realization;

vii The Port is berth deficient to accommodate existing and the projected future vessel fleet of post-Panamax ships.

The existing conditions at the Port may contribute to ship collisions with vessels in transit or allisions with stationary vessels, channel walls, or reefs. USCG casualty data dating from 1998-2008 contained 55 casualties related to groundings in and around Port Everglades (Figure 71). Review of the data showed that a handful of the groundings occurred outside of the marked channel and the vessel was typically a towing vessel. Some of the allisions were head on, broadside, and others astern. The collision data did not have an explanation and in some cases "special circumstances" was the notation. Vessel control for all the casualties ranged from no control to partial to full control, and was not known for some incidences. These findings do not necessarily highlight one particular concern with the channel, but demonstrates the risk and safety encountered everyday by the pilots and other vessel operators in and around Port Everglades.

Section 4.2 (Problems and Opportunities) of the Feasibility Study provides a more detailed examination of these important issues and additional figures.

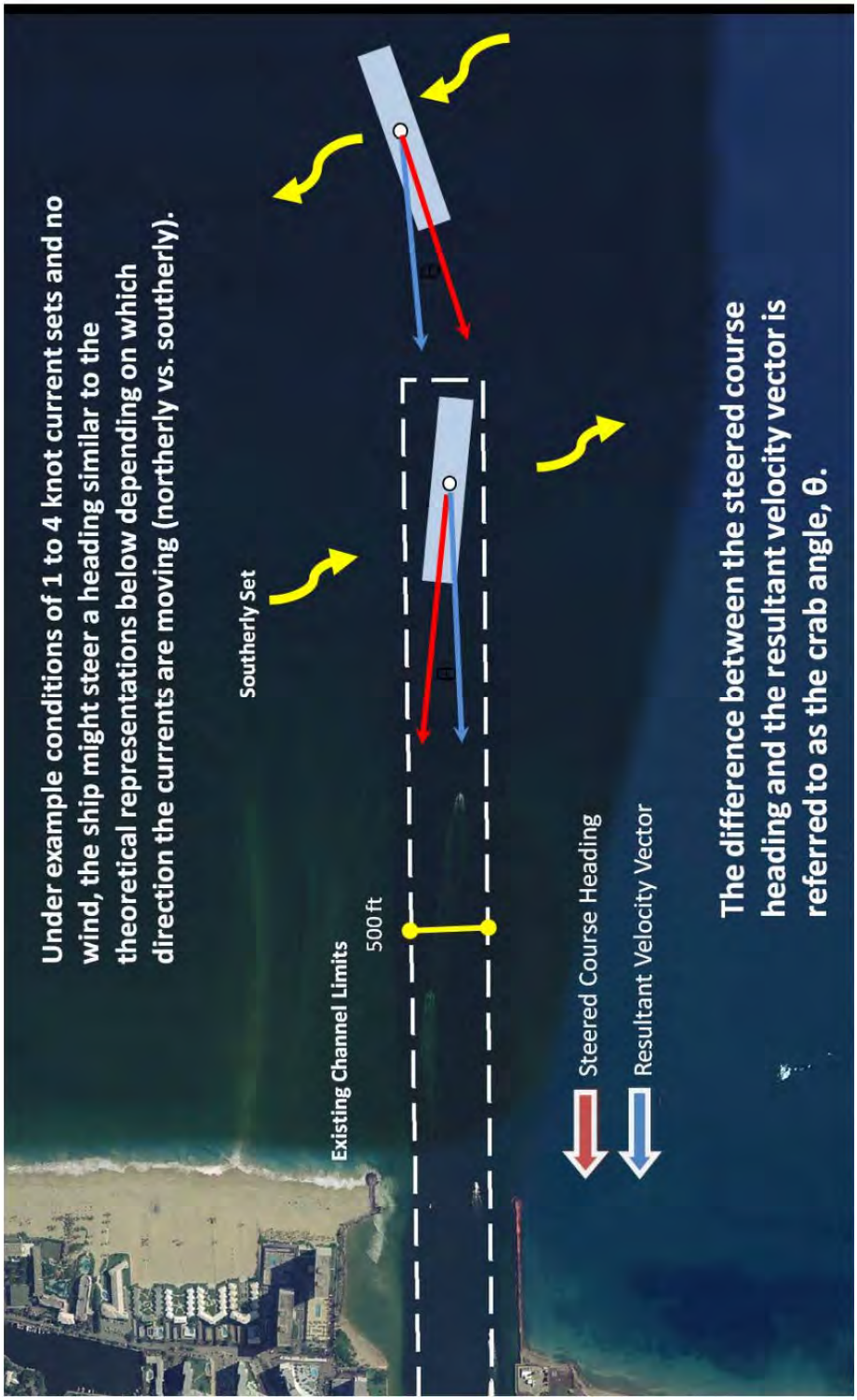


Figure 70 Cross-currents at eastern terminus of the Outer Entrance Channel

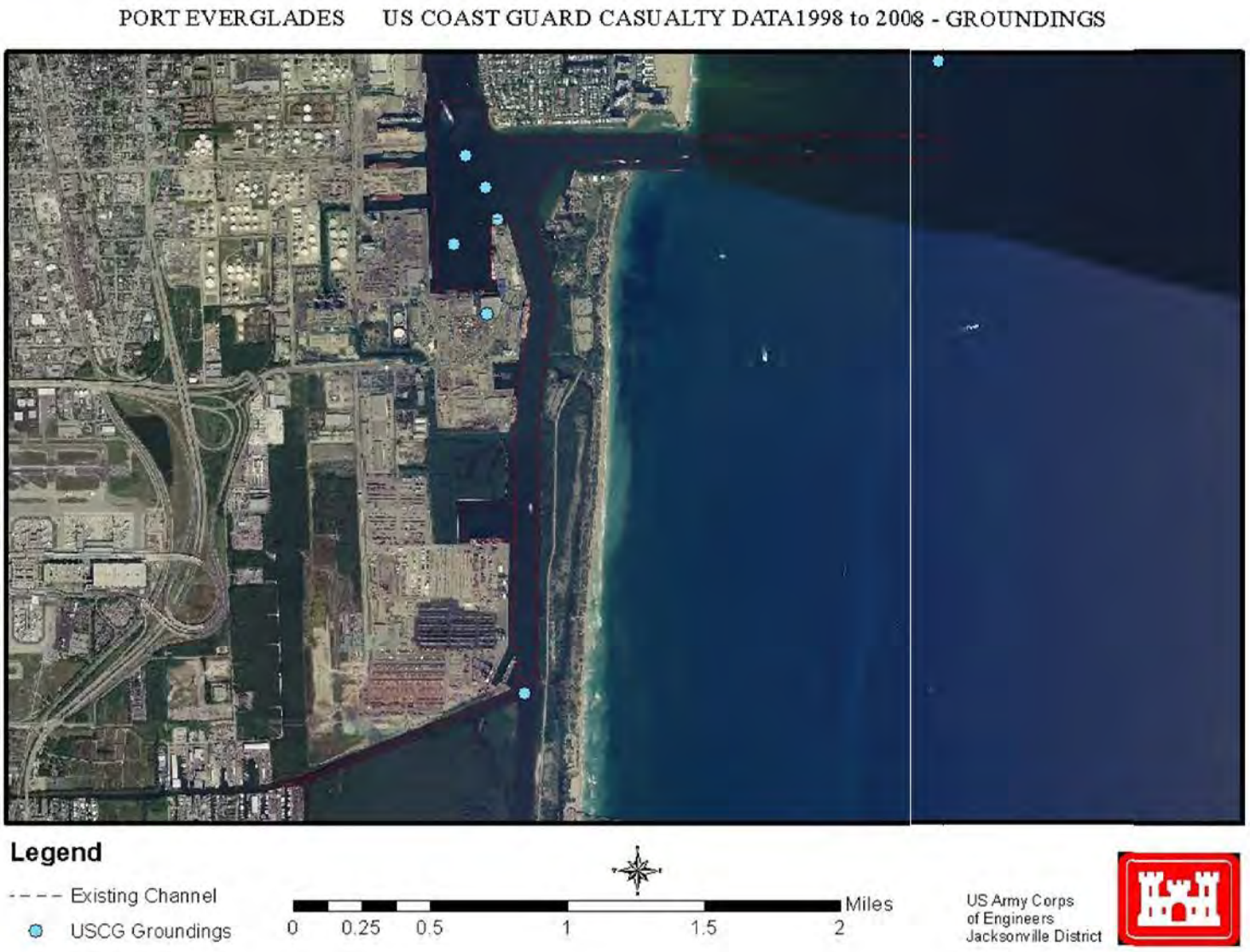


Figure 71 Groundings (U.S. Coast Guard data, 1998-2008)

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Surface Waters

See Section 4.4.3 *Essential Fish Habitat* detailing effects to the water column, and Section 4.7 addressing water quality.

4.2 Geology and Sediments

4.2.1 No-Action Alternative

Under the No-Action Alternative, maintenance dredging will still occur and remove/disturb sediments in the federal channels of the Port.

4.2.2 Recommended Plan and National Economic Development Plan

The majority of substrate materials within the project area include inter-bedded layers of sand and rock. A minority of the material includes silts, clays, and peat/organics. Approximately 80 to 90% of the softer excavated rock would be classified as sands with mixed gravel. The harder material would be classified as boulders of varying size. After excavation, the majority of the project-area bottom materials would comprise gravelly sand with some rock substrates. The only location in the project area where the substrate is composed of fine sediments is the previously dredged area of the TN. The above conclusions apply to all dredge-depth options for Alternative 2E, including those for the Recommended Plan (the LPP) and the NED Plan.

4.3 Wetlands (Mangroves)

4.3.1 Impact Assessment Technical Approach

The determination of impacts (on various habitat types, including mangroves, seagrasses, and hardbottoms) due to the project footprint was based on geographic information system (GIS) data and analysis. The project footprint (in CAD format) developed by USACE in September 2010 was developed for appropriate post-dredge channel side-slopes based on depth and substrate. This "top-of-slope to top-of-slope" (or "bulkhead-to-bulkhead," where appropriate) footprint was used to determine project impact estimates for the Recommended Plan (i.e., the LPP with an authorized depth of -48 feet), the NED plan (authorized depth of -47 feet) as well as for several other dredge-depth options (for Alternative 2E) in February 2011, May 2012, September 2013 and February 2014. Subsequent impact analyses were necessary to incorporate any new natural resource data as well as to ensure consistency with previous efforts (QA/QC due to extended timeframe of feasibility study). The February 2014 impact assessment was verified for the FEIS by comparison to CAD files generated in September 2014 by USACE Engineering Division at the Jacksonville District. No discrepancies were detected.

Estimates for potential resource impacts were derived by first developing a comprehensive GIS resource layer by merging the seagrass, mangrove wetland, and hardbottom resources into one unified data set. The unified data set was then clipped by the limits of the project footprint yielding an estimate of potentially impacted resources within the project footprint. The impacts (in approximate acreages) to biotic communities in the project footprint according to project component of the Recommended Plan are included in Table 18.

Table 18 Approximate Acreages of Direct Impacts of Recommended Plan (LPP) by Construction Element and Habitat Type

	Habitat Type	Turning Notch	Southport Access Channel	Widener	Main Turning Basin	Inner Entrance Channel	Outer Entrance Channel	Subtotal per Habitat Type**
Resources for which **NO** mitigation is proposed	Uplands: forest and scrub-shrub		0.37					0.37
	Previously dredged Inlet channel					26.76	56.61	83.37
	Unconsolidated substrates: soft bottom	26.03	119.28	10.94	120.48	4.12		280.85
	Unconsolidated substrates: sand					3.39	9.95	13.34
----------Resources for which mitigation **IS** proposed----------	Seagrasses: non-special-status		0.15	0.21	*	0.08	0.20	0.64
	Seagrasses: *Halophila johnsonii* only (special-status)		1.77	1.39				3.16
	Seagrasses: *H. johnsonii* with other species		0.18	0.23				0.41
	Wetlands: mangroves		1.16					1.16
	Hardbottom: shallow colonized pavement						0.02	0.02
	Hardbottom: deep colonized pavement						4.73	4.73
	Linear reef: middle tract						4.92	4.92
	Linear reef: outer tract						4.14	4.14
	Spur and groove reef: outer tract						0.73	0.73
	Unclassified hardbottom						0.09	0.09
	Subtotals	26.03	122.91	12.77	120.48	34.15	80.66	397.93

*Approximately 87 square feet for the sum of two areas. **Impacts do not include channel wall impacts, incidental impacts due to dredge equipment, below-dredge-depth incidental impacts, or indirect impacts to hardbottoms due to water quality. Source: DC&A September 2014 ArcInfo GIS analysis.

All data creation, editing and geospatial modification was performed with a chronology of ESRI GIS software products including ArcView GIS (3.2a,) with Image Analysis (ERDAS), ArcGIS, ArcInfo (8, 9, 10) including Spatial and 3D Analyst analysis extensions. In addition, AutoCAD (2000, 2006, 2010, 2014, AutoDesk) and MicroStation V8, V8i (Bentley Systems) were used for data display and import/export when necessary. *In situ* field surveys were conducted with a chronology of Hypack (formerly Coastal Oceanographics, 4.3, 2009. 2013, 2014) and Trimble sub-meter marine and terrestrial navigation hardware and software as well as ArcPad (ESRI, 6, 7).

The estimate of mangrove wetlands was initially developed using a combination of aerial photo interpretation of one-foot-resolution natural color photography from USGS (Fall 2005) and ground-truthed by wetland scientists equipped with sub-meter GPS. The extent of mangrove wetlands has continued to be updated and refined since the initial layer was developed as new photography and additional data sources have become available. Mangrove wetland impacts are discussed in detail below.

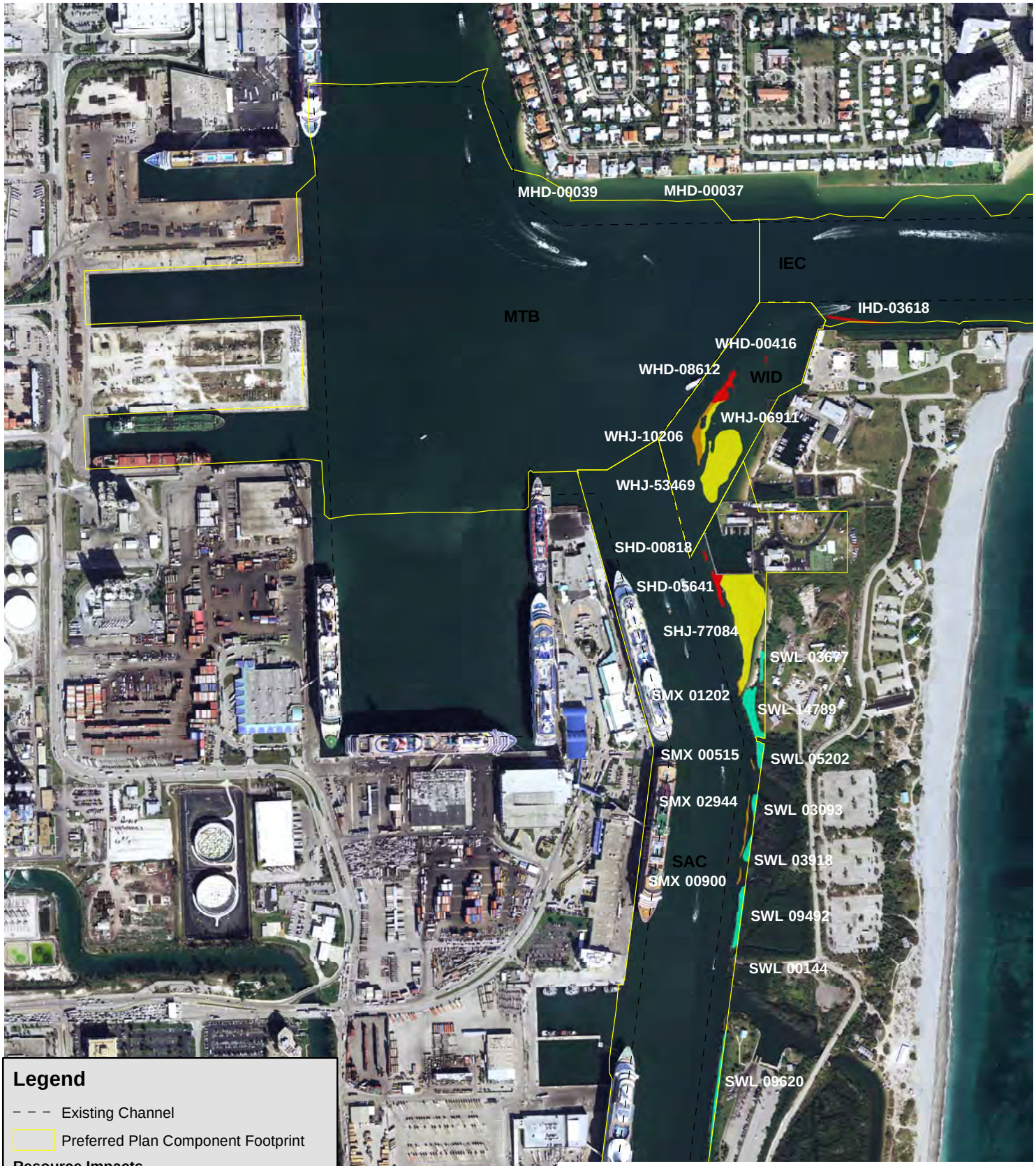
4.3.2 No-Action Alternative

No mangrove or other wetland types will be directly impacted under the No-Action Alternative.

4.3.3 Recommended Plan and National Economic Development Plan

Impacts for mangroves do not differ among the five possible channel depths (including the LPP and NED Plan depths). Figures 72 and 73 show impacts to mangrove wetlands due to implementation of the Recommended Plan. The impact polygons in the figures have unique numeric labels indicating project component/location (first letter: e.g., S = SAC), general habitat type (second and third letter of the code: either WL for wetland, or seagrass species initials, e.g., HJ for *H. johnsonii*) and the polygon's square feet of habitat loss (e.g., 03618 is 3,618 sf). In sum, the Recommended Plan would remove approximately 1.16 acres of jurisdictional, mangrove wetlands. These habitats areas are located along the east side of the SAC along the western shore of JUL. Potential indirect impacts from removal of mangroves in these areas include impacts to adjacent vegetation by destabilizing sediments and dislodging roots and pneumatophores. Unanticipated mortality of trees may result. Also, if these alterations significantly alter substrate elevation and hydrology of microhabitats, various opportunistic exotic and invasive species known to live in the area may gain a foothold in the wetlands. Such species include Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casuarina equisetifolia*) and melaleuca (*Melaleuca* sp.).

No indirect effects due to side-slope equilibration are expected because sediments/materials will be contained behind the environmentally friendly bulkheads (EFB) which will prevent sloughing of material into the channel. The existing bulkhead in front of the mangroves in assessment area #2 (see figure in Section 3.0), which was constructed in the early 1990s, will have to be removed and replaced with an EFB. Rebuilding the bulkhead will also afford the opportunity to increase the gaps in the flushing channels, which may increase flushing of the habitat, as well as provide increased access to fishery resources that utilize the mangrove prop-root system for shelter and forage.



Legend

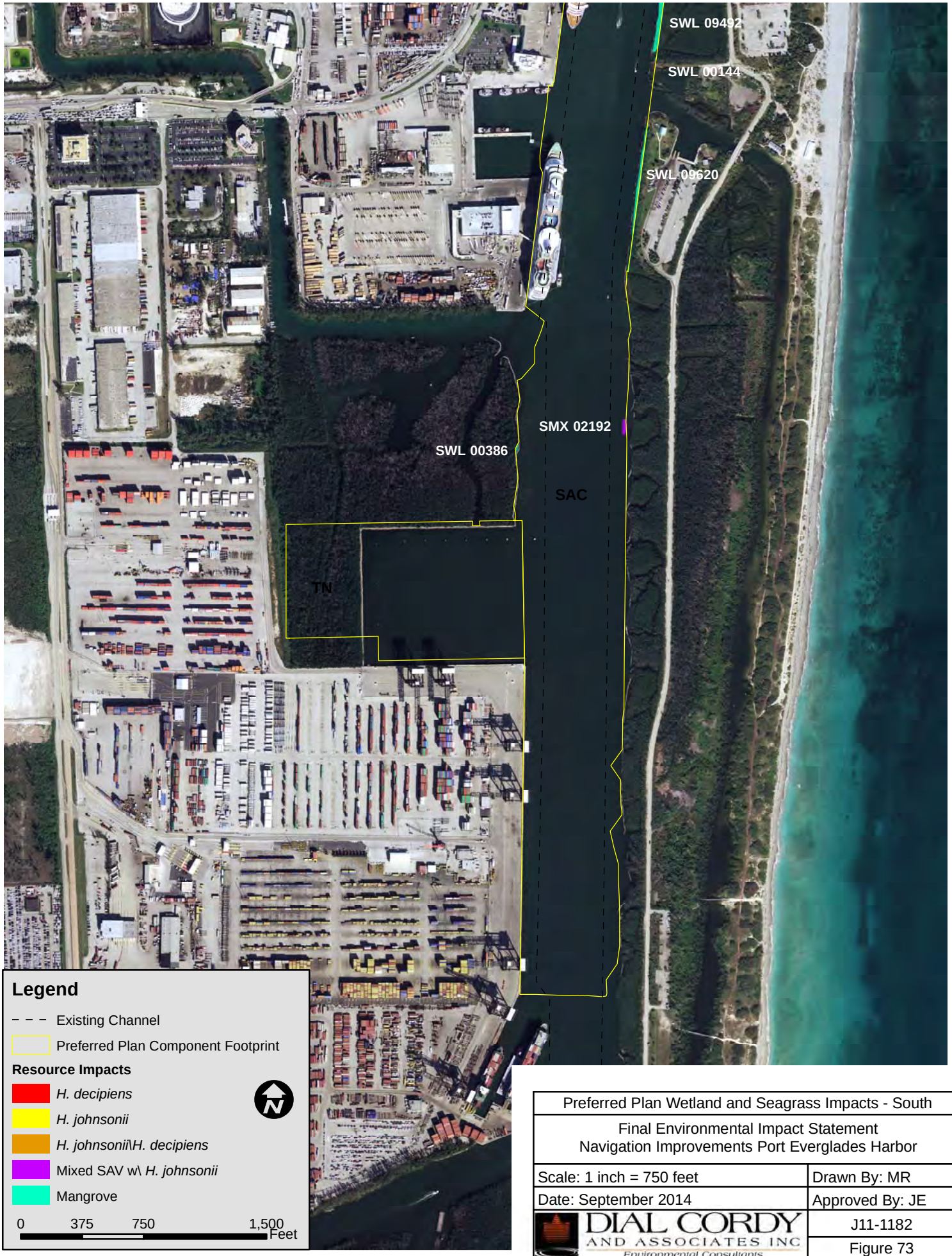
- Existing Channel
- Preferred Plan Component Footprint

Resource Impacts

- *H. decipiens*
- *H. johnsonii*
- *H. johnsonii\H. decipiens*
- Mixed SAV w\ *H. johnsonii*
- Mangrove

0 375 750 1,500 Feet

Preferred Plan Wetland and Seagrass Impacts - North	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 750 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 72



Preferred Plan Wetland and Seagrass Impacts - South	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 750 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 73

4.4 Marine Resources

4.4.1 Seagrass Communities

4.4.1.1 No Action Alternative

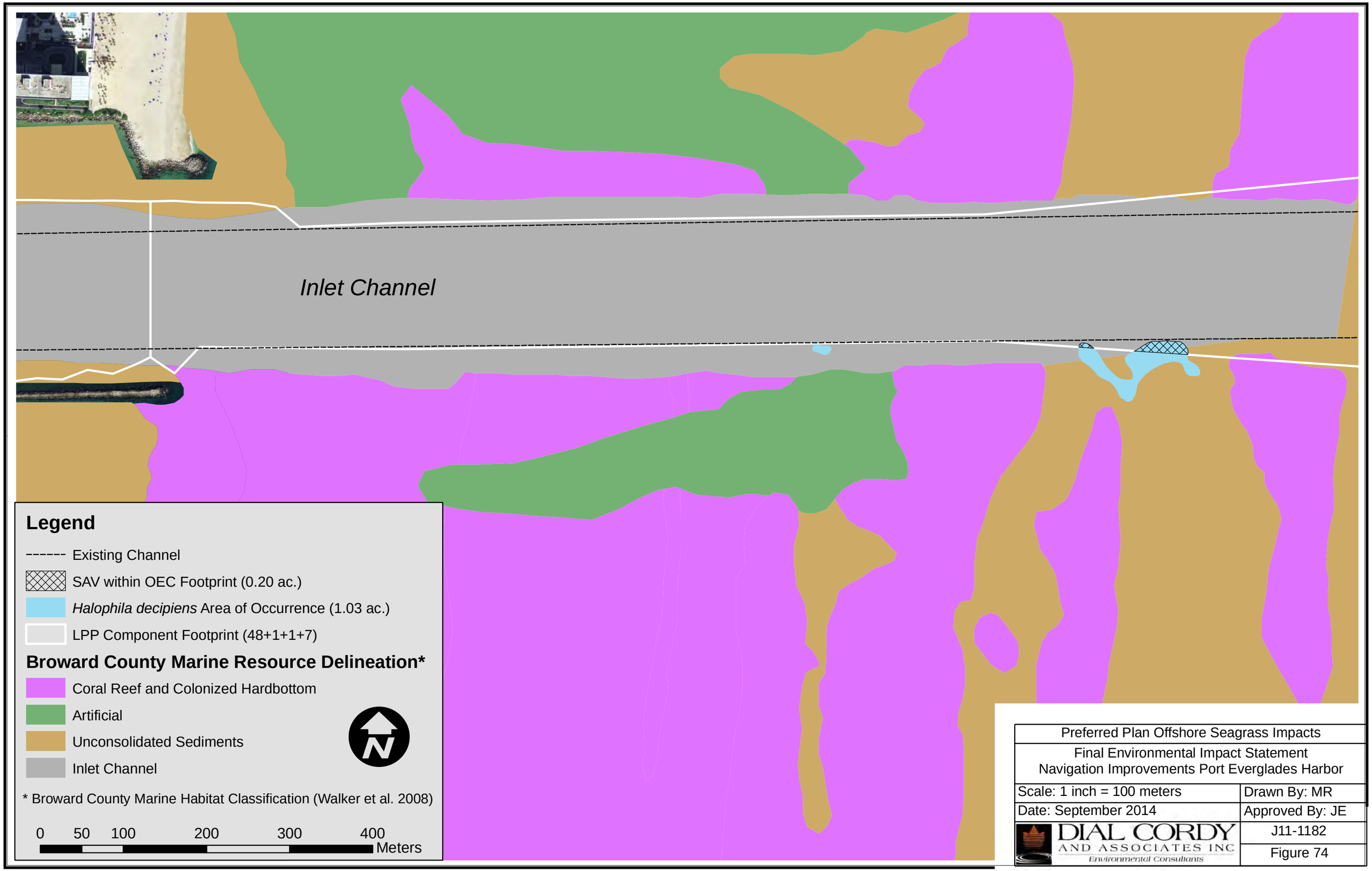
The No Action Alternative would not directly impact any seagrasses. However, seagrass beds adjacent to existing channels may continue to be subject to some turbidity and/or sedimentation generated from vessels that pass nearby.

4.4.1.2 Recommended Plan and National Economic Development Plan

Construction of either the Recommended Plan (i.e., the LPP) or the NED Plan would permanently remove approximately 4.21 acres of seagrass communities, which have the species composition noted in Table 18. This is based on the impact assessment methodology discussed above in Section 4.3 and the most recent USACE seagrass surveys (i.e., DC&A 2009b for harbor areas and DC&A 2013 for the OEC). The 2009 survey was conducted 27 July 2009 through 3 August 2009 and comprised the IEC, the Widener, an area extending approximately 1,000 feet north of the MTB, the SAC, the DCC and an area extending approximately 1,500 feet south of the DCC. Listed impacts do not include areas previously supporting seagrasses that are now devoid of vegetation (See Section 6.20 for details in that regard). As demonstrated by the seagrass surveys conducted over the life of the project's feasibility phase, the size of seagrass beds in the project area have varied spatially, temporally, and in species composition in response to environmental conditions. At no time during seagrass surveys performed for the proposed action did seagrass comprise more than five acres of seagrasses in the project footprint. However, to ensure the most environmentally sensitive impact assessment is used, and in compliance with USACE impact assessment regulations, USACE has estimated potential impacts based on the survey that showed the highest density and coverage of sea grasses in the project footprint, i.e., the 2009 surveys in addition to the 2013 OEC survey.

Figures 72 and 73 show impacts to inshore seagrass beds due to implementation of the Recommended Plan. The impact polygons in the figures have unique numeric labels indicating project component/location (first letter: e.g., S: SAC; W: Widener; M: MTB; I: IEC; and O: OEC), general habitat type (second and third letter of the code: either WL for wetland, or seagrass species initials, e.g., HD: *H. decipiens*; HJ: *H. johnsonii*; MX: mixed including *H. johnsonii*) and the polygon's square feet of habitat loss (e.g., 03618 is 3,618 sf). The beds are primarily concentrated in/near the Widener and the northwest part of the SAC. Figure 74 shows a small area (0.20 ac) where *H. decipiens* will be impacted due to construction of the OEC widener. In general, seagrass habitat loss results in loss of refugia and foraging habitat for many marine invertebrates and vertebrates, including both protected and managed species. Removal of seagrasses also affects the ecosystem by impeding important processes and functions such as sediment stabilization, nutrient cycling, and oxygen production.

Deepening shallow-water habitats beyond 10-13 feet (3-4 m) is likely to impede post-dredging seagrass recolonization (NMFS 2007c, Kenworthy 2000, Hammerstrom *et al.* 2006). This effect would be seen at the location of the proposed Widener (Seagrass Assessment Area #4) where water depths will be deepened from as shallow as 4-16 feet (near the USCG Station and the Navy berth, respectively, at the northern end of the Widener) to 50 feet (actual depth; i.e., *authorized* depth of 48 feet). It would also occur along the eastern side of the SAC on the 10 to 20-foot wide side slopes of the existing channel where water depths are currently between five and eight feet (USACE July 2010 hydrographic survey).



Preferred Plan Offshore Seagrass Impacts

Final Environmental Impact Statement
Navigation Improvements Port Everglades Harbor

Scale: 1 inch = 100 meters	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 74

Indirect effects to seagrass habitats outside the project footprint due to turbidity/sedimentation caused by dredging activities are not anticipated due to implementation of water-quality-preserving BMPs in inshore areas as required by State issued Water Quality Certification. However, temporary displacement of fish and invertebrates from seagrass beds adjacent to construction areas may occur. This would result in short-term changes in the biotic assemblage within this area.

4.4.2 Hardbottom and Reef Communities

4.4.2.1 The No-Action Alternative

No intentional impacts to hardbottom habitats or reefs would occur under the No-Action Alternative. However, vessels occasionally scrape across the tops of offshore reefs directly north and south of the OEC, and at least on one occasion, have damaged reef habitat through more direct collisions with the middle reef tract. Additionally, the *Queen Mary 2*, the largest cruise ship in the world at the time, was documented hitting the channel wall in February 2006 as it left Port Everglades resulting in damage to one of the four engines on the ship. Neither the FDEP nor the BCEPD conducted post-collision resource surveys to assess damage to resources along the channel (K. Banks and J. Walzack, pers com, August 4, 2011). It is expected that these types of impacts will continue to occur due to the unpredictable currents and insufficient channel width of the OEC as documented by the Port Everglades Pilots Association and NOS (2010). The economic analysis shows that under the No Action Alternative (i.e., the without-project condition), the numbers of larger vessels calling the harbor increases through 2073. As larger vessels call Port Everglades, the potential to impact hardbottom/reef resources adjacent to and on the channel walls increase due to the unpredictability of the currents, the effect of wind on the ships (sail area), and the increasing size of ships. See Section 2.4 for more information.

4.4.2.2 Recommended Plan

Technical approach for impact assessment. The assessment methodology for determining hardbottom impacts relied on techniques as detailed in Section 4.3. In addition, hardbottom and reef resources were based on the “SE FL Benthic Habitats” data modified to include previously unmapped resources per Nova Southeastern University (NSU) GIS. These data were provided to the USACE by NSU on 30 August 2013 and has become the conventional (with respect to academic and resource agency staff) representation of hardbottom and reef resources for the Port Everglades project area. The surface model used to establish the depth of hardbottom and reef resources is the Broward County 2008 LADS (NAVD88) data. The previous surface model (used during the study’s feasibility phase until 2013) was developed from the Broward County 2001 LADS (NGVD29). A vertical datum transformation was performed on the native NAVD88 2008 LADS data in order to have the potential impacts remain in the same vertical datum as previous iterations of impact calculations. The datum transformation was performed using VDatum (v3.2) from NOAA to translate the native NAVD88 to NGVD29. The most recent impact analysis for hardbottom habitats was completed in February 2014. Results from that analysis are presented below. The three impact characterizations below (direct from dredge, incidental from dredge equipment, and indirect from water quality) correspond to the manner in which compensatory mitigation requirements (Component 1, Component 2, and Component 3, respectively) were calculated in USACE and NMFS (2014), an appendix to the mitigation plan.

Direct dredging impacts and partial incidental rubble impacts (“Direct Impact Component 1”). This alternative would result in direct impacts to hardbottom and reef habitats that would vary

depending on which dredge depth was selected. Analyzed alternatives for dredging the OEC comprised actual depths of -55, -56, -57, -58, and -59 feet. Impacts to specific hardbottom habitat types for each potential dredge depth are listed in Table 19. For the Recommended Plan (authorized 48-foot dredge depth), approximately 14.62 acres of the middle and outer reef tracts would be directly removed. Habitat classes in the impact area (see Figure 75) comprise colonized pavement (4.75 acres), linear reef (9.05 acres), and spur and groove reef/hardbottoms (0.73 acres).

The biota of low- and high-relief communities found in the hardbottom impact areas and hard substrates such as outcrops, rocks, and exposed hardbottom, form the backbone of a diverse and ecologically important ecosystem. Direct habitat loss to previously un-impacted hardbottom assemblages associated with dredging would be permanent. Impact to the hardbottom habitat at the eastern end of the OEC would result in direct removal of corals, gorgonians, and sponges as well as associated flora and fauna. This hardbottom provides an important habitat for many sea turtle, fish, and invertebrate species. The areas to be impacted and their functional value are thoroughly discussed in earlier sections of this EIS, the Benthic Community Assessment (Appendix D), and the Habitat Equivalency Analysis found in the Compensatory Mitigation Plan (Appendix E).

In addition to the direct loss of hardbottom habitats (14.62 acres, as noted above) due to the implementation of the Recommended Plan, additional impacts could occur to the existing channel walls (approximately 0.36 ac, generally located where the channel extends through the previously dredged sections of the middle reef) and some hardbottom areas adjacent to and downhill of the dredge footprint. For the Recommended Plan, it was estimated that 7.08 acres of hardbottom occurs within the area that could be affected by materials dislodged from the dredge footprint. It is not likely that this area would be impacted in its entirety. USACE anticipates that as little as 10% of such areas (if any) may be directly impacted by the project, but will review impacts during post-dredging monitoring to determine the precise extent of impacts. Based on existing information from previous dredging operations at Port Everglades and Port of Miami, there is no data to indicate these assumed impacts will occur.

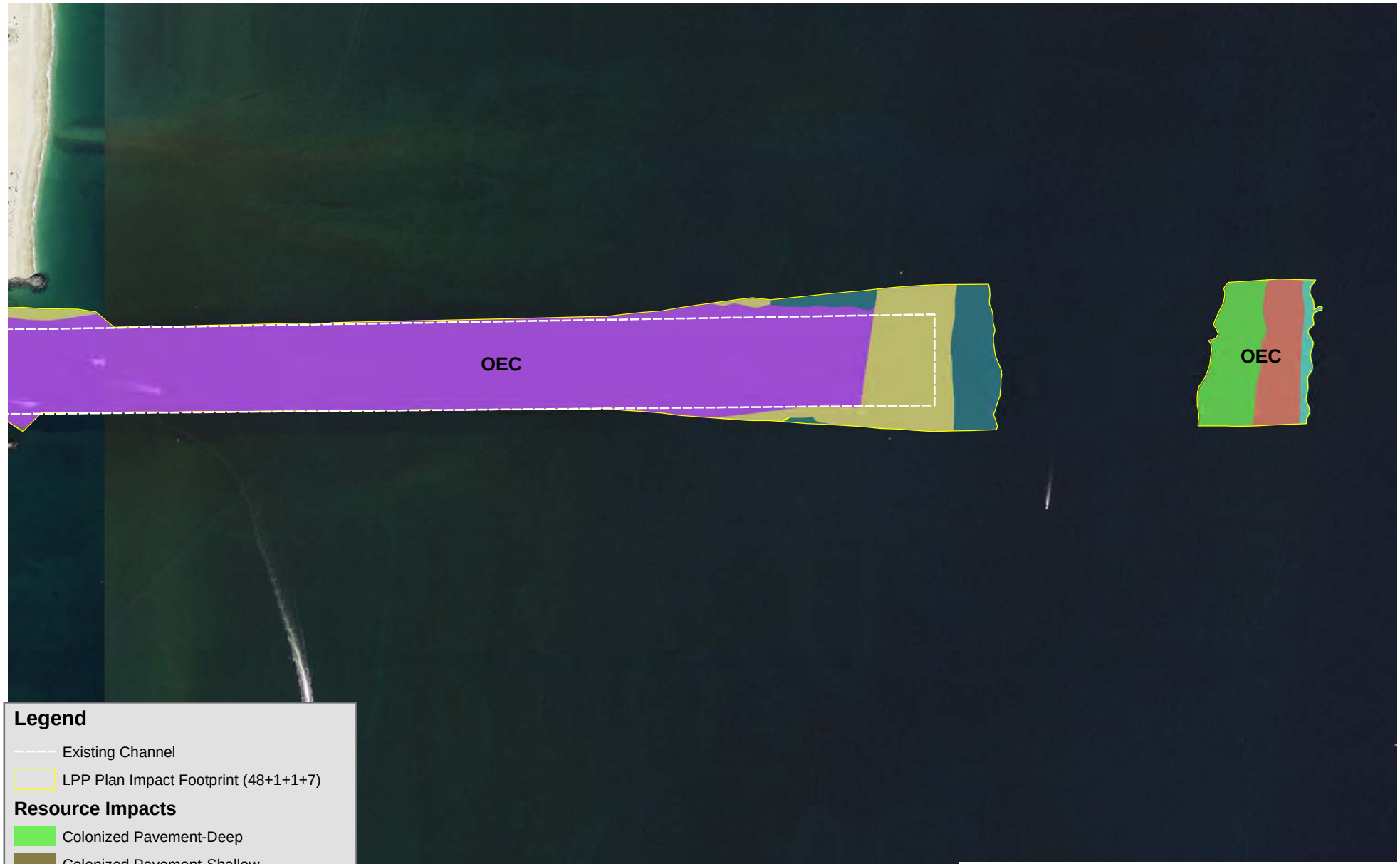
Impacts from the implementation of the Recommended Plan include removal of approximately five acres of the Middle Reef, in addition to existing channel wall habitat (0.36 acres) in that area. Also, approximately 0.2 acres of habitat below the proposed dredge depth within the Middle Reef complex is anticipated to be affected. Based on sampling (DC&A 2009), approximately 56% of horizontal benthic habitat in this area supports some type of live cover. There are no available quantitative data concerning type or density of biotic cover on the channel walls due to its inaccessible location (i.e., diver safety). As a result, impacts to the channel walls are not characterized separately in this section. Stony coral colony density estimates at middle reef sample sites were 0.48 colonies/m^2 and that for octocorals was 0.34 colonies/m^2 (DC&A 2009).

Impacts from the implementation of the Recommended Plan include removal of approximately ten acres of the Outer Reef, in addition to approximately half an acre of below-dredge-depth, adjacent habitat. Based on sampling data from DC&A (2009), the mean total live cover at the Outer Reef is approximately 73%. Stony coral colony density estimates at middle reef sample sites were 1.88 colonies/m^2 and that for octocorals was 1.44 colonies/m^2 (DC&A 2009).

Table 19 Comparison of Hardbottom Habitat Impacts Based on Outer Entrance Channel Dredge Depth (MLLW) for Alternative 2E construction configuration

Authorized Dredge Depth	Actual Maximum Dredge Depth	Habitat Classification	Acres of Direct Impact*
-46	-55	Colonized Pavement-Shallow	0.019
		Colonized Pavement-Deep	3.815
		Linear Reef-Middle	4.453
		Linear Reef-Outer	3.992
		Spur and Groove	0.167
		Unclassified	0.087
		TOTAL	12.533
-47 (National Economic Development Plan)	-56	Colonized Pavement-Shallow	0.019
		Colonized Pavement-Deep	4.337
		Linear Reef-Middle	4.685
		Linear Reef-Outer	4.129
		Spur and Groove	0.417
		Unclassified	0.087
		TOTAL	13.674
-48 (Locally Preferred Plan, and Study Recommended Plan)	-57	Colonized Pavement-Shallow	0.019
		Colonized Pavement-Deep	4.725
		Linear Reef-Middle	4.915
		Linear Reef-Outer	4.138
		Spur and Groove	0.734
		Unclassified	0.087
		TOTAL	14.618
-49	-58	Colonized Pavement-Shallow	0.019
		Colonized Pavement-Deep	5.095
		Linear Reef-Middle	5.191
		Linear Reef-Outer	4.138
		Spur and Groove	1.007
		Unclassified	0.087
		TOTAL	15.537
-50	-59	Colonized Pavement-Shallow	0.019
		Colonized Pavement-Deep	5.404
		Linear Reef-Middle	5.436
		Linear Reef-Outer	4.138
		Spur and Groove	1.218
		Unclassified	0.123
		TOTAL	16.338

*Impacts do not include channel wall impacts, incidental impacts due to dredge equipment, below-dredge-depth incidental impacts, or indirect impacts to hardbottoms due to water quality.



Legend

- Existing Channel
- LPP Plan Impact Footprint (48+1+1+7)

Resource Impacts

- Colonized Pavement-Deep
- Colonized Pavement-Shallow
- Linear Reef-Middle
- Linear Reef-Outer
- Spur and Groove
- Inlet Channel
- Sand

0 375 750 1,500 Feet

Preferred Plan Hardbottom / Reef Impacts	
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Scale: 1 inch = 750 feet	Drawn By: MR
Date: September 2014	Approved By: JE
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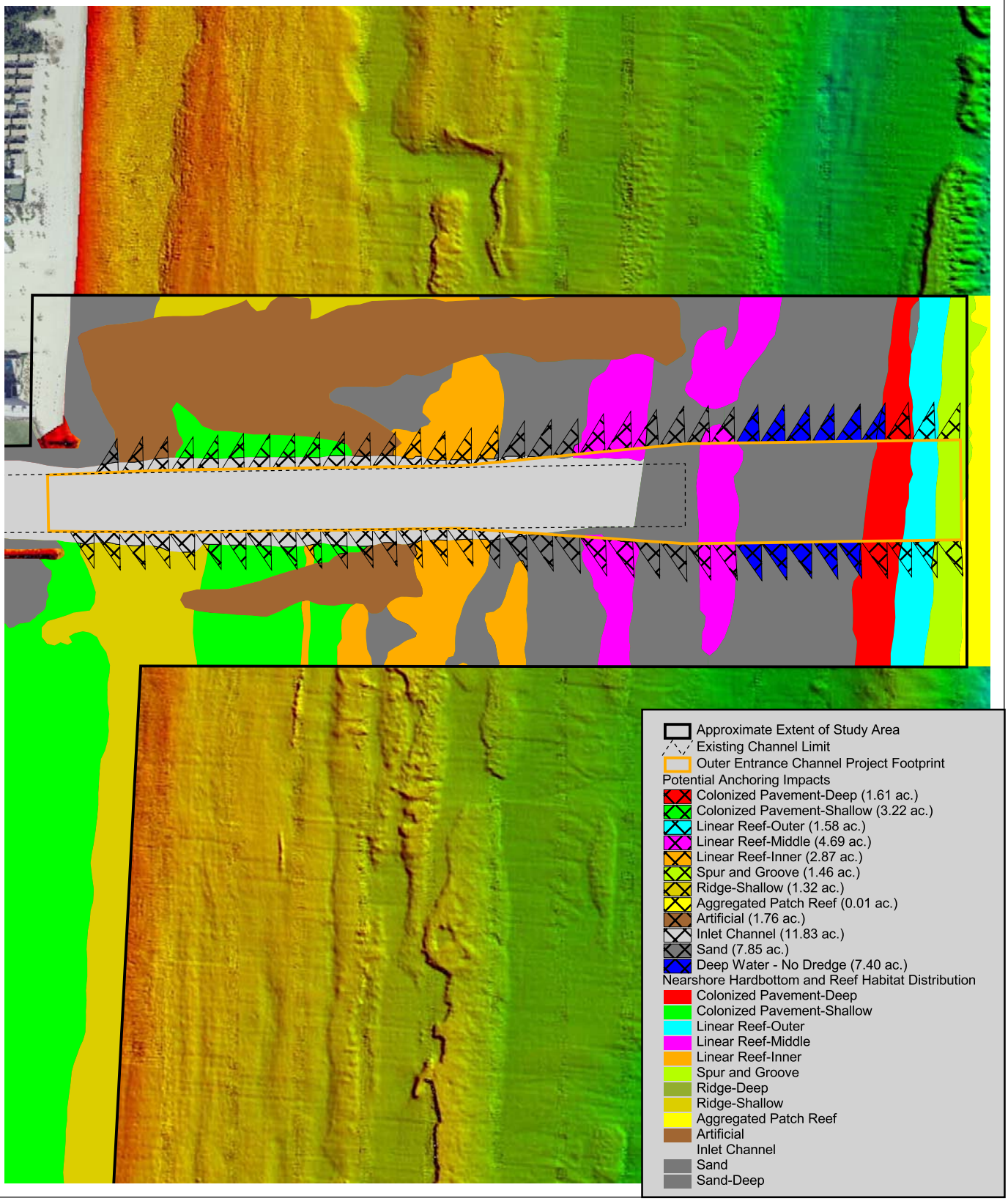
	Figure 75

Incidental direct impacts from equipment ("Direct Impact Component 2"). If a cutterhead dredge is used to deepen the OEC or IEC, and the contractor is unable to anchor only inside the proposed channel boundaries, additional direct impacts to both low-relief and high-relief hardbottom reefs may occur due to anchoring and cable systems used for the dredge (Figure 76). Because the acreage of such impacts cannot be determined prior to construction, they are not included in the impacts shown in Table 18. The maximum possible (albeit not probable) incidental impacts due to dredge anchor and cable is approximately 15 acres. Many of the same reef habitat classes would be affected in the "equipment polygons" (see Figure 76) as in the targeted direct-impact, channel footprint (i.e., linear reefs, spur and groove reefs, and colonized benthic pavement), but in addition, some nearshore hardbottoms, inner reef, and artificial reef would be affected. The peer reviewed literature demonstrates that these habitats are less species-rich and have fewer hard corals than the second and third reefs (Moyer *et al* 2003; Gilliam 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012).

During project implementation, procedures and/or a plan to anchor and operate vessels during construction will be required to be developed with the goal of minimizing certain environmental impacts (e.g., impacts to hardbottom habitat and corals). Since construction methods are not yet defined, actual impacts will be quantified using pre-construction and post-construction surveys. Impacts will be coordinated with resource agencies. The maximum potential mitigation required for potential incidental impacts is calculated in USACE and NMFS (2014).

USACE reviewed two previous projects that used a cutterhead dredge with the anchor-cable configurations: 1980 in Port Everglades and 1993 at Miami Harbor. In 1980, the project was monitored for impacts associated with the dredging, and no impacts associated with the use of the cutterhead anchoring system are noted in the final report (CSA 1981). In the 1993 Miami Harbor Phase I project, the Miami-Dade County Department of Environmental Resources Management (DERM) calculated that the area of impact for each anchor/cable point (using a float on the cable to minimize impact) was 0.029 acres. Actual levels of equipment impact due to the proposed project at Port Everglades will be determined based on pre- and post- construction monitoring, should the selected contractor choose to use anchor & cable outside the channel as part of their construction technique. Notwithstanding its expectation of minimal impacts, USACE has planned for maximum impacts as detailed above and shown in Figure 76. Stony and soft coral densities are noted above for the middle and outer reefs; by multiplying those densities by the acreages indicated in Figure 76, an approximation of number of colonies lost can be calculated (see USACE and MNFS 2014 for calculations).



1000 0 1000 2000 Feet

Potential Marine Resource Impacts from Dredge Equipment	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1000 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 76

Incidental impacts from significant rubble movement ("Direct Impact Component 3"). Pursuant to a request from one of the project's cooperating agencies (NMFS), USACE identified areas adjacent and downslope from the project footprint that could be affected if rubble loosened or dislodged from the dredging operation crushed or covered live bottom biota. As noted above ("Direct Impact Component 1"), USACE determined that approximately 7.08 acres of hardbottom occurs within or adjacent to the areas to be dredged that could be affected by materials dislodged from construction. Though up to only 10% of such areas (if any) are anticipated to be affected, USACE is prepared to perform mitigation if impacts exceed expectations, as determined by post-dredging monitoring. This impact component (Component 1) assumes that the additional 90% of the adjacent, downslope habitat acreage (i.e., 6.37 acres) is adversely affected. These impacts may or may not occur depending on dredging methodology (i.e., cutterhead vs clamshell/backhoe). The surface area of the remaining 90% of the middle (second) reef, below dredge depth, which may be impacted by rubble moving downslope that was not mitigated for in advance of project construction is 1.69 acres. The surface area of the remaining 90% of the outer (third) reef, below dredge depth, which may be impacted by rubble moving downslope, that was not mitigated for in advance of project construction is 4.68 acres. Stony and soft coral densities are noted above for the middle and outer reefs, and by multiplying those densities by the acreages indicated above, an approximation of number of colonies lost can be calculated (see USACE and MNFS 2014 for calculations).

Indirect impacts. Indirect impacts to hardbottom habitat adjacent to the OEC extension may result from (1) turbidity of fine materials suspended in the water column over reefs and (2) temporary resuspension and deposition of sediments on nearby coral communities during construction (anticipated duration is 11 months to three years). Turbidity is typically less physically damaging to corals than sedimentation (which could actually bury coral colonies), and is usually a condition shorter in duration. The time that materials stay in suspension and the distance they may travel is based in large part on speed of any currents that sweep over the hardbottom/reef areas. Erftemeijer et al (2012) specifically commented that the risks and severity of impact from dredging (and other sediment disturbances) on corals are primarily related to the intensity, duration and frequency of exposure to increased turbidity and sedimentation.

The sensitivity of a coral reef to dredging impacts and its ability to recover depend on the antecedent ecological conditions of the reef, its resilience and the ambient conditions normally experienced. In the case of the reefs in the vicinity of Port Everglades they are regularly subjected to variable and often high levels of turbidity and sedimentation (Edge et al. 2013) including storms (see Figures 77 and 78 below). Craft (2008) noted that adjacent to the Port Everglades area, coral cover was naturally low due to stochastic events such as hurricanes and tropical storms. As such, the coral community is comprised primarily of eurytopic, stress-tolerant species (Burman et al. 2012, Darling et al. 2012) thus, minimizing the overall risk of lethal impacts due to dredging.

Figure 77 Natural sedimentation and turbidity associated with the passage of Hurricane Sandy (October 2012, view seaward from beach toward outer reef

Figure 78 Natural sedimentation and turbidity associated with Hurricane Sandy (October 2012, view north toward Commercial Street Pier)

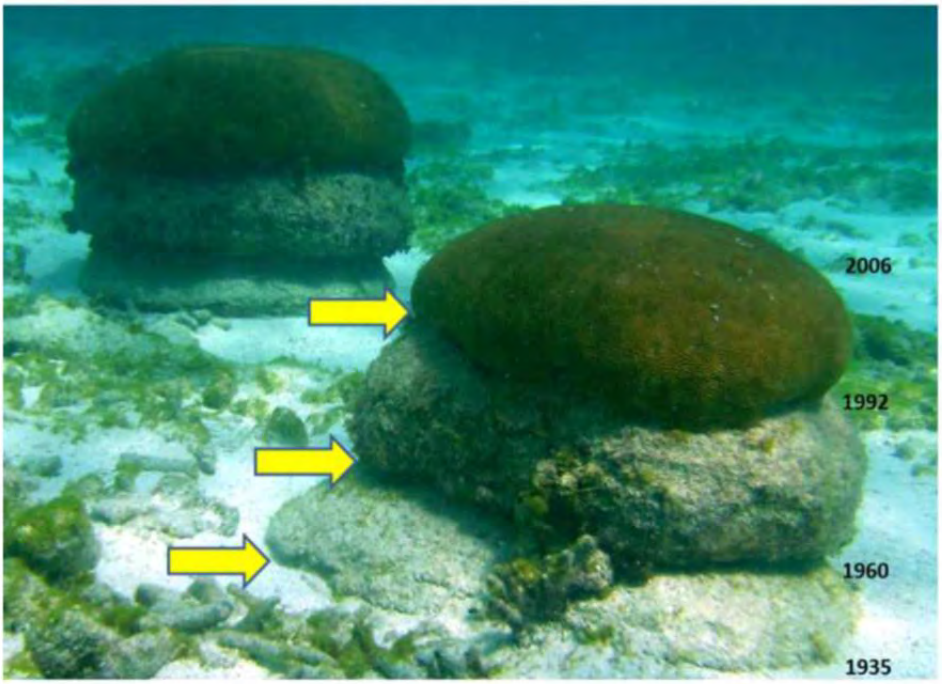
Partial burial of coral colonies by sediment, particularly fine, silty clay-like material is not uncommon in SE Florida reef ecosystems, mainly in response to large storms and hurricanes. This was demonstrated in Miami-Dade County after the passage of Hurricane Andrew in 1992. Regarding that, Blair et al 1994 noted the following:

> "The qualitative surveys revealed substantial sediment scour on all reef areas. As much as 1.0 m of sediment was removed from "gullies" and accumulation areas on the outer reef. Commonly, shallow depressions and sand channels «15 to 25 cm deep) were cleared of all sediment, leaving clean, exposed carbonate rock. A moderate silt layer (1 to 2 cm thick), however, was noted on the reef surfaces within the first month after the storm. These areas had a variable layer (1-3 cm) of congealed, silty sediment. In many locations a gray-back layer (assumed to be anoxic) had formed at the interface between the congealed sediment and the underlying sand. The sediment layer dispersed during the subsequent 2 months. Concurrent with this dispersal, a moderate accumulation of sediment occurred in the scoured depression and gully areas."

Additionally, Precht and Precht (in press) found large corals showing upward "pillow-like" growth (Figure 79) in response to large influxes of sediments due to hurricanes in 1935, 1960 and 1992. Specifically, Precht and Precht observed the following:

> "These corals were found in areas dominated by carbonate sand. Based on measured growth rates of shallow-water colonies of *Siderastrea siderea* (average ~5.75 mm yr -1) from the region (WF Precht, unpublished data), we calculated that the exposed portions of these corals are approximately 70-75 years in age. Using the measured height of each individual section, we can deconstruct the history of these colonies in relationship to the passage of known significant hurricanes in the upper Florida Keys. The notch at the base of the lowermost section is coincident with the passage of the Great Florida Keys Hurricane of 1935, the second notch correlates with the passage of Hurricane Donna in 1960, and the third notch (at the base of the living coral) is contemporaneous with Hurricane Andrew in 1992. Each of these three storms moved from east-to-west over the Florida Keys. The resulting sediment movement was onshore, with fore-reef sediments draping over the reef-flat and burying all but the very top of these back-reef *Siderastrea* colonies. Each punctuated segment records coral growth during the intervening period between major storms. During the passage of Hurricane Wilma in October 2006, the bases of these colonies were excavated and exposed.

USACE expects turbidity and sedimentation effects associated with the Port Everglades Navigation Project Recommended Plan to be similar to those seen at the ongoing Miami Harbor expansion project. That project has provided numerous insights into how dredging affects corals in South Florida. Some recent findings are detailed below.



Miami, Florida, 2014

Bocas del Toro, Panama, February 2015

Figure 79 Coral growth in response to effects of hurricanes and other stochastic sedimentation challenges

During construction, sedimentation rates increase quickly as dredging is initiated. This rate is dependent on numerous things including dredge type (See Section 2.9), local micro-currents in the specific habitat (eddies that form as a result of longshore current and tidal flows from the inlet), and type and size of material being dredged. In general, indirect effects of dredging on corals can include stress to the colony due to sediment settling out onto the top of the colony, Over time, this may result in partial burial of corals within the sedimentation zone on either side of the channel. When colony shape is round or flat, the sediment is moved off of the top of the corals generally through ciliary action of the polyps. This can create a ring of material at the base of the coral which may result in partial mortality of the coral colony as demonstrated in the three photos below (Figure 80).

Based on monitoring data from the ongoing Miami Harbor dredging project, after the dredging is complete in an area adjacent to reef habitats, the deposited material begins to be worked into the system's existing sediment budget and is no longer discernible from the background sediment; it abates in a short period of time (3-6 months). This may occur while other areas of the channel are still being dredged.

Earlier projects at Miami have also been useful to guide impact assessment. USACE reviewed data from the Port of Miami outer entrance channel which was deepened and extended through the 3rd reef in 1993. The Miami-Dade County Department of Environmental Resources (DERM) did a pre-construction habitat assessment of the project area prior to dredging, but there was no during or post-construction monitoring of the project. It is known that the project was conducted with a cutterhead dredge and scows which were emptied in the Miami ODMDS. There were no restrictions on water overflow from the scows, so impacts along the channel side would have included direct burial by fine sediments falling out of solution and settling on the hardbottom and reef habitats adjacent to the channel. Seven years after the Miami Harbor project was completed, a baseline impact assessment was prepared for a new feasibility study which included assessing resources directly adjacent to the Miami Harbor Entrance channel. This assessment showed no difference in functional group composition (sponges, soft corals, hard corals, bare rock, turf algae, etc.) or in hard and coral species composition and density from other areas in the county which were not adjacent to a major shipping channel that had been deepened and widened seven years earlier (DCA 2001). Another more detailed baseline assessment reconfirmed this determination (DCA 2006).

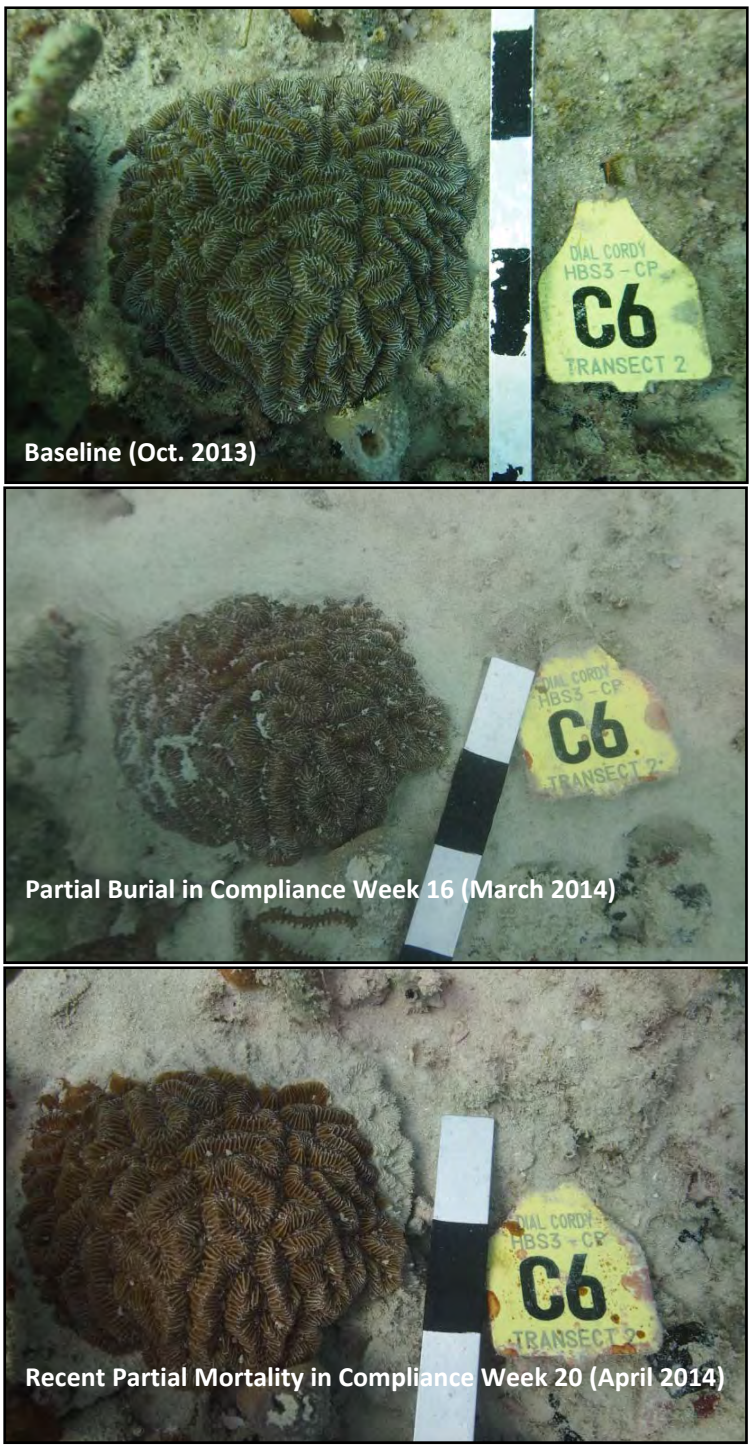


Figure 80 Monitored corals documenting effects of sedimentation at channel-side monitoring sites (Miami Harbor 2014)

It has been more than 30 years since the Port Everglades channel was last widened and deepened. During the 1980 project, the closest monitored coral to the channel was located approximately 250 meters (750 feet) south of the channel on the nearshore hardbottom in 8 meters (~27 feet) of water. The closest monitored coral on the north side was located approximately 1,000 meters (~300m) north of the channel in 3 meters (~10 feet) of water. The next closest corals are further away from the channel; i.e., another 1,000 meters away to both the north and south. Quarterly monitoring of these marked corals did not document adverse impacts associated with the dredging of the channel in 1980-1981.

Impacts at Port Everglades for the proposed project will vary depending on where the dredging takes place (see below). All sediments released by construction, either through agitation by the dredge itself or from overflow from a hopper dredge or disposal scow, will be calcium carbonate in composition, the same composition of the natural sandy sediments found in this ecosystem. The difference between the dredged material that may be resuspended and the natural sandy (source) sediments will be grain size, i.e., typically, dredging results in the release of much smaller, finer grained material back into the water during dredging operations. This is because the heavier, larger-grained material settles out into either the hopper dredge or scow bottom.

Nearshore hardbottom/First Reef. These habitats are composed of shallow colonized pavement, artificial and ridge-shallow habitats (Walker 2008). At the nearshore hardbottom sites, the habitats are heavily impacted by the north to south longshore drift, as well as the tidal effluent coming from the inlet itself as previously discussed in Section 3.9.1. The currents here spin around the jetties and have a very high current velocity that prevents very fine grain material from settling out on the adjacent hardbottom communities. The amount of sediment able to settle on the nearshore hardbottom increases the further east you travel along the channel toward open-ocean. In some areas, it is expected there will be a mixture of fine sediment and natural sandy sediments. The fine sediments will settle on top of the habitat and become intermixed with the natural sandy sediment through wave action and bioturbation. In some areas, a fine layer of sediments may be found on turf algae located on the hardbottom habitats, this is commonly seen in habitats with high levels of turf algae, like those at Port Everglades. Sediment that settles in these habitats is expected to be detected visually for approximately six months to 1 year, and based on the influence of the longshore current, more sediment is expected to settle on the south side of the channel in these habitats than the north side of the channel.

Second Reef/Third Reef. These habitats are composed of linear reef, deep colonized pavement and spur and groove habitats. In this area the predominant current is from South to North (gyres can spin off the Gulf Stream and result in a short term reverse the current direction). The third reef is under the direct influence of the Gulf Stream, and the influence is sometimes seen at the second Reef. As a result of this influence, any dredging material suspended in the water column the visible plume will be greater to the north of the channel. This analysis is based on more than 5,000 *in situ* SCUBA dives conducted during monitoring of the ongoing Miami Harbor project. At the third reef on the north side of the channel, in particular, based on a qualitative assessment, it appears that soft, fine sediment attributable to the dredging project is observable on the reef. On the south side of the channel at the third Reef the fine grain sediments limited to nooks, crannies, depressions, gullies, etc.

USACE has reviewed other reports to gauge risk. A review of US Environmental Protection Agency (USEPA) monitoring reports for disposal plume at the Port of Miami mapped the plume's travel time and sediment concentration after disposal. USEPA (2008) found that at the time of initial disposal (1 minute post disposal) in the water column, sedimentation levels (surface TSS) concentration ranged from 34 to 77 mg/l. Despite being visually spectacular (especially by being distinguishable in color from ambient ocean water) the sediment load carried by such turbidity plumes is minimal. As the plume ages it is subject to a cascade of processes, which result in a significant diffusion and dispersion as the plume mixes with ocean currents (Bloetscher et al. 2012). Little supporting evidence exists for increased rates of sediment accumulation at reef sites within or near these turbid plumes (CSA 1981, CSA 2007). There have been no refereed journal publications that directly link impacts on reefs with raised turbidity and/or rates of sediment accumulation associated with these plumes from past port dredging projects in southeast Florida. The material disposed in the Port of Miami project is the same type of material being dredged at Port Everglades (hard limestone) and should result in similar conditions regarding associated sedimentation and turbidity generated by the material.

Finally, USACE has been a party to recent consultations under Section 7 of the Endangered Species Act with the National Marine Fisheries Service for two projects in Miami-Dade County. They concluded that the effects of sedimentation on the adjacent threatened coral, *Acropora cervicornis*, to be insignificant, as the rates of sedimentation documented in a similar offshore dredging project were within the bounds of sedimentation documented to occur naturally. NMFS concluded that due to this sedimentation rate, and a proposed 400-foot buffer between the dredging area and the threatened corals, the effects on the coral would be “insignificant” (NMFS 2009, NMFS 2011). For the proposed project at Port Everglades, NMFS calculated that up to 98.18 acres of habitat within 150-meters of the channel could be impacted by sedimentation during the dredging of the Port Everglades project (NMFS 2014). The method which NMFS used to calculate their values is not known, as GIS data was not provided with the biological opinion. The values differ slightly from those calculated by USACE and presented here.

Project-generated turbidity should appear white in color, since the material being dredged is white limestone rock. This rock has voids in it which over time have filled with fine flakes of eroded limestone. Because the limestone is white, it is highly reflective, particularly in the very clear water offshore of Broward County and as a result will be very visible in the water column as demonstrated in Figure 81 taken on October 9, 2014. Turbidity measurements from the ongoing dredging of Miami Harbor show NTU (turbidity) values in the single digits to the mid-teens above background (Miami Harbor Weekly Turbidity Monitoring Reports to FDEP). Seas on the day of this photograph were in excess of 4 feet in height and winds were in excess of 15 knots. Compliance turbidity values ranged from 5.81 NTU at the surface to 4.84 NTU at midwater. Background turbidity values were 4.49 NTU at the surface and 3.81 NTU at midwater. The delta between compliance and background was 1.32 NTU above background for the surface and 1.03 NTU above background at midwater. The photo displays very clearly how the white reflective limestone material can look like a plume containing a significant amount of sediment when the sediment in the plume is very low as demonstrated by the NTU values. This is significantly less than the state standard of 29 NTUs above background for state waters.

Adverse effects of project generated turbidity should be negligible during construction due to the use of turbidity-mitigating BMPs anticipated to be required by the state permit. Examples of BMPs include (1) turbidity monitoring with contingency shutdown stipulations when specific thresholds of measured turbidity are reached; (2) limitations on the amount of overflow allowed from scows; (3) near-real time tracking of scows, etc. More information on BMPs can be found in Best Management Practices for Construction, Dredge and Fill, and Other Activities Adjacent to Coral Reefs (PBS&J 2008), prepared by FDEP in partnership with USACE and other resource agencies

under the U.S. Coral Reef Task Force. Best Management Practices specific to project construction will be developed during the PE&D phase of the project when the project specific plans and specifications are developed. While generalized BMPs can be cited and incorporated in the EIS, the project details needed for specific, effective BMPs are not developed for the project until the PE&D phase. Additional BMPs are also developed by the contractor as part of their proposal package as well as developed continually throughout the life of the project based on lessons learned throughout the implementation of the project. Also, under USACE project specifications, the contractor is required to minimize environmental effects of their project to the maximum extent practicable by implementing Best Management Practices. USACE does not dictate means and methods for compliance with this contract language, but leaves it up to the contractor to determine the best methods based on their expert knowledge of their equipment and how it operates.

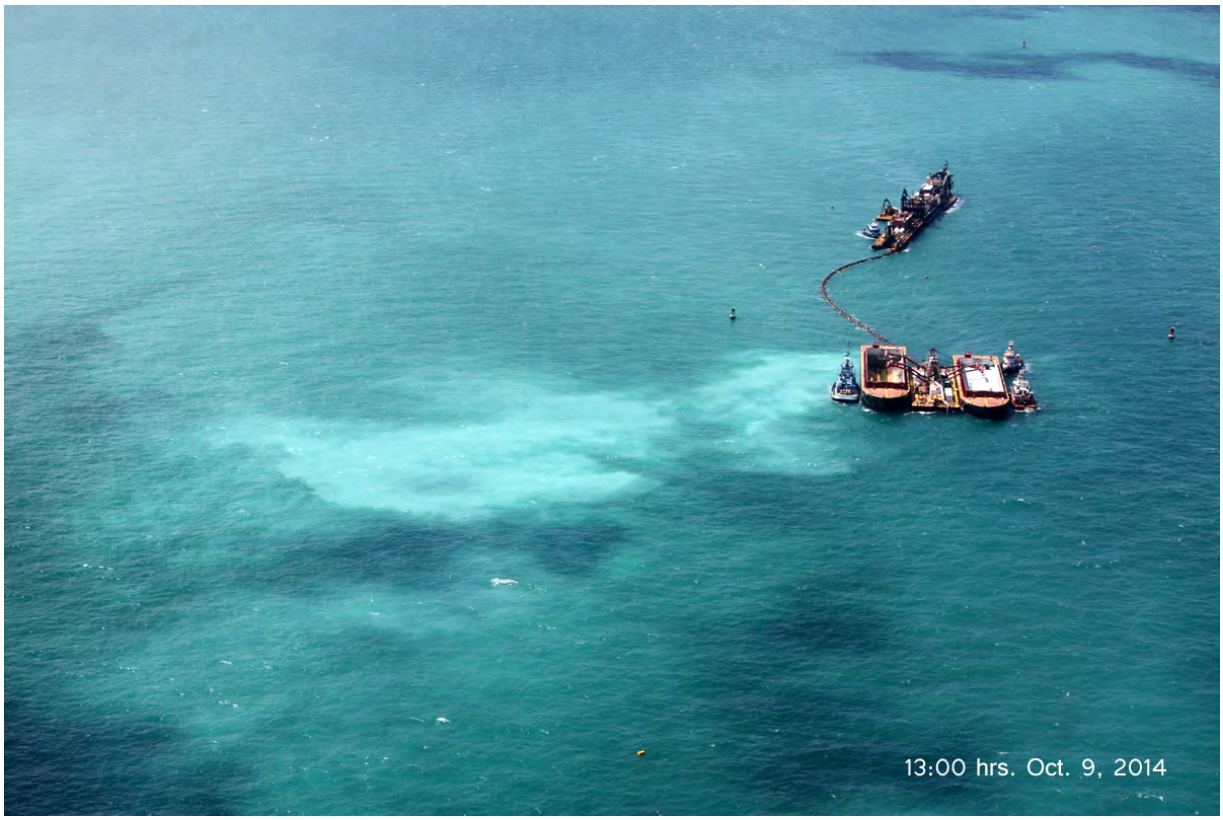


Figure 81 Cutterhead dredge and spider barge being loaded at Miami Harbor (October 9, 2014)

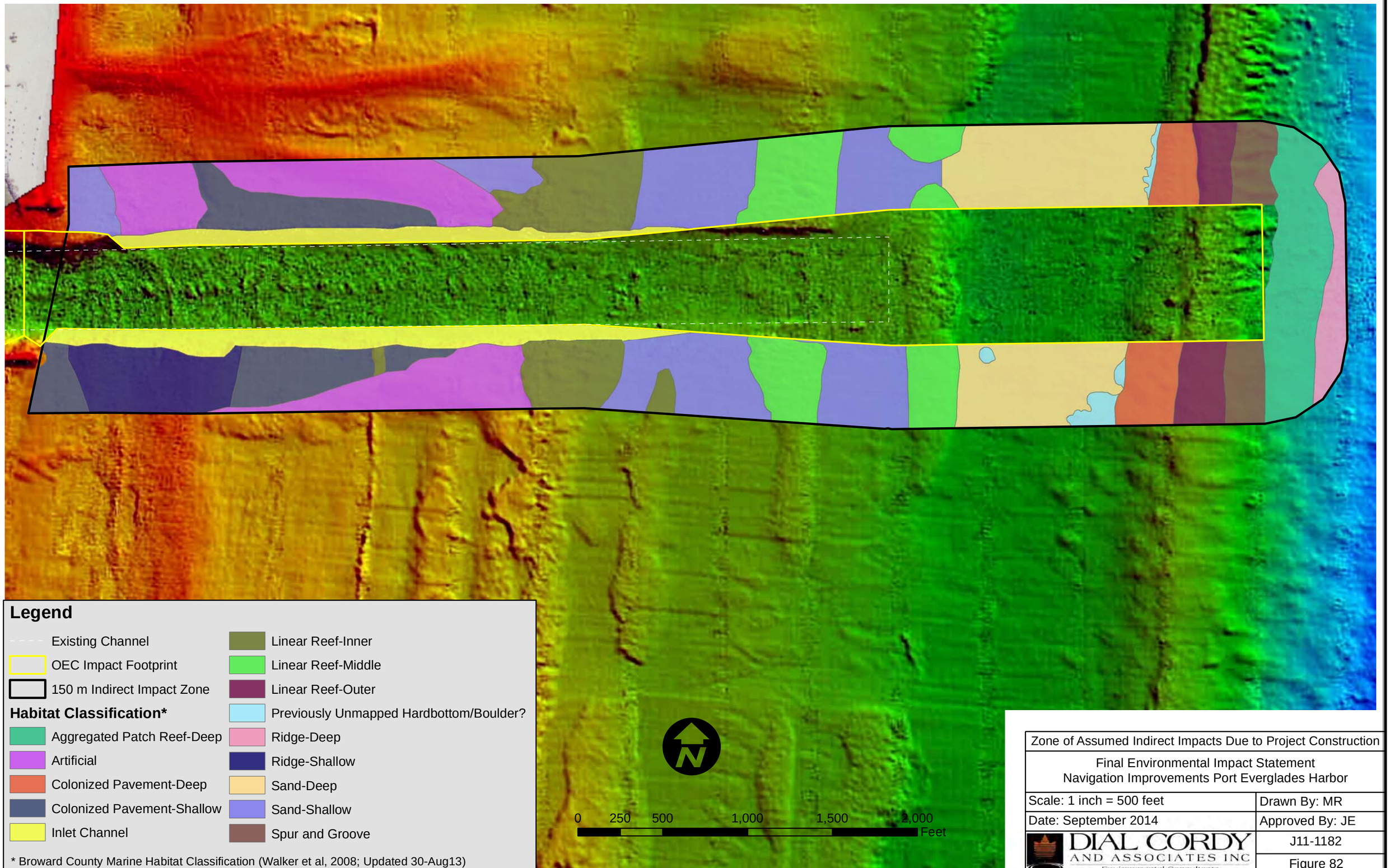
In conclusion, USACE acknowledges that the possibility of temporary, uncontrolled, incidental resuspension of material during dredging operations. In that event, the effects of this turbidity/sedimentation should be temporary (less than two years), but could include a temporary loss of photosynthetic activity on the hardbottoms/reefs adjacent to dredging sites, partial burial of

some coral heads located closest to the channel edge, particularly on the northern side of the channel under the predominate south to north current which runs over the second and third reef areas. To monitor and accommodate for any potential effects of turbidity and sedimentation, USACE established a potential indirect impact zone around the proposed, expanded channel limits. The zone extends to the north, east, and south from the proposed channel limits 150 meters (Figure 82). It comprises approximately 109 acres of 11 reef and hardbottom classes/types. (If 100% of the potential anchor/cable impact areas are affected, those areas would be subtracted from consideration as "indirect impact zone," and the hardbottom/reef habitats within the indirect impact zone area would be reduced by approximately 20 acres; see USACE and NMFS 2014 for details.) The distance of this indirect impact zone was based on a review of the result from in-water coral sedimentation monitoring associated with the 1980-1981 Port Everglades deepening project (CSA 1981) and Key West dredging project in 2004 (CSA 2006). In addition, the zone is wider than the 400 feet required by NMFS as a buffer in the Miami-Dade County project mentioned above. USACE will monitor for any adverse effects in this zone, and provide mitigation accordingly if any impacts in the area are related to dredging.

4.4.2.3 National Economic Development Plan

Direct impacts. If the NED Plan were to be constructed instead of the Recommended Plan (the LPP), the OEC would be dredged to an authorized depth of only -47 feet (actual depth of up to -56 feet due to squat and underkeel clearance requirements) rather than -48 feet. In that case (NED Plan), direct dredge (footprint) impacts to hardbottom habitats would be approximately 6.5% *less* (i.e., 0.94 acre less) than those due to the Recommended Plan. Impacts to shallow colonized pavement, unclassified hardbottom, and channel walls (associated with the Middle Reef) would be identical, and impacts to outer/linear reef would be decreased by just 0.01 ac if the NED Plan were constructed instead of the Recommended Plan. Recommended Plan/direct impacts are 0.39, 0.23, and 0.32 ac greater than those for the NED Plan for deep colonized pavement, middle/linear reef, and spur and groove reef, respectively. Potential below-dredge impacts for the NED Plan would comprise just over eight acres of various hardbottom and reef habitats, and USACE would recognize and plan for mitigation for 10% of those potential impacts prior to construction. Potential, incidental, direct impacts from dredge equipment (anchors and cables) are assumed to be similar regardless of which depth (i.e., authorized depths of -46, -47, -48, -49, or -50 MLLW feet) is selected for the OEC because dredge vessel positions are likely to remain the same for each option. GIS analysis did confirm that there would be no difference in such impacts (approximately 15 acres) depending on whether the NED Plan or the Recommended Plan were constructed.

Indirect impacts. Indirect impacts (turbidity and sedimentation) from dredging are assumed to be similar regardless of which depth (i.e., -55, -56, -57, -58, or -59 feet) is selected for the OEC. Dredging to a shallower depth would decrease the amount of time of construction (i.e., by the amount of time necessary to remove approximately 130,000 cy less material from the OEC), and thereby decrease risk of sedimentation and the amount of time materials are in suspension (turbidity) slightly. The amount of hardbottom/reef habitat comprised in the indirect impact zone that may be subject to adverse effects is the same regardless of whether the Recommended Plan (LPP) or the NED Plan is constructed.



Zone of Assumed Indirect Impacts Due to Project Construction	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 500 feet	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 82

4.4.3 Essential Fish Habitat

4.4.3.1 No-Action Alternative

Under the No-Action Alternative, no new EFH areas would be dredged among federal navigation channels. Only previously dredged EFH (unvegetated, unconsolidated bottom, and coastal inlet substrates) would continue to be impacted through previously permitted O&M dredging operations, as previously described in USACE 2005 (permitted by the State of Florida through 2015). Under this future-without-project condition, as the channels shoal-in prior to O&M activities, vessel and tug movements would re-suspend sediments in the bottom of the channel with increasing frequency, increasing levels and associated effects of turbidity and sedimentation to habitats adjacent to the existing channels (particularly seagrass habitats). This would temporarily adversely affect the offshore and estuarine (in-harbor) water column EFH, although due to implementation of BMPs, effects would be minimal. See also discussion above regarding seagrass beds, mangroves, and hardbottom/reef impacts under the No-Action Alternative, as these habitats are EFH. As previously stated, reefs adjacent to the channel and benthic species that have colonized the channel walls are more likely to be impacted as larger ships call and lack sufficient maneuvering space in the existing channel under the unpredictable currents and effect of wind on the ships. See Section 2.4 for more information.

4.4.3.2 Recommended Plan

The Recommended Plan would impact EFH including high-quality habitat and some designated as HAPC. EFH present in the footprint of this alternative include the habitats noted in Table 20 below. Footprint acreages are found in Table 20.

EFH-HAPCs. Impacts to hardbottom habitat, seagrass beds, and mangrove wetlands are discussed above in previous sections. The loss of these EFHs results in the loss of substrates/resources used by managed species for spawning, nursery, foraging, and migratory/temporary habitats. The most critical losses of EFH would be those areas additionally designated as HAPC (see table above). For example, medium- and high-profile reefs are among valuable HAPC, due to use by species of the snapper-grouper complex. Other HAPC includes seagrass beds. Loss of these two habitats (reef and seagrass) would result in a loss of habitat important in the spawning and early life-stages for species of the snapper-grouper complex, which consists of 73 species that commonly use the inshore habitats for part of their life cycle. Some of these species include blue stripe grunts, French grunts, mahogany snapper, yellowtail snapper, and red grouper.

Loss of mangrove habitat would result in additional losses of HAPC, specifically for juvenile fishes and invertebrates. These mangrove areas serve as a nursery for many managed species including pink shrimp, spiny lobster, and members of the snapper-grouper complex. Mangrove habitat is also important for many species of crabs, shrimp, and fishes that are not managed, but serve as prey species for managed species. These include blue crab, needlefishes (family Belonidae), silversides (family Athernidae), killifishes (family Cyprinodontidae) and livebearers (family Poecillidae) (Odum *et al* 1982). Removal of mangroves would have adverse effects on the community structure and food web within the harbor and associated waterways.

Table 20 Essential Fish Habitats and Habitat Areas of Particular Concern in Recommended Plan Footprint

Project Area	EFH and/or **HAPC (in bold)**	Within Footprint
DCC, SAC, TN, WID, NTB, & MTB	Estuarine emergent vegetation	
	Estuarine shrub/scrub (including mangrove fringe)	X
	Mangrove wetlands	**X**
	Seagrass	**X**
	Intertidal flats	
	Shallow subtidal bottom	X
	Estuarine water column	X
	Unconsolidated bottom	X
IEC	**Coastal inlet**	**X**
OEC	**Med-high profile live-/hardbottom**	**X**
	Nearshore hardbottom	
	Coral and coral reef (**hermatypic habitats**)	**X**
	Artificial reefs	
	Sargassum	
	Attached macroalgae	X
	Sponges	X
	Water column	X
	Shallow subtidal bottom	
	Unconsolidated bottom	X
	Unvegetated softbottom (Sand)	X

Coastal inlets are HAPC for shrimps, red drum, and grouper. Inlets are important for these species that prefer estuarine, inshore habitats such as mangroves, seagrass beds, and mudflats. NMFS (2011) stated the following with regard to impacts to this EFH:

> "While modeling studies conducted for this project and summarized in this Draft EIS conclude that changes in the physical characteristics of Port Everglades Inlet as a result of dredging will be minor, these studies do not examine the response of fish and other organisms to those changes, and such examinations would be difficult to do. Most larval and juvenile fish that utilize the inlet to access their inshore nurseries respond to a variety of environmental factors once they reach the inlet (Boehlert and Mundy 1988). Dredging of inlets, including their ebb and flood tide shoals, may result in unanticipated changes to the cues used by migrants to the estuary. Species that orient to cues associated with the sea bottom may be affected by a deepened channel. Channel dredging also may change flow of long-shore currents. These currents not only affect the transport of sediments along the beach but also influence the recruitment of early life history stages of fish and invertebrates into the estuary. In short, complex modeling and empirical studies would be needed to examine how fish would respond to the modified inlet."

Water Column. Impacts to the water column can have widespread effects on marine and estuarine species. Hence, it is recognized as EFH. The water column (both inside the estuary and offshore) comprises habitat used for foraging, spawning, and migration by both managed

species and organisms consumed by managed species. Water quality concerns are of particular importance in the maintenance of this important habitat. During dredging in substrates comprising coarser materials and rock, water quality impacts are expected to be inconsequential. However, dredging will result in some local turbidity which could affect plankton dynamics and affect larger organisms in the immediate vicinity. Use of BMPs and use of monitoring and application of water quality permit conditions/thresholds will aid the contractor in controlling turbidity by shutting down operations in the event of higher-than-acceptable turbidity.

Unvegetated and unconsolidated bottom. The majority of benthic habitat to be dredged is categorized as softbottom habitat (i.e., sand or softer materials) lacking seagrasses, or rock/rubble habitats lacking coral communities. The majority of these habitats proposed for dredging have already been dredged at some time in the past (i.e., inlet channel), and even maintained as late as 2005, but there are other areas that will be dredged for the first time. The softbottom habitats are dominated by a wide variety of substrates, from silt and clays, to sand and gravel (generally located in the SAC, all turning basins, and parts of the IEC).

Direct impacts to softbottom communities would result from the removal of substrates that contain benthic infauna and epibenthic sessile organisms. In some of the more diverse habitats, sponge-algae communities may be removed. These benthic organisms are used as prey by many managed species and may temporarily lower the carrying capacity of the project area for certain species (such as red drum) that largely forage on such taxa. Within several weeks, colonization by opportunistic species is expected. Algae and sponge colonies may take a few years to become re-established, if conditions remain conducive to such taxa.

In deeper areas, or where fine silt and silty sand are dominant, functional losses may be minimal. These softbottom habitats have lower levels of infaunal biomass production (i.e., associated with low dissolved oxygen levels) and/or no coarse material for attachment of benthos. However, the substrates themselves do serve biogeochemical processes (NMFS 2011), which may be temporarily suspended during and for some time following dredging until natural processes are again regenerated.

This section details impacts to only Essential Fish Habitats not previously discussed in this EIS. For information pertaining to the proposed project's impacts on wetlands, seagrass beds, and hardbottom habitats, please see Sections, 4.3.2, 4.4.1.2, and 4.4.2.2, respectively.

Shallow sub-tidal bottom. These areas within the project footprint are primarily in the areas proposed for deepening to create the Widener and widen the SAC. These areas, which serve as foraging and refugia for many species will be permanently removed. However, some functions provided by these habitats will be compensated through improvements at West Lake Park.

4.4.3.3 National Economic Development Plan

The implementation of the NED Plan would affect the same EFH resource types as the Recommended Plan would. As discussed above, impacts to mangrove wetlands and seagrasses would be identical. Impacts to reefs and hardbottoms would be slightly less under the NED Plan. Work in the coastal inlet itself (if defined as comprising only the IEC), listed as HAPC, would involve dredging 60,000 cy less material under the NED Plan. Therefore, the time spent dredging in this area would be less under the NED Plan than it would be under the Recommended Plan.

Likewise, impacts to other EFH types would be decreased under the NED Plan, as less material (and surface area) would be removed from benthic habitats, including unvegetated/unconsolidated bottom and shallow subtidal bottom. Decreased dredging quantities and intervals may also provide more water quality benefits, as less material is exposed to the water column under the NED Plan.

4.4.4 Other Fishery Resources

4.4.4.1 No-Action Alternative

Under the No-Action Alternative, O&M dredging operations would continue in Port Everglades Harbor. In the 2005 EA for Ongoing O&M Dredging at Port Everglades (USACE 2005), the USACE analyzed the effects of ongoing O&M dredging operations. USACE's discussion of effects on fishery resources therein is still relevant as representing a future-without-project condition; it is incorporated here by reference.

4.4.4.2 Recommended Plan and National Economic Development Plan

4.4.4.2.1 Dredging Impacts

Dredging with hydraulic dredges usually results in little to no effect on adult fishes due to their size and ability to avoid either the drag head or cutterhead. The same cannot be said of larval fishes and eggs, which lack the ability to avoid the suction near the drag head or cutterhead. Larvae and egg distribution and concentrations in a channel are highly variable on a range of scales (spatially and temporally). Therefore it is important to recognize that not all larvae in an inlet like Port Everglades would be vulnerable to entrainment. Larvae and eggs are not equally distributed in the inlet as the tidal flows in and out of the inlet can show asymmetry. In addition, many larvae exhibit a vertical migration strategy that facilitates tidal stream transport. That is, larvae are up in the water column during flood and descend to near the bottom during ebb; such behavior helps to prevent larvae from being flushed back out the inlet (Settle 2003).

Settle (2003) discussed NOAA/NOS' National Centers for Coastal Ocean Science report entitled *Assessment of Potential Larval Entrainment Mortality Due to Hydraulic Dredging of Beaufort Inlet*. NOAA found, and USACE agrees that "any larvae entrained in the dredge are likely to be killed; it is likely that the impact at the population level would be insignificant" (Settle 2003). In this assessment, NOAA also determined that the use of a 30-inch hydraulic dredge dredging 24-hours a day in Beaufort Inlet, North Carolina, would result in entrainment mortality "even under the worst case scenario" of 0.1% per day where there are high densities of larval fishes (up to 5 larvae per m^3). This may be informative of potential impacts at Port Everglades Inlet, although it is far from Beaufort Inlet. Unfortunately, after discussions with BCDEPD, FWC (including FWRI) and NOAA, USACE was not able to locate any studies regarding larval fish or egg densities in or around the Port Everglades inlet. Therefore, USACE assumes that if an inlet such as Beaufort with high densities of larval fishes can be dredged for 24-hours-a-day without significant population level impacts to larval fish densities, that the same would hold true at Port Everglades, where a significant portion of the larval development habitat is in the nearshore and offshore to the north and south of the Port (USACE 2003).

To better understand the effects of dredging on larval fishes and eggs, USACE compared Settle's analysis to the daily entrainment and impingement rate at the FPL Port Everglades power plant. A 30-inch dredge takes in approximately 45 million gallons of water per day (mgd), and the power

plant takes in 1,295 mgd. This means the dredge takes in 3.4% of the water that the power plant takes in daily; one may argue that dredges cause less damage to larvae and eggs than do power plant equipment (see entrainment/ impingement discussion elsewhere in this document).

Although the above may be useful for appreciating the effects of hydraulic dredges, quantitative information on the effects of mechanical dredge types on fish, larvae, or eggs is not available to date.

The effects of dredging to fishery resources under the NED Plan would not differ significantly from those under the Recommended Plan, except that fisheries may be indirectly affected via slight differences in the amount of habitat removed (see above discussions).

4.4.4.2.2 Blasting Impacts

Following a review of the effects of blasting on fishes during previous port deepening projects, including a project in an environment similar to that of Port Everglades, USACE has determined that, as with marine mammals and reptiles, the confinement of the blast in the rock greatly reduces the impacts of the blasting via pressure wave, and as a result, greatly reduces the impacts to fish in the project area.

The primary cause of injury and mortality to aquatic organisms from blasting in aquatic environments appears to be damage associated with rupture and hemorrhage of air-filled internal organs, in particular, the swim bladder (Wright and Hopky 1998; Keevin and Hempen 1997), which, in many pelagic fishes, plays a role in buoyancy. Demersal species, such as flounder, typically do not have swim bladders and are frequently less susceptible to blast impacts. Less information is available, but it is generally reported that there is minimal injury and mortality from blasting to mollusks, shellfish, and crustaceans which do not have gas-filled organs similar to the swim bladder in fish (Wright and Hopky 1998). Although the structure of the swim bladder and the mechanism for adjusting gas volume vary among species, generally the process for release of gas from the swim bladder is too slow to compensate for the rapid fluctuations in hydrostatic pressure associated with the pressure shock wave. This, and other, physiological considerations are discussed below (Hempen et al 2005):

> "The primary cause of damage in finfish exposed to a pressure shock wave appears to be the outward rupture of the swim bladder as a result of the expansive effect of the negative hydrostatic pressure associated with the reflected air-water surface wave. While the organ may tolerate the compressive portion of the shock wave, the rapid drop to negative hydrostatic gage pressure and expansion of the gas that cannot otherwise be released, causes the rupture of the organ. Vibration, expansion, and rupture of the swim bladder can also cause secondary damage and hemorrhage due to impact with other internal organs in close proximity to the swim bladder. Other organs typically exhibiting damage include the kidney, liver, spleen, and sinus venosus (a structure in the heart). Extensive tearing of tissue has been observed in species where the swim bladder is closely attached to the visceral cavity. Close attachment to the dorsal cavity wall was typically associated with extensive damage to the kidney. Species with thick-walled swim bladders and cylindrical body shape (e.g., oyster toad fish and catfish) appear to be more resistant to pressure waves than species with laterally compressed bodies such as herring and menhaden (Linton *et al.* 1985, as cited in Keevin and Hempen 1997). Smaller individuals of a species are generally more sensitive than larger fish. Early-stage larvae do not have swim bladders and are more resistant than older larvae after development of the swim bladder. The extent of injury and mortality decreases with distance from the

detonation, as the magnitude of the pressure drop declines due to dissipation of the blast impulse (*I*) and energy flux density (*Ef*) with distance. In a review of a number of studies of primarily open water blasting, Keevin and Hempen (1997) concluded that *I* was the best predictor of potential damage for shallow depths (less than 3 m), while *Ef* was the best predictor for deeper conditions.

"The weight of the charge and distance from the detonation are the most important factors affecting the extent of injury and mortality, although water depth, substrate, depth of the fish, and size and species of fish are also important (Keevin and Hempen 1997; Wiley *et al.* 1981; Teleki and Chamberlain 1978). The size of the lethal zone (the radius from detonation that would result in death) is dependent on the depth of the detonation. In shallow water, the horizontal extent is greater than in deep water. However, for buried explosives (as with confined blasts), the lethal zone is conical with the narrow portion of the lethal zone near the bottom expanding horizontally toward the water surface (Linton *et al.* 1985)."

During the Port of Miami Phase II project conducted in 2005, confined blasting activities comprised 40 blast events over a 38-day time frame; 23 (57.5%) of these blasts were monitored by the FWC and the dredging contractor's staff, who collected all injured and dead fishes following each detonation. That they did so only after the "all-clear" was provided (normally at least 2-3 minutes after the shot is fired) is important, since seagulls and frigate birds quickly learned to approach the blast site to forage on some of the stunned, injured, and dead fish floating on the surface. CU blasting monitors collected the carcasses of floating fish. However, not all dead fish *float* after a blast, and due to safety concerns, divers did not recover *non-floating* carcasses from the blast zone. The fish were described to the lowest taxonomic level possible (usually species) and the injury types were categorized. A summary of that data shows that 24 different genera were collected during Miami Harbor blasting. The species with the highest abundance were white grunts (*Haemulon plumieri*) (*n* = 51); scrawled cowfish (*Lactophrys quadricornis*) (*n* = 43) and pygmy filefish (*Monocanthus setifer*) (*n* = 30). The total number of fish collected during the 23 blasts was 288, or an average of 12.5 fish per blast (range 3 to 38). In observation of the three blasts with the greatest number of fishes killed (see Table 21) and reviewing the maximum charge weight per delay for the Miami Harbor project, it appears that there is no direct correlation between charge weight and number of fish killed, albeit only three events were recorded. Reviewing the 23 blasts where dead and injured fish were collected, no discernible pattern exists. Factors that affect fish mortality include, but are not limited to, fish size, body shape (e.g., fusiform, etc) and proximity of the blast to a vertical structure like a bulkhead. The August 10, 2005 blast data shows a much smaller charge weight resulted in a higher fish kill possibly due to the closeness of a bulkhead.

Table 21 Confined Blast Maximum Charge Weight and Number of Observed Fish Killed

Date	Max Charge Wt/delay (lbs)	Fish killed
7/26/2005	85	38
7/25/2005	112	35
8/10/2005	17	28

To estimate the total number of fish killed during construction of the Miami Harbor Phase II project, USACE used a 12.5 fish/blast kill estimate based on the collected fish data, and multiplied it by the 40 shots, arriving at a total estimate of floating fish killed in Miami of 500 fish.

As stated previously, not all carcasses float to the surface and there is no way to estimate how many carcasses will not float. However, it can be determined that at Miami, the minimum estimated fish kill for the entire project, was 500 fish. It should be noted that no tarpon or snook (species of concern for the State) were observed or collected.

This system of estimating impacts is limited by physically being able to collect the carcass of the fish. As previously stated, due to human health and safety concerns, no collection of carcasses from the bottom of the blast zone will be conducted, and this method also does not allow for the estimate of any eggs or larval fishes that may be in the water column near the blast. To estimate this mortality, instead of estimating the number of fishes, eggs and larvae killed or injured (which are considered killed for the purposes of this analysis), a model would need to be developed to estimate, based on site geology, potential charge weights per hole and blast pattern what the injury/mortality radius would be for a maximum blast at Port Everglades. While this will not allow for a quantification of individual fishes, eggs, and larvae, it would allow USACE to determine that any fish, egg or larvae within *X* feet of a charge of *X* lbs (values to be determined upon collection of data) would be injured or killed.

Using the MR_{ow} (feet) = 260 $w_{ow}^{1/3}$ equation, suggests that the kill radius of a 1-lb, open water booster test was 260 feet at Miami Harbor. The kill radius would have only been 56 feet, as a conservative assessment, for a 1-lb charge that was confined by stemming within rock at Miami Harbor. The same charge may only have a kill radius of 22 feet when confined within competent rock and well stemmed. The kill radii for the shots recorded at Miami Harbor of 17, 32, 67, and 134 lb/delay may have been 140, 180, 230, and 290 feet, respectively (Hempen *et al*. 2007). Radiation of the wave energy into rock reduced the available energy reaching the water column. The pressures entering the water column were well below those pressures that typically propagate away from open-water (unconfined by solid media that may radiate the energy away with less harm) charges relative to charge-weight per delay. As will be discussed below, the waveform is more complex with less negative pressure duration. This may lead to the conclusion that the 40 psi of open-water shots is more lethal than the same 40-psi (but more pronounced) waveforms of confined shots.

There are a number of physical attributes of the pressure waveform from the confined shots that suggest mortality would be lower than indicated by the peak-pressure measurements. The rapid oscillation from a high, brief overpressure and a moderate, but longer, underpressure associated with detonation of high explosives in the water column is most probably responsible for organ damage and mortality in fish. This oscillation in waveform is responsible for the rapid contraction and overextension of the swim bladder resulting in internal damage and mortality (Wiley *et al*. 1981, as cited in Keevin and Hempen 1997). It has also been suggested that the negative phase (relative to ambient) of the pressure wave is responsible for organ damage (particularly the swim bladder) and mortality (Chesapeake Biological Laboratory 1948; Hubbs and Rechnitzer 1952 and Wiley *et al*. 1981, as cited in Keevin and Hempen 1997). As noted in the waveforms of the Miami Harbor Phase II study (Hempen *et al* 2007), the high-frequency compressing pressures, usually associated with the detonation of high explosives, were reduced in amplitude and negative pressures were small relative to the background noise.

Hubbs and Rechnitzer (1952) determined that the lethal threshold peak pressure for a variety of marine fish species exposed to dynamite blasts varied from 40 psi to 70 psi. The more conservative pressure of 40 psi from Hubbs and Rechnitzer (1952) was used to develop the analysis at Miami Harbor, even though their range extends much further than for 70 psi. Keevin (1995) found no mortality or internal organ damage to bluegill exposed to a high explosive at pressures at or below 60 psi (420 kPa). The 40-psi value is also conservative because the waveform of the mortality value was established from an open-water testing program and not

from similar confined shots that did not have clear extension (negative pressure) phases for measurable impulse and energy measures. There is some evidence, as previously stated, that confined shots may not have mortal pressures as low as those for open-water shots, but this conclusion requires further testing.

This study clearly demonstrates that explosives shot in open water will produce both higher amplitude and more rapidly oscillating shock waves than rock removal shots. Thus, the use of blasting in rock removal will result in lower aquatic organism mortality than the same explosive weight detonated in open water, when confinement of the blasting agent is controlled. This conclusion is important because the majority of aquatic organism mortality models were developed using open-water shot data that will overestimate rock-removal shot mortality. Safety zones calculated using open-water mortality models are used to establish watch plans and optimal observer locations to protect aquatic organisms (Jordan *et al*. 2007). If the observation area becomes too large, based on the use of open-water shot pressures, then there is also the possibility that the level of intended species protection is diminished. It is much easier to monitor a small area than a very large area. As the dimensions of a watch zone unnecessarily increase, there is undoubtedly a safety radius that would also preclude blasting, because of the high cost of monitoring, long blasting delays due to aquatic organisms wandering into the enlarged blast zone, and the reduced efficiency of being able to protect the organisms of concern.

Blasting Effects on Juvenile, Larval Fishes, and Fish Eggs. As was the case with marine mammals (Ketten 2004), the smaller the animal (in this case, fish), the more sensitive the animal is to the effects of a blast (Ketten 2004). Govoni *et al*. (2008) reviewed the effects of unconfined blasts on larval and juvenile fishes in the Wilmington River, North Carolina. They determined that the strength of the pressure wave has the greatest impact on juvenile and larval fish. As expected, they found that shock wave pressure was highest closer to the blast. They determined that the closer a juvenile or larval fish is to the blast, the more likely they will be injured or killed by the blast. They also determined that larvae may be injured by the blast, but not immediately die. It is very likely that these larvae would not continue to normally develop and would eventually die. They estimated the overall impact to larvae and juvenile fishes for the Wilmington Harbor project over the 5 to 7 years of construction consisting of 725 planned blasts at 2.3% (5 years) - 3.2% (7 years) of the total juvenile and larval fish in the river over the duration of the project. They also determined “that this low level of impact is unlikely to affect the local population.” Unlike the study in the Wilmington River that used an unconfined blast, USACE proposes to utilize confined blasts to pre-treat the rock as previously explained in Section 2.9.2.3. The confinement of the blast reduces the strength of the pressure wave that is released into the surrounding water column by 60-90% (Nedwell and Thandavamoorthy 1992; Hempen *et al*. 2005; Hempen *et al*. 2007), and as a result would reduce the lethal and injurious effects to larval and juvenile fishes proportionately.

Larval distribution and concentrations in a channel are highly variable on a range of scales (spatially and temporally). Therefore it is important to recognize that not all larvae and juvenile fishes in an inlet like Port Everglades would be vulnerable to being within the blast impact zone. Larvae and juvenile fishes are not equally distributed in the inlet as the tidal flows in and out of the inlet can show asymmetry. In addition, many larvae exhibit a vertical migration strategy that facilitates tidal stream transport. That is, larvae are up in the water column during flood and descend to near the bottom during ebb (Settle 2003). As previously stated, USACE has been unable to locate any studies of larval and/or juvenile fish densities in or around the Port Everglades inlet to perform inlet specific calculations like those conducted for the Wilmington River project.

Blasting impacts to fish eggs has not been well studied in the literature for either confined or open water blasts. The Canadian government has guidelines that limit the maximum allowable

overpressure (100 kPa) and peak particle velocity (PPV) (13 mm/s) for blasts in Canadian waters to protect fish and incubating eggs (Wright and Hopky, 1998). Faulkner *et al.* (2008), set up a study to determine if this guideline was an effective level to be protective of fish eggs exposed to unconfined blasts. They state that the impact to fish eggs from blasts is not the change in pressure, since fish eggs do not have gas spaces to expand or contract in response to the change in pressures, but as a result of the shaking of the substrate where the eggs have settled (Wright 1982 in Faulkner *et al*. 2008), which is typically measured as PPV. In their study, they determined that an exposure of 219.3 mm/s was required to increase mortality in free floating eggs (eggs sitting on the bottom of a container without substrate like gravel) and 245.4 mm/s were required when eggs were placed on spawning gravel. The study concluded that the 13 mm/s standard was exceptionally protective of eggs and fish. In reviewing the Shot Report Summaries for Miami Harbor where 10 separate locations surrounding each blast were monitored, the PPVs for the 40 blasts ranged from a maximum of 0.018 – 1.080 in/s (.457mm/s – 27.43 mm/s) with a standard deviation of 0.2539 in/s (6.45 mm/s). This also demonstrates that confining the blast in rock results in significant reductions in not only overpressures, but also PPV and associated movement of the bedrock that is being pre-treated. Based on Faulkner *et al.'s* (2008) results, blasting at Port Everglades should result in minimal impact to fish eggs in the Port Everglades inlet.

Blasting, Fishery Resources, and the NED Plan. The effects of blasting on fishery resources under the NED Plan may be slightly less than under the Recommended Plan, as potentially fewer charges may need to be used if a shallower project depth was selected (the may not be able to be verified until the PED phase when additional geologic cores are taken and examined). However, any differences in resulting fish population densities would be unquantifiable.

4.5 Protected Species

4.5.1 Terrestrial Species

Neither direct nor indirect impacts to terrestrial protected species are anticipated for the No-Action Alternative, the Recommended Plan, or the NED Plan. GIS analysis indicates that the three known beach clustervine colonies in JUL range in distance from 550 to 650 feet from the project footprint. They are located east of the park road that runs north/south separating the mangrove/slough community along the eastern shore of the SAC from the interior JUL wetlands (at approximately the same latitude as the TN). Therefore, they will suffer neither direct nor indirect impacts due to construction of the Recommended Plan.

4.5.2 Johnson's Seagrass

4.5.2.1 No-Action Alternative

Under the No-Action Alternative, Johnson's seagrass will continue to be impacted through previously permitted maintenance dredging operations conducted in the Port. Additionally, as the channels shoal in prior to O&M activities, vessel and tug movements may stir up the sediments in the bottom of the channel with increasing frequency, which may increase levels of turbidity and sedimentation effects to seagrass beds adjacent to the existing channels where Johnson's seagrass is commonly found.

4.5.2.2 Recommended Plan and the National Economic Development Plan

Dredging would result in the permanent removal of up to approximately 3.57 acres of mixed or monoculture Johnson's seagrass where it occurs along the SAC and Widener. The impact is considered permanent because deepening of shallow-water habitats beyond 10 to 13 feet (3 to 4 meters) is likely to impede post-dredging recolonization of areas that currently support *H. johnsonii* (NMFS 2007c, Kenworthy 2000, and Hammerstrom *et al*. 2006). This effect would be seen throughout the improved Widener and SAC, where water depths will be -48 feet MLLW or deeper (depending on which plan is selected). Due to implementation of water-quality-protection BMPs, USACE does not anticipate indirect effects to seagrasses including Johnson's seagrass outside the impact footprint.

USACE initiated consultation under the ESA with NMFS regarding potential effect of the proposed project on threatened Johnson's seagrass in a September 2004 Biological Assessment, providing supplemental survey data collected in 2006 and 2009, with a finding of "may affect, likely to adversely affect" due to the direct removal of up to an approximate maximum of 3.57 acres of Johnson's seagrass (both as monospecific and mixed species beds).

4.5.3 Smalltooth Sawfish

4.5.3.1 No-Action Alternative

The No-Action Alternative would have no effect on the smalltooth sawfish.

4.5.3.2 Recommended Plan and the National Economic Development Plan

A detailed discussion of the biological status of each species and the effects of the proposed action is included in the ESA consultation documents (prepared by USACE, USFWS and NMFS), which are located in Appendix F of the EIS.

Effects from Dredging. Although 16 sightings of sawfish have been made within the boundaries of Broward County, the likelihood of sawfish being in the project area is minimal, as the Port does not provide optimal habitat for sawfish (Simpendorfer 2006). The proposed deepening activities using a cutterhead, clamshell, or hopper dredge are not expected to affect the sawfish (NMFS 2003b).

The assumptions and conclusions regarding cutterhead (pipeline) and mechanical (clamshell) dredges in the 1991, 1995 and 1997 South Atlantic Regional Biological Opinions (SARBO) and 2003 (as amended) Gulf Regional Biological Opinion (GRBO) (NMFS 1991, NMFS 1995, NMFS 1997, and NMFS 2003b, respectively) for sea turtles apply to sawfish as well. The 1991 SARBO states the following:

> "…pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. Presently, NMFS has determined that pipeline dredges are unlikely to adversely affect sea turtles."

The 2003 GRBO states the following:

> "In contrast to hopper dredges, pipeline dredges are relatively stationary, and therefore act on only small areas at any given time. In the 1980s, observer coverage was required by NOAA Fisheries at pipeline outflows during several dredging projects deploying pipeline dredges along the Atlantic coast. No turtles or turtle parts were observed in the outflow areas. Additionally, the COE's South Atlantic Division (SAD) office in Atlanta, Georgia, charged with overseeing the work of the individual COE Districts along the Eastern Seaboard from North Carolina through Florida, provided documentation of hundreds of hours of informal observation by COE inspectors during which no takes of listed species were observed. Additional monitoring by other agency personnel, conservation organizations, and the general public has never resulted in reports of turtle takes by pipeline dredges."

USACE concludes that if this statement holds true for species that are relatively abundant in south Florida like sea turtles, it should also hold true for a very rare species like sawfish.

In the 2003 GRBO, NMFS made the determination that "After consultation with individuals with many years in the business of providing qualified observers to the hopper dredge industry to monitor incoming dredged material for endangered species remains (C. Slay, Coastwise Consulting, pers. comm. August 18, 2003) and a review of the available scientific literature, NOAA Fisheries has determined that there has never been a reported take of a smalltooth sawfish by a hopper dredge, and such take is unlikely to occur because of smalltooth sawfishes affinity for shallow, estuarine systems."

The probability of a sawfish being taken by a cutterhead, mechanical, or hopper dredge is so unlikely as to be discountable. Furthermore, neither of the proposed actual dredge depths (-59, -58, -57, -56, or -55 feet MLLW) for the OEC results in higher or lower likelihood of impacting the species. To help minimize the potential for sawfish take, USACE will incorporate the NMFS sawfish protection construction protocols into the plans and specifications. Based on the information included in the recovery plan, the census information from FWC and the proposed construction techniques, USACE determined that the expansion of Port Everglades using a cutterhead, clamshell or hopper dredge "may affect, but is not likely to adversely affect" the endangered smalltooth sawfish.

Effects of Blasting. Review of ichthyological information and test blast data indicates that fishes with swim bladders are more susceptible to damage from blasts, and some less-tolerant individuals may be killed within 140 feet of a confined blast (USACE 2000b). Sawfishes, as chondrichthyans, do not have air bladders, and, therefore, they would be more tolerant of blast overpressures closer to the discharge, possibly even within 70 feet of a blast (Keevin and Hempen 1997).

Direct Effects on Habitat. Direct effects on sawfish habitat include removal of some mangroves as well as some seagrass and softbottom habitats (as described above).

Indirect Effects on Habitat. Although seagrass and other softbottom habitats will be removed, USACE does not anticipate that the proposed project will have any adverse indirect effects on smalltooth sawfish in the vicinity of the action area. These habitats may be utilized by the species, however, loss of seagrass habitats is relatively small with respect to overall seagrass abundance throughout the area, and will be compensated through mitigative measures that have already begun to show increases in seagrass coverage in West Lake Park associated with the

first phases of restoration efforts (Dylan Larson, pers comm., August 2011). Nearshore softbottom areas are also plentiful in and near the action area, and impacts to them would not limit resource use by sawfish, especially since population density of individuals in the area is extremely low. Construction of gaps in the rip-rap as part of the environmentally friendly bulkheads along the SAC and TN will ensure that juvenile sawfish will have access to the existing mangroves (and those that recruit in the future) on the western shoreline of JUL and the western side of the SAC, where currently they have no access due to the height of the rip-rap along the mangroves edge.

Precautions. As part of the standard plans and specifications for the project, USACE has agreed to implement the NMFS "Sea Turtle and Smalltooth Sawfish Construction Conditions" as follows:

1. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.
2. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.
3. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.
4. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.
5. If a sea turtle or 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 sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.
6. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.
7. Any special construction conditions, required of the project, outside these general conditions, if applicable, will be addressed in the primary consultation.

More detailed information concerning the sawfish impacts associated with the project is available in the Biological Assessment submitted to the NMFS that is included in Appendix F. It is USACE's determination that, while the project may affect smalltooth sawfish, the project is "not likely to adversely affect" them, and USACE requested that NMFS concur with that determination (Appendix F). NMFS concurred with that determination in the March 7, 2014 project biological opinion.

4.5.4 American Crocodile

4.5.4.1 No-Action Alternative

Under the No-Action Alternative, O&M dredging will continue to occur within the Port, as authorized under permit from FDEP and vessels will continue to call on Port Everglades. For years 2060 through 2073, in the “without-project” condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. The project was analyzed under NEPA with an EA and FONSI April 28, 2005. In the EA, USACE determined that O&M operations (to occur even in absence of the proposed Recommended Plan) "may affect, but will not adversely affect" American crocodile in the Port due to the incorporation of the standard manatee protection protocols, which would benefit crocodiles (if they were observed, operations would shut-down temporarily). The USFWS concurred with the USACE determination that proposed maintenance dredging at Port Everglades "may affect, but is not likely to adversely affect" the threatened American crocodile on November 29, 2004. The analysis of these effects and this concurrence are incorporated by reference into this analysis.

4.5.4.2 Recommended Plan and the National Economic Development Plan

The only known location of American crocodile habitation near the Port is in West Lake Park, however, crocodiles have been documented on at least one occasion transiting through the Port. The American crocodile is found primarily in mangrove swamps and along low-energy mangrove-lined bays, creeks, and inland swamps (USFWS 1999). This would include the interior areas of West Lake Park. Dredging activities associated with Port expansion are not expected to impact the American crocodile, as they tend to be shy, unaggressive animals and as such the normal noisy and busy activities in the Port would tend to discourage their presence in the Port.

Potential effects to crocodiles will not differ based on the selected depth to which the OEC is dredged. The greatest potential impact to crocodiles may be the use of explosives to remove areas of rock within the Port. Due to the presence of safety zones associated with all proposed blasting activities, it is highly unlikely that blasting will have an adverse effect on threatened crocodiles. It is extremely likely that both the pressure and noise associated with blasting would physically damage sensory mechanisms and other physiological functions of individual crocodiles should they be within the danger zone during detonation. To date, there has not been a comprehensive study to determine the effects of underwater explosions on reptiles that defines the relationship between distance/pressure and mortality or damage (Keevin and Hempen, 1997). However, there have been studies that demonstrate that sea turtles are killed and injured by underwater explosions (Keevin and Hempen 1997).

Crocodiles are shy, typically non-aggressive animals, and as such, USACE concludes that it is very unlikely that a crocodile will be seen in or near the project area during construction. However, due to the project’s proximity to areas of recorded sightings of crocodiles, USACE is including the American crocodile in the assessment of effects. Impacts associated with blasting can be broken into two categories: direct impacts and indirect impacts.

Direct Impacts. As with sea turtles, noise and pressure effects on crocodiles have been poorly studied. As such, in the absence of species-specific (or in this case, order-specific) data, USACE is using assumptions regarding effects on sea turtles as proxies for the American crocodile, given their common reptilian morphology and physiology, and the similarity in body size between adult dolphins and crocodiles. If these comparisons are valid, direct impacts to crocodiles could include

injury or death associated with physical damage from blast-induced, pressure-related injuries. Both the pressure and noise associated with blasting could injure crocodiles. Utilizing the same calculations for crocodiles as provided in Hempen *et al*. (2007) regarding sea turtles and dolphins, it is expected that crocodiles in the immediate vicinity of any detonation site would likely be killed, and individuals existing within 400-600 feet of the blast would likely suffer injury.

Sub-lethal effects could also occur within the 600-foot radius, though the degree of risk is uncertain. Crocodilians are known for complex communication behaviors, sometimes involving use of sounds transmitted below the range of frequencies audible to humans. As such, their ears may be susceptible to low-frequency noise. Damage to sensitive ear structures and tissues (though externally covered by a thick flap of skin/scale) could result. If there is any temporary or permanent hearing loss, individuals may not behave normally, but the degree to which this would affect foraging, reproductive success, and other functions is unknown.

Pressure data was collected during the 2005 Miami Harbor project by USACE geophysicists and biologists and showed that using the three zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the safety zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen *et al*. 2007).

Indirect effects. Indirect impacts on crocodiles due to blasting activities in the project area include alteration of behavior (possibly due to hearing/vibration sensitivity to both dredging and/or blasting). For example, movements of crocodiles may be impeded or altered. Indirect effects on crocodiles are not anticipated to differ depending on which dredge depth is selected for the OEC.

Protection. USACE plans to protect crocodiles in the same manner as manatees and other listed and protected species in the action area. Based on the protective measures proposed for this project, in concert with the reduction in pressure from the blast due to the confinement of the pressure in the substrate, the impacts to crocodiles associated with blasting should be minimal.

Biological Assessment. More detailed information concerning the impacts associated with the project is available in the Biological Assessment submitted to the USFWS that is included in Appendix F. It is USACE's determination, that while the project may affect crocodiles under USFWS' jurisdiction, the project is "not likely to adversely affect" them, and USACE requested that USFWS concur with that determination. The USFWS has concurred with USACE's determination of "may affect, not likely to adversely affect". This determination can be found in the Fish and Wildlife Coordination Act Report for this project located in Appendix G.

4.5.5 Sea Turtles

4.5.5.1 No-Action Alternative

The No-Action Alternative may adversely affect sea turtles if hopper dredges are used to conduct O&M dredging operations. Sea turtles can be lethally or injuriously taken by hopper dredges, and O&M dredging often utilizes hopper dredges to remove unconsolidated sediments from the bottom of Federal channels. This analysis has previously been conducted by NMFS (NMFS 1997) and USACE (2005) and is incorporated by reference For years 2060 through 2073, in the "without-project" condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. Risk of vessel strikes may increase as more *and* larger vessels transit the inlet.

4.5.5.2 Recommended Plan and the National Economic Development Plan

Since beaches of JUL provide important nesting areas for four sea turtle species and the offshore areas provide foraging ground for five listed sea turtle species, the project area comprises important resources for turtles. With-project vessel calls in 2073 are estimated to be less than the without-project vessel calls, (Economic appendix of the Feasibility Study). The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo resulting in a decrease in overall vessel calls. Due to the widening and deepening components of the project, larger container, petroleum, bulk cargo and cruise vessels will call at Port Everglades and more tonnage will be carried per vessel call. The widened and deepened channels may provide sea turtles more room to maneuver around incoming and outgoing vessels throughout the action area, and avoid vessel strikes. Dredge activities and associated disturbances (noise, lights, etc.) offshore may interrupt the movement of turtles swimming toward or away from nesting beaches. USACE anticipates that effects to turtles will not differ significantly based on which dredge depth is selected for the OEC. However, dredging to greater depths may require additional dredging time offshore and additional time results in more opportunities for incidental take should a hopper dredge be used, although this additional risk cannot be quantified.

Turtles associated with beaches. To ensure compliance with the ESA, USACE has reviewed all of the potential effects of the project on turtles protected under the ESA, including lighting-associated disorientation of nesting females or hatchlings attempting to enter the ocean. Because no new lights on-shore are associated with the Recommended Plan, its implementation would have no impact on nesting and hatchling sea turtles with regard to an increase in disorientation associated with lighting. Additionally, NMFS has evaluated these effects under previous biological opinions for dredging operations in the Southeast U.S. and Gulf of Mexico, finding that the effects are minimal and that analysis is incorporated by reference (NMFS 1997 and 2003 as amended).

Therefore, in accordance with Section 7 of the ESA, USACE has made a "may affect, not likely to adversely affect" determination for nesting and hatchling sea turtles for actions associated with this alternative. In addition to USACE's determination, the USFWS has made the following determination in the CAR completed for this project:

> "Another possible element of the action that may affect sea turtles is the presence of light and/or noise from construction/dredging vessels anchored offshore. These factors may interrupt the movement of adult, nesting, female turtles swimming toward or away from nesting beaches, and may cause disorientation of hatchlings following emergence. However, since the Port is an active facility, offshore lighting is not an unusual feature of the area, and should not appreciably change the ambient conditions of nesting areas in the vicinity of the action. In addition, all construction/dredging vessels are required to adhere to best management practices, such as preventing lights from exposure to shore through use of shields. Therefore, no adverse indirect impacts to sea turtle nesting habitat due to dredging operations are anticipated for the proposed action."

Free-swimming turtles. To address concerns regarding free-swimming sea turtles and the effect the proposed project may have on them, USACE has requested initiation of consultation with the NMFS by preparing a Biological Assessment under Section 7 of the ESA. If a hopper dredge is utilized to clear shoaling material from the top of rock prior to dredging the rock within Port Everglades, USACE will comply will all terms and conditions for the use of hopper dredges in the

Biological Opinion for this project to assure that incidental take of sea turtles is minimized during hopper dredging operations. A rigid-draghead designed to deflect sea turtles is required for all hopper-dredging projects throughout the year in South Florida, due to the year-round presence of sea turtles. The South Atlantic Regional Biological Opinion (NMFS 1997) mandates that year round, 100% observer coverage on the hopper dredge by NMFS-approved Endangered Species Observers is required for the Port Everglades project. Complete (100%) inflow screening is required, and complete (100%) overflow screening is recommended. If conditions prevent 100% inflow screening, inflow screening can be reduced, but 100% outflow screening is required, and an explanation must be included in the preliminary dredging report. Preliminary dredging reports which summarize the results of the dredging and any sea turtle take must be submitted within 30 working days of completion of any given dredging project. Logs of any sea turtle injuries or deaths due to hopper dredging activities will be maintained, with immediate notification by the contractor to USACE-Jacksonville District, and NMFS. NMFS has previously determined (NMFS 1991, 1995, 1997 and 2003 as amended), as discussed in section 4.5.3.2 that cutterhead (pipeline) dredges and clamshell dredges have a low likelihood of take of sea turtles. USACE included that analysis in the Biological Assessment prepared for this project, and also incorporates it by reference into this discussion.

A hopper dredge was used in the entrance channel and inner portions of the Port in 2005 and 2013 for three separate dredging events. More than 235 loads were dredged with no documented lethal or injurious take of sea turtles during those dredging operations.

As part of the standard plans and specifications for the project, USACE has agreed to implement the NMFS "Sea Turtle and Smalltooth Sawfish Construction Conditions," as detailed above in the section discussing sawfish. Additionally, the USACE will include all terms and conditions from the SARBO (NMFS1997) regarding vessel lighting and sea turtles, including the following:

> "From May 1 through October 31, sea turtles nesting and emergence season, all lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nm of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with USCG and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches."

As part of this effort, the USACE conducts lighting surveys of the contractor's dredges when they arrive on site, and require the contractor to meet all USCG and/or OSHA requirements. This process will be adhered to for the Port Everglades project. As stated by USFWS in the CAR, the Port is an active facility, offshore lighting is not an unusual feature of the area, and should not appreciably change the ambient conditions for free-swimming turtles in the vicinity of the project. In addition, all construction/dredging vessels are required to adhere to best management practices, such as preventing lights from exposure to shore through use of shields. Therefore, no adverse indirect impacts to free swimming sea turtles due to lighting associated with dredging operations are anticipated for the proposed project.

The highest potential impact to sea turtles may be the use of explosives to remove areas of rock within the Port. It has been documented that the pressure and noise associated with unconfined blasting can physically damage sensory mechanisms and other physiological functions of individual sea turtles (Keevin and Hempen 1997). Impacts associated with blasting can be broken into two categories: direct impacts and indirect impacts.

Direct Impacts. To-date, there has not been a single comprehensive study to determine the effects of underwater explosions on reptiles that defines the relationship between distance/pressure and mortality or damage (Keevin and Hempen 1997). However, there have been studies, which demonstrate that sea turtles are killed and injured by underwater explosions (Keevin and Hempen 1997). Sea turtles with untreated internal injuries would have increased vulnerability to predators and disease. Nervous system damage was cited as a possible impact to sea turtles caused by blasting (U.S. Department of Navy 1998 as cited in USACE 2000b). Damage of the nervous system could kill sea turtles through disorientation and subsequent drowning. The Navy's review of previous studies suggested that rigid masses such as bone (or carapace and plastron) could protect tissues beneath them; however, there are no observations available to determine whether the turtle shells would indeed afford such protection. Studies conducted by Klima *et al.* (1988) evaluated unconfined blasts of only approximately 42 pounds on sea turtles (four ridleys and four loggerheads) placed in surface cages at varying distances from the explosion. Christian and Gaspin's (1974) estimates of safety zones for swimmers found that, beyond a cavitation area, waves reflected off a surface have reduced pressure pulses; therefore, an animal at shallow depths would be exposed to a reduced impulse. This finding, which considered only very small-unconfined explosive weights, implies that the turtles in the Klima *et al.* (1988) study would be under reduced effects of the shock wave. Despite this possible lowered level of impact, five of eight turtles were rendered unconscious at distances of 229 to 915 meters from the detonation site. Unconscious sea turtles that are not detected, removed and rehabilitated likely have low survival rates. For CU blasting, these types of effects would not have occurred, due to the significantly reduced pressures associated with CU blasting. The proposed action will use CU blasts, which will significantly reduce the pressure wave strength and thus area around the discharge where injury or death may occur (Hempen *et al*. 2007). USACE assumes that tolerance of turtles to blast overpressures is approximately equal to that of marine mammals (Department of the Navy 1998 in USACE 2000b), *i.e.*, death would not occur to individuals farther than 400 feet from a confined blast (Konya 2001).

For assessing impacts of blasting operations on sea turtles, USACE relied on the previous analysis conducted by NMFS-OPR as part of their ESA consultations on the Miami Harbor GRR [NMFS Consult # F/SER/2002/01094] (NMFS 2003a); Miami Harbor Phase II project [NMFS Consult #I/SER/2002/00178] (NMFS 2002b) as well as the results from the blasting conducted at Miami, where 16 sea turtles were recorded being in the action area during the 38-days when blasting occurred, without a single stranding of an injured or dead turtle being reported (Trish Adams, USFWS pers.com, 2005; Wendy Teas, NMFS, pers.com 2005; Jordan *et al*. 2007). In both of the ESA Consultations for the two projects in Miami, with regard to impacts to sea turtles, NMFS found that "NOAA Fisheries believes that the use of the mitigative measures above in addition with capping the hole the explosives are placed in (which will greatly reduce the explosive energy released into the water column) will reduce the chances of a sea turtle being adversely affected by explosives to discountable levels." (NMFS 2002a and 2003a).Pressure data collected during the Miami Harbor project by USACE geophysicists and biologists showed that using the four zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the exclusion zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen *et al*. 2007).

Indirect Effects due to Construction. Indirect impacts on sea turtles due to dredging/blasting and construction activities in the project area include alteration of behavior. For example, daily movements of sea turtles may be impeded or altered. Based on the protective measures proposed for this project, in concert with the reduction in pressure from the blast due to the confinement of the pressure in the substrate, the impacts to sea turtles associated with blasting should be minimal.

Indirect Effects due to Removal of/Damage to Foraging Habitat and Loggerhead Designated Critical Habitat. Removal of reef associated with the OEC expansion will remove foraging habitat potentially utilized by the five sea turtle species known to use Broward County habitats. This is also a specific impact to the loggerhead designated critical habitat in unit LOGG-N-19. Based on a GIS analysis of habitat types (NSUOC & NCRI 2007), the project will remove 0.07% of the middle reef (shallow colonized pavement and linear reef middle tract) and 0.52% of the outer reef (deep colonized pavement; linear reef outer tract; spur & groove reef) foraging habitat within Broward County by expansion of the outer entrance channel (Table 22). Although NSUOC's minimum mapping unit was limited to the one-acre level, and the project impacts are assessed at a more detailed level, a more detailed assessment of all the impact categories throughout all of Broward County is not likely to change the results significantly. The removal percentages would also decrease significantly if the calculations included existing middle and outer reef habitats in the adjacent counties of Miami-Dade and Palm Beach available for sea turtle foraging. Removal of this habitat within the project footprint is relatively small in the overall county-wide assessment of available foraging habitat. Nevertheless mitigation will be provided to compensate for this loss. However, there is no guarantee that sea turtles will utilize that mitigation as foraging habitat. NOAA (in *Endangered and Threatened Species: Critical Habitat for the Northwest Atlantic Ocean Loggerhead Sea Turtle Distinct Population Segment (DPS) and Determination Regarding Critical Habitat for the North Pacific Ocean Loggerhead DPS; Final Rule*. 2014. Federal Register Vol. 79, No. 132, pp. 39856-39912) did not describe a particular habitat type associated with the nearshore reproductive habitat, so the estimated impact of the removal of the portions of the middle and outer reefs will de less when the entire geographic area of LOGG-N-19 is taken into account. The impacts associated with the expansion of the OEC are not expected to adversely modify designated critical habitat for the loggerhead sea turtle.

Turtle foraging habitats may also suffer some indirect effects, including temporary increases to turbidity and sedimentation on foraging habitat within the indirect impact zone for the project (the area within 150 meters surrounding the impact footprint). However, implementation of BMPs should reduce potential impacts, and they are not expected to be any greater than the effects of sedimentation and turbidity commonly experienced in this area due to the passage of storms (Pennekamp et al 1996).

Biological Assessment. More detailed information concerning the impacts associated with the project is available in the Biological Assessment submitted to the NMFS that is included in Appendix F. It is USACE's determination that the permanent removal of the reef habitat associated with the outer entrance channel expansion, or the utilization of a hopper dredge to construct the project may adversely affect sea turtles. All other construction methodologies and associated project components may affect sea turtles, but are "not likely to adversely affect" them. USACE requested initiation of formal consultation for the removal of the reef habitat and utilization of a hopper dredge in association with project construction. If USACE does utilize a hopper dredge, it acknowledges this could have an adverse effect and, per the requirements of the NMFS Biological Opinion, USACE will comply with the terms and conditions of the SARBO (NMFS 1997) for dredging operations. The USACE Biological Assessment is located in Appendix F. NMFS issued a biological opinion on March 7, 2014 which determined that the project may adversely affect sea turtles and provided incidental take for hopper dredging operations associated with the project.

Table 22 Sea Turtle Foraging Habitat to be Removed Due to the Recommended Plan

Position and Habitat	Parameter	Coverage (ac)*	Proportion (%)
Middle reef tract: shallow colonized pavement and linear reef habitats	Projected direct impact	5.07	-
	Total available in Broward Co.	6,383	-
	Relative impact	-	0.07
Outer reef tract: deep colonized pavement, linear reef, and spur and groove habitats	Projected direct impact	10.10	-
	Total available in Broward Co.	1,958	-
	Relative impact	-	0.52

* Acreage totals based on NSUOC & NCRI's 2007 habitat cover data and September 2014 DC&A GIS data

4.5.6 West Indian Manatee

4.5.6.1 No-Action Alternative

Under the No-Action Alternative, O&M dredging will continue to occur within the Port, as authorized under permit from FDEP and vessels will continue to call on Port Everglades. For years 2060 through 2073, in the "without-project" condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. Risk of vessel strikes may increase as more and larger vessels transit the inlet in the absence of the project. The project was analyzed under NEPA with an EA and FONSI dated April 28, 2005. In the EA, USACE determined that O&M operations "may affect, but will not adversely affect" West Indian manatees in the Port due to the incorporation of the standard manatee protection protocols. The USFWS concurred with the USACE determination that proposed maintenance dredging at Port Everglades "may affect, but is not likely to adversely affect" the endangered Florida manatee on November 29, 2004. The analysis of these effects and this concurrence are incorporated by reference into this analysis.

4.5.6.2 Recommended Plan and the National Economic Development Plan

Port Everglades has taken steps to reduce manatee-human interaction, injury, and mortalities within the Port (see list in Section 3.7.5.2). During the warmer months, manatees have been documented transiting through the IWW (SAC) from north to south using it as a "travel corridor" from Lake Worth Lagoon in Palm Beach County and Biscayne Bay in Miami-Dade County, both possessing seagrass habitats that manatees use as foraging grounds. In the colder months, high numbers of manatees aggregate at the Port Everglades and Fort Lauderdale FP&L power plants, including numerous mother/calf pairs. Deepening and widening the channels in the Port is not expected to result in any change of use by manatees in either of these capacities. No changes to

manatee/vessel interactions within the harbor are expected as a direct result of the expansion project, as no previously undredged areas utilized by manatees are being impacted and the Port continues to actively work to protect the manatees that utilize the harbor as a refuge habitat through efforts previously discussed in section 3.7.5.2. The 2060/2073 (years are not predicted to differ appreciably) the “with-project” vessel call total is estimated to be 5,061, i.e., a decrease of 191 calls compared to the “without-project” condition (Economic appendix of the Feasibility Study). The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls. Due to the widening and deepening components of the project, larger container, petroleum, bulk cargo and cruise vessels will call at Port Everglades and more tonnage will be carried per vessel call. This will be an indirect benefit to manatees, since there will be fewer ships in the area to potentially affect them. Additionally, the widened and deepened channels may provide manatees more room to maneuver around incoming and outgoing vessels throughout the action area. No changes in water temperatures within the Port are expected as a result of the dredging due to the high volume of water that transfers through the inlet on each tidal cycle which results in significant mixing of water through the column. Finally, it is anticipated that effects to manatees will not differ significantly based on which dredge depth is selected for the OEC.

As part of the ESA consultation with USFWS, USACE has agreed to incorporate the standard protection measures for all construction activities to minimize potential impacts to manatees into the project plans and specifications:

1. 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) these protected marine species. 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.
2. 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.
3. Siltation or turbidity barriers shall be made of material in which manatees and marine turtles cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee or marine turtle movement.
4. All on-site project personnel are responsible for observing water-related activities for the presence of marine turtles and manatee(s). All in-water operations, including vessels, must be shutdown if a marine turtle or manatee comes within 50 feet of the operation. Activities will not resume until the animal(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the animal(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.
5. Any collision with or injury to a marine turtle or manatee shall be reported immediately to the Florida Fish and Wildlife Conservation Commission (FWC) Hotline at 1-888-404-3922, and to FWC via e-mail at the following address: ImperiledSpecies@myFWC.com. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service (Vero Beach 1-772-562-3909). Care should be taken in handling sick or injured marine turtle specimens to ensure effective treatment and care and in handling dead marine turtle specimens to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the

responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

6. 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. Temporary signs that have already been approved for this use by the FWC must be used. One sign which reads *Caution: Boaters* must be posted. A second sign measuring at least 8½" 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. These signs can be viewed at www.MyFWC.com/manatee. Questions concerning these signs can be sent to the email address listed above.
7. A log detailing work activities, sightings, collisions, or injuries to protected marine species during the contract period shall be maintained. Within 30 days following each event, the logs and a report summarizing incidents and sightings shall be submitted to the Florida Fish and Wildlife Conservation Commission, Imperiled Species Management Section at: ImperiledSpecies@myfwc.com.
8. During construction, all project lighting shall be limited to the immediate area of active construction only and shall be the minimal lighting necessary to comply with USCG and/or OSHA requirements. Stationary lighting and all lighting on equipment shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of marine turtle nesting beaches.

Utilization of blasting as a technique to remove the rock from Port Everglades may have an effect on manatees in the area of any blasts fired. The project area is an important area for manatees, particularly in the winter, and manatees are commonly seen transiting along the IWW and it is likely that any effect on manatees outside of the proposed safety radius will be in the form of an auditory Temporary Threshold Shift (TTS). Both the pressure and noise associated with blasting can injure marine mammals.

Direct impacts on marine mammals due to blasting activities in the project area include alteration of behavior and autecology. For example, daily movements and/or seasonal migrations of manatees may be impeded or altered. In addition, manatees may alter their behavior or sustain minor physical injury from detonation of blasts outside the danger zone. Although an incidental take would not result from sound/noise at this distance, disturbances of this nature (alteration of behavior/movements) may be considered harassment under MMPA and ESA. These are special concerns related to resident populations of manatees.

Utilizing data from rock-contained blasts such as those at Miami Harbor in 2005, USACE has been able to estimate potential effects on protected species. These data can be correlated to the data from work completed for the Navy by the Woods Hole Oceanographic Institute (WHOI) (Ketten 2004), and USACE during the construction at Miami Harbor in 2005 (Hempen *et al*. 2007; and Jordan *et al*. 2007) concerning blasting impacts to marine mammals. These data indicate that impacts from explosives can produce lethal and non-lethal injury as well as incidental harassment. The pressure wave from the blast is the most causative factor in injuries because it affects the air cavities in the lungs and intestines. The extent of lethal effects are proportional to the animal's mass, *i.e.*, the smaller the animal, the more lethal the effects (Ketten 2004); therefore all data are based on the lowest possible affected mammal weight (infant dolphin). Non-lethal injuries include tympanic membrane rupture; however, given that manatee's behavior relies heavily on sound, the non-lethal nature of such an injury is questionable in the long-term. For that reason, it is important to use a limit where no non-lethal tympanic membrane damage occurs. Based on the WHOI and USACE Miami Harbor test data, the level of pressure impulse where no

lethal and no non-lethal injuries occur is reported to be 10-12 pounds per square inch of pressure in the smallest species and 20-25 psi for larger species.

Studies by Finneran *et al*. (2000) demonstrated that temporary and permanent auditory threshold shifts (TTS and PTS, respectively) in marine mammals were used to evaluate explosion impacts. Due to the fact that marine mammals, particularly dolphins and manatees (Dr. John Reynolds, pers com., 2008; Reynolds 2003a), are highly acoustic, such impacts in behavior should be taken into account when assessing harmful impacts. While many of these impacts are not lethal and this study has shown that the impacts tend not to be cumulative, significant changes in behavior could constitute a "take" under the MMPA and the ESA.

By utilizing the confined blasting technique that was used and studied at Miami Harbor in 2005, the blasting will result in the maximum pressures from the confined shot being significantly lower than open-water shot pressures at the same charge weight. Radiation of the wave energy into rock reduces the available energy to reach the water column (Hempen *et al*. 2007). The pressures entering the water column are well below those pressures that typically propagate away from open-water (unconfined by solid media that may radiate the energy away with less harm) charges relative to charge weight per delay.

In addition to reducing the pressure wave by confining the blasts in rock, by putting in place a series of protective zones around the blast array and monitoring the area for the presence of protected species, including the Florida manatee, USACE does not believe that any manatee will be injured or killed by the blasting activities. Hempen *et al*. (2007) also demonstrate that the pressure data collected at Miami Harbor showed that using the four zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the safety zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen *et al*. 2007, Jordan *et al* 2007). However, to ensure that the project was being very conservative in estimation of effects to listed species, USACE assumed that the proposed action may harass manatees by causing a TTS. As a result of this assumption, USACE consulted with USFWS under the ESA and MMPA for potential effect to the species. As part of the consultation, USACE agreed not to conduct blasting operations during the winter months (November 15 to March 15) when manatee populations are expected to be at their highest concentration in the action area. More detailed information concerning the impacts associated with the project is available in the Biological Assessment submitted to the USFWS that is included in Appendix F. It is USACE's determination, that while the project may affect manatees under USFWS' jurisdiction, the project is "not likely to adversely affect" them, and USACE requested that USFWS concur with that determination. The USFWS has concurred with the USACE's determination of "may affect, not likely to adversely affect". This determination can be found in the Fish and Wildlife Coordination Act Report completed for this project located in Appendix G.

4.5.7 Bottlenose Dolphins

4.5.7.1 No-Action Alternative

Under the No-Action Alternative, O&M dredging operations would continue in Port Everglades Harbor and vessels will continue to call at Port Everglades. For years 2060 through 2073, in the "without-project" condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. In the 2005 EA for Ongoing O&M Dredging at Port Everglades (USACE 2005), USACE determined "The proposed dredging is not expected to have any negative effect on dolphins that inhabit the waters in the Port. The dolphins

that transit through the Port are acclimated to large vessels and a large amount of vessel traffic." USACE concludes this determination of effect remains valid for the No-Action Alternative and incorporates it by reference.

4.5.7.2 Recommended Plan and the National Economic Development Plan

Other than the effects of CU blasting, the remaining construction activities associated with the expansion of Port Everglades would result in no additional effect on the bottlenose dolphins in the vicinity because these animals, which transit through the Port, are familiar with large vessels operating in a largely urban waterway. It is anticipated that effects to dolphins will not differ based on which dredge depth is selected for the OEC.

The use of blasting to expand the Port may have an effect on dolphins that are in close proximity to any blasts fired to crack rock. Although there have been very few sightings of dolphins in the boundaries of the Port, or in Broward county inland waters, it is likely that any effect on dolphins outside of the proposed safety radius will be in the form of a TTS. Both the pressure and noise associated with blasting can injure marine mammals.

As with manatees, direct impacts on dolphins due to blasting activities in the project area include alteration of behavior. For example, daily movements and/or seasonal migrations of dolphins may be impeded or altered. Although incidental take would not result from sound/noise outside of the CU blast danger zone, disturbances of this nature (alteration of behavior/movements) are considered harassment under MMPA. It is anticipated that effects to dolphins will not differ based on which dredge depth is selected for the OEC.

Utilizing data from rock-contained blasts such as those at Miami Harbor in 2005, USACE has been able to estimate potential effects on protected species. These data can be correlated to the data from work completed for the Navy by the Woods Hole Oceanographic Institute (WHOI) (Ketten 2004), and USACE during the construction at Miami Harbor in 2005 (Hempen *et al*, 2007; Jordan *et al.* 2007) concerning blasting impacts to marine mammals. These data indicate that impacts from explosives can produce lethal and non-lethal injury as well as incidental harassment. The pressure wave from the blast is the most causative factor in injuries because it affects the air cavities in the lungs and intestines. The extent of lethal effects are proportional to the animal's mass, *i.e.*, the smaller the animal, the more lethal the effects (Ketten 2004); therefore all data are based on the lowest possible affected mammal weight (infant dolphin). Non-lethal injuries include tympanic membrane rupture; however, given that dolphin's behavior relies heavily on sound, the non-lethal nature of such an injury is questionable in the long-term. For that reason, it is important to use a limit where no non-lethal tympanic membrane damage occurs. Based on the WHOI and USACE Miami Harbor test data, the level of pressure impulse where no lethal and no non-lethal injuries occur is reported to be 10-12 pounds per square inch of pressure in the smallest species and 20-25 psi for larger species.

Studies by Finneran *et al.* (2000) showed that TTS and PTS in marine mammals were used to evaluate explosion impacts. Due to the fact that marine mammals are highly acoustic, such physiological impacts should be taken into account when assessing harmful impacts. While many of these impacts are not lethal and this study has shown that the impacts tend not to be cumulative, significant changes in behavior could constitute a "take" under the MMPA.

By utilizing the confined blasting technique that was used and studied at Miami Harbor in 2005, the blasting will result in the maximum pressures from the confined shooting being significantly lower than open-water shot pressures at the same charge weight. Radiation of the wave energy

into rock reduces the available energy to reach the water column (Hempen *et al*. 2007). The pressures entering the water column are well below those pressures that typically propagate away from open-water (unconfined by solid media that may radiate the energy away with less harm) charges relative to charge weight per delay.

In addition to reducing the pressure wave by confining the blasts in rock, by putting in place a series of protective zones around the blast array, and monitoring the area for the presence of protected species, including bottlenose dolphins, USACE does not believe that any dolphin will be killed or injured. Hempen *et al*. (2007) also demonstrate that the pressure data collected at Miami Harbor showed that using the three zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the safety zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen *et al*. 2007, Jordan *et al.* 2007). However, to ensure that the project was being very conservative in estimation of effects to listed species, USACE assumed that the proposed action may harass dolphins by causing a TTS. As a result of this assumption, USACE will submit a request for an IHA from the NMFS during the PE&D portion of the project. Section 101 (a)(5) of the MMPA allows the incidental (but not intentional) taking of marine mammals upon request if the taking will (1) have a negligible impact on the species or stock(s); and (2) not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses. USACE concludes that causing a TTS in an individual dolphin near a confined blast meets these criteria.

4.5.8 North Atlantic Right Whale

4.5.8.1 No-Action Alternative

Under the No-Action Alternative, O&M dredging operations would continue in Port Everglades Harbor and vessels will continue to call at Port Everglades. For years 2060 through 2073, in the “without-project” condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. In the 2005 Environmental Assessment for ongoing O&M dredging at Port Everglades (USACE 2005), USACE did not specify any whale species for analysis of effects in association with O&M dredging. In the EIS prepared by USEPA for the designation of the Port Everglades ODMDS, NMFS determined "that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities" (USEPA 2005). Additionally, in their final publication of the "speed rule" (NMFS 2008e), NMFS did not require vessels transiting to and from any harbor south of Port Canaveral (located 195 miles north of Port Everglades) to observe a 10-knot speed between 15 November and 15 April based on the "The timing, duration, and geographic extent of the speed restrictions were tightly constricted to reflect right whale movement, distribution, and aggregation patterns to minimize potential impacts to ship operations." As NMFS has previously stated that dredge disposal operations off of Port Everglades are unlikely to adversely impact listed whales off of Port Everglades and has not determined there are sufficient NARW off of Port Everglades between 15 November and 15 April (when NARW are most likely to be in the SE Atlantic) to warrant speed restrictions for vessel operations in the area, USACE concludes that the determination in the O&M EA remains valid for the No-Action Alternative and incorporates it by reference.

4.5.8.2 Recommended Plan and the National Economic Development Plan

Under the Recommended Plan, construction dredging and disposal in the Port Everglades ODMDS would take place in the inner Harbor and the OEC. For the ESA consultation for the designation of the Port Everglades ODMDS by USEPA, NMFS determined "that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities" (USEPA 2005). Additionally, in their final publication of the "speed rule", NMFS did not require vessels transiting to and from any harbor south of Port Canaveral (located 195 miles north of Port Everglades) to observe a 10 knot speed between 15 November and 15 April based on the "timing, duration, and geographic extent of the speed restrictions were tightly constricted to reflect right whale movement, distribution, and aggregation patterns to minimize potential impacts to ship operations" (NMFS 2008e). USACE does not anticipate that potential impacts to whales would differ based on which dredge depth alternative is selected for the OEC.

There have been two documented sighting of North Atlantic right whales (NARWs), as well as three additional NARW documented north of Port Everglades in Palm Beach County since sighting data collection began in 1989. USACE concludes that based upon NMFS' previous determinations, the NARW is so rare in South Florida that it is not expected to be in the project area during construction. However, if a NARW is sighted in the area during construction, or noted to be approaching the project area by the Right Whale Early Warning System or any other sighting method, protective measures will be implemented including cessation of blasting operations until the whale has been documented as leaving the project vicinity. Dredging and disposal activities may continue, however with significant attention paid to the whale's location and activities, similar to the mode of operation that USACE uses when it dredges in NARW critical habitat in Jacksonville and Fernandina Harbors during NARW calving season (November 15 - April 15).

Because NMFS (1) has previously stated that dredge disposal operations off of Port Everglades are unlikely to adversely impact all listed whales off of Port Everglades (USEPA 2005) and (2) has not determined there are sufficient NARW off of Port Everglades between November 15 – April 15 (when NARW are most likely to be in the waters off of southeast Florida) to warrant speed restrictions for vessel operations in the area, USACE concludes that the determination in the O&M Environmental Assessment remains valid for the No-Action Alternative and incorporates it by reference. Additionally, in the Miami Harbor Expansion Biological Opinion for activities similar to those proposed here and 25 miles south of this project, NMFS made a no effect determination for the NARW (NMFS 2003a). Hence, USACE determines (as seen in the Biological Assessment submitted to NMFS under the ESA, Appendix F) that the potential impacts to NARW from the project are so unlikely as to be discountable. NMFS concurred with that determination in the March 7, 2014 project biological opinion.

4.5.9 Sperm, Humpback, Sei, Blue, and Fin Whales

4.5.9.1 No-Action Alternative

Under the No-Action Alternative, O&M dredging operations would continue in Port Everglades Harbor and vessels will continue to call at Port Everglades. For years 2060 through 2073, in the "without-project" condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. In the 2005 EA for ongoing O&M dredging at Port Everglades (USEPA 2005), USACE did not single out any specific whale species

for analysis of effects in association with O&M dredging. In the EIS prepared by USEPA for the designation of the Port Everglades ODMDS, NMFS determined "that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities" (USEPA 2005). As NMFS has previously stated that dredge disposal operations off of Port Everglades are unlikely to adversely impact listed whales, including the sperm whale, off of Port Everglades, USACE concludes that the determination in the O&M EA remains valid for the No-Action Alternative and incorporates it by reference.

4.5.9.2 Recommended Plan and the National Economic Development Plan

Under the Recommended Plan, dredged material from the inner harbor and the OEC would be disposed in the Port Everglades ODMDS. In the EIS prepared by USEPA for the designation of the Port Everglades ODMDS, NMFS determined “that adverse impacts were unlikely to occur to the shortnose sturgeon, smalltooth sawfish, or any of the whale and turtle species listed above as a result of project activities” (USEPA 2005). USACE does not anticipate that potential impacts to whales would differ based on which dredge depth alternative is selected for the OEC.

NMFS has previously stated that dredge disposal operations off of Port Everglades are unlikely to adversely impact all listed whales off of Port Everglades (USEPA 2005). Sperm, humpback, sei, blue, and fin whales are rarely seen inshore of the three reefs in the nearshore waters where the project will be constructed, and they are not expected to be in the project area during construction. However, if a whale is sighted in the area during construction, protective measures would be implemented including cessation of blasting operations until the whale has been documented as leaving the project vicinity.

For years 2060 through 2073, in the “without-project” condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals (Economic appendix of the Feasibility Study). The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo resulting in a decrease in overall vessel calls. Due to the widening and deepening components of the project, larger container, petroleum, bulk cargo and cruise vessels will call at Port Everglades and more tonnage will be carried per vessel call. This will be an indirect benefit to the sperm, humpback, sei, fin, and blue whales since there will be fewer ships in the area to potentially affect them.

In the Miami Harbor Expansion Biological Opinion, which addressed impacts for activities similar to those proposed in the Recommended Plan, NMFS made a no effect determination for the sperm, humpback, sei, fin, and blue whales (NMFS 2003a). The Miami work is being conducted 25 miles south of Port Everglades. USACE made a determination that the project “may affect, but was not likely to adversely affect” sperm, humpback, sei, fin, and blue whales and requested that NMFS concur with that determination (Appendix F). NMFS concurred with that determination in the March 7, 2014 project biological opinion.

4.5.10 Staghorn and Elkhorn Corals

4.5.10.1 No-Action Alternative

The No-Action Alternative would have no effect on staghorn and elkhorn corals because after three separate survey efforts from 1999 through 2011, no elkhorn or staghorn corals have been documented in the channel,existing reefs, or on the channel walls. Additionally, the channel was

excluded from designated critical habitat; as a result, there will be no adverse modification of designated critical habitat with O&M dredging activities.

4.5.10.2 Recommended Plan and the National Economic Development Plan

4.5.10.2.1 Introduction

The Port Everglades *Acropora* survey area included the direct footprint and indirect impact area (out to 150 meters away from the proposed channel limits). As of the writing of this document, no colonies of *A. palmata* have been documented within the vicinity of the existing channel. In addition, to date, no *A. cervicornis* colonies have been identified within either the direct or indirect impact areas within the proposed project area (DC&A 2009, USN 2011). *Acropora cervicornis* colonies are known to exist in the vicinity of Port Everglades in the following locations: approximately 500 feet south of the Port entrance channel; in near shore hardbottom areas; and 1,400 feet north of the existing OEC on the inner reef tract (DC&A 2010b; NSUOC 2008; USN 2011). These locations are outside both the direct impact project footprint and the indirect impact assessment area (i.e., within 150 meters of the proposed footprint).

The previous survey efforts conducted by USACE (2010, 2006, and 2001), as well as surveys conducted by other entities (see Broward County 2001, Gilliam *et al* 2004, and USN 2011) have not documented any acroporid corals. While the acroporid species are exceedingly rare in the waters adjacent to the project area, it is certainly possible that all of these combined survey efforts may have missed some small isolated or ephemeral acroporid colonies. If any of these potential acroporid corals are encountered at a later date, in the proposed footprint or nearby, they may be impacted, and hence, USACE recognizes that the effects would need to be addressed.

USACE initiated consultation under the ESA with NMFS regarding the potential effect of the proposed project on threatened *A. palmata* and *A. cervicornis* in June 2005, and reaffirmed that determination in a October 18, 2006 letter with a finding of “may affect, not likely to adversely affect”. In September 2011, USACE combined all previous ESA consultations on acroporid corals and designated critical habitat into one assessment, and submitted to NMFS with a continuing determination that the project “may affect, but is not likely to adversely affect” the species and will not adversely modify designated critical habitat for either species”. The Biological Assessment is located in Appendix F. NMFS determined that the project as proposed may adversely affect acroporid corals and designated critical habitat and provided incidental take in the March 07, 2014.

4.5.10.2.2 Direct Impacts

Hopper Dredging. If sandy material comprises the sea floor in the OEC, the contractor may utilize a hopper dredge to remove the sand overburden. This material will be placed in the ODMDS. No direct impacts (breakage, removal, or direct burial of *Acropora sp.*) are anticipated from hopper dredging activities associated with the sand removal operations, since the hopper dredge will not leave the channel and there are no known *Acropora spp.* in the federal channel or on the channel walls. The hopper dredge locations will be monitored at all times via the Data Quality Management (DQM) system, which includes a dredge and scow tracking function. If the dredge leaves the channel, USACE will be able to determine when and where this occurred and the area can be surveyed immediately for any potential damage or adverse effects. No direct impact to designated critical habitat located north or south of the entrance channel is expected to occur.

The channel walls and bottom are not designated critical habitat (NMFS, 2008b) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c)(2).

Clamshell or Backhoe Dredging. Clamshell dredging environmental impacts in unconsolidated sediment include resuspension of sediments when the clamshell drops to the bottom and as material washes from the bucket as it rises through the water column. Operational controls such as reducing the bucket speed as it drops to the bottom and as it rises through the water column will reduce impacts, as will use of a closed bucket system.

Backhoe marine excavator dredging environmental impacts in unconsolidated sediment are similar to those of a clamshell dredge, as are the operation controls to reduce that impact. The key is slowing the movement of the bucket through the water. Environmental impacts are significantly less for a backhoe marine excavator dredge removing fractured (blasted) rock as the volume of fine grained sediment is significantly less in fractured rock than unconsolidated sediment and as a result the potential for sediment resuspension is reduced. The same operational controls can be applied to fractured rock as unconsolidated sediment, basically slowing the bucket's speed in the water.

The clamshell and backhoe dredges will "spud down" in the channel proper, and as such, have no direct impacts to hardbottom outside of the channel where *Acropora sp*. may be located. No direct impact to designated critical habitat located north or south of the entrance channel is expected to occur. The channel walls and bottom are not designated critical habitat (NMFS, 2008b) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c)(2).

Cutterhead Dredging. Environmental impacts from cutterhead dredges include localized suspended sediment along the bottom of the excavation site around the cutterhead and fine-grained sediment turbidity plumes from barge overflow or pipeline leaks. This can be reduced or eliminated by restricting the amount of overflow time, eliminating barge overflow, and performing regular inspections of the floating pipeline. Locating barges the furthest possible distance from resources can further reduce environmental impacts. The most significant impact associated with dredging the entrance channel is the permanent removal of 14.62 acres of the middle and outer reefs to create the entrance channel flare as identified as a need for vessel safety due to the variable and unpredictable cross currents that are a result of eddies spinning off of the Gulf Stream located just offshore of the entrance channel as documented by Martinez-Pedraja, *et al.* (2004) and the National Ocean Service (NOS 2010 *Coast Pilot*). Due to the increased size of the ships arriving at the Port, these cross currents can prove extremely unpredictable and may cause the ship to run aground on either side of the entrance channel.

Deepening of the entrance channel and dredging the flare is not expected to impact any biological functions of acroporid corals (feeding, breeding, settling, etc). Concern has been expressed that deepening the existing channel and dredging the flare in the outer reef may create a "sink" that fragments of acroporid corals could fall into and not escape, thus creating a physical blockage to fragments of acroporid corals moving north with the currents, thus hindering reproduction. USACE has reviewed the available information regarding acroporid life history strategies and the known locations of *Acropora spp*. throughout south Florida, specifically focusing on colonies in the vicinity of the entrance channels, and find this concern to be unwarranted. USACE has been unable to locate any research studies, monitoring reports or other publications that discuss this issue in any detail specific to *Acropora* species. There are 14 deepwater navigation channels; three of which are currently slated to be deepened in the next 2-10 years located within Designated Critical Habitat (DCH). This issue was not identified in the pending draft Recovery Plan for *Acropora* spp. (NMFS 2014a) (that USACE reviewed as part of

the recovery plan development team) as a potential hindrance to species recovery. USACE was able to determine that there are two deepwater entrance channels within 25 miles of each other within DCH for acroporid corals: Miami Harbor and Port Everglades, both of which have been dredged to 45 feet. Miami was initially constructed late in 1905, and Port Everglades was originally constructed in 1927. Miami was deepened to its current depth with deepening resulting in all three offshore reefs being cut, in 1991 and Port Everglades was deepened to -45 feet and widened from 300 feet to 500 feet in 1981. *A. cervicornis* has been documented at Miami Harbor on the southern edge of the entrance channel and additional colonies have been documented on the northern side of the channel, within 200-feet of the channel edge (DC&A 2010a; DERM 2008), unlike Port Everglades where the closest documented colonies of *A. cervicornis* are 2,780 feet to the south of the channel and 1,400 feet north of the channel by USACE surveys, a survey conducted by the Navy in 2011 documented *Acropora cervicornis* on the first reef, south of the channel approximately 450 feet from the channel. Neither channel has *A. palmata* documented as being in close proximity. Since the early 1980s, *A. cervicornis* has been documented as expanding its range northward through Broward County and into Palm Beach County (Vargas-Angel *et al.* 2003, Precht and Aronson 2004), into areas previously documented as being devoid of acroporid corals in the 1970s, 1980s, and even the 1990s and early 2000s, or where acroporid corals were documented as being rare (*A. cervicornis*) or absent (*A. palmata*) (Goldberg 1973).

As is similar to the case above, the first observations of living *A. palmata* were made on the reefs of the Flower Gardens Banks (FGB) in 2003 and 2005 (Zimmer *et al*. 2006). These discoveries were also the deepest records of extant *A. palmata*, at water depths down to 23 m. The FGB are located more than 690 km from the nearest emergent reefs dominated by *Acropora* (Jordan-Dahlgren and Rodriguez-Martinez 2003; Schmahl *et al*. 2008). Ocean current models indicate that the reefs in the southern GOM are the most likely sources of larval immigration to the FGB (Bright *et al*. 1984; Lugo-Fernández, 2006); however, larval supply from the Meso-American reef tract, Cuban reefs, and the Florida reef tract are also possible (Rezak *et al*. 1990; Biggs, 1992; Lugo-Fernández *et al*. 2001; Lugo-Fernández 2006; Johns and Lamkin 2008). Initial results of genetic analysis reveal that the source of the recent *A. palmata* colonies is the western Caribbean (Iliana Baums, unpublished data 2012). No further subdivision of the western Caribbean population is apparent and thus more precise assignment to potential source locations is presently not possible (Baums *et al*. 2005, 2006). One of the most important aspects of the discovery of living acropoid corals at the FGB is the implication that viable *A. palmata* larvae had to be competent for sufficiently long durations allowing them to recruit to the surfaces of the reef caps, wherever their source locations were. The same can be said for the *Montastraea annularis* species complex, which also broadcasts its gametes into the water column and is presently the dominant species at the FGB (Szmant and Meadows 2006). Hence, in addition to temperature, dispersal and larval duration may help explain the ranges of these corals in time and space (Davis *et al*. 1998; Mora *et al*. 2003).

There are several natural breaks in the 2nd and 3rd reefs located between the Miami and Port Everglades channels, including one in the third reef that is more than 1,000 meters wide located more than eight km south of Port Everglades and *Acropora cervicornis* has been located north of this natural break on the third reef. Since acroporid species reproduce predominately through fragmentation (NMFS 2005a) and there are natural breaks in the 2nd and 3rd reefs located between the Miami and Port Everglades entrance channel more than seven times wider than the cut proposed for the channel extension (500 feet/ 0.15 km), USACE concludes that *Acropora sp.* corals are capable of reproducing over large geographic area as demonstrated by the FGB *Acropora*, and that these dredged channels that are narrower in width than natural breaks in the reefs have not previously hindered, nor will they hinder in the future after deepening, the continued ability of fragments of acroporid coral species to migrate northward and continue to expand the species range in southeast Florida, as habitat conditions warrant.

Incidental Impacts due to Cutterhead Dredge Equipment. Anchors are placed to both sides of the dredge to provide the ability to swing the cutterhead dredge. The anchors are placed using a crane on a workboat. If traditional cutterhead dredging is used with unrestricted anchor/cable placement as a construction method to deepen the entrance channel, additional direct impacts to both low relief and high relief hardbottom reefs would occur due to anchoring and cable systems for the cutterhead vessel. If the selected contractor uses the worst-case anchor-cable setup, the anchors will be placed at the apex of each triangle approximately 150 feet from the channel edge and a cable brought back to the dredge. This cable will move along the bottom as the dredge moves forward until it reaches the apex of the triangle. At that time, the anchor would be relocated and the process repeated. Figure 76 provides a worst-case scenario of potential hardbottom impacts with this construction method. The potential exists for up to approximately 17.13 acres of all reef habitat types (inner, middle and outer) as well as nearshore hardbottom and rubble zones to be impacted based on the maximum number of anchor positions with any impacts to hardbottom or coral habitats (A total of 69 anchor placement sites with 54 placed in coral/hardbottom environments), and footprint of cable movement (0.32-acre/anchor site). The number of anchor sites and the distance of the anchor from the channel edge, thus the length of cable, may increase or decrease, dependent upon what equipment type and size contractors propose.

Implementation of an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat will be required to be submitted by the contractor under the contract specifications. USACE has invited all federal, state and local resource agencies, including NMFS-OPR, to have staff present in Jacksonville as non-voting advisors to the Source Selection Team during contract bid package evaluation. The advisors must be physically present in Jacksonville, sign a non-disclosure agreement and pay for the per diem and labor costs associated with their participation. Potential ideas provided by coordination with DERM (2003), dredging companies, and other consultants that would probably appear in contractor proposals for evaluation during the RFP process include:

- Use of surge buoys along the anchor cable to help lift it up off the reef areas during dredging operations to minimize the area impacted by the anchor cable; reviewing an assessment of the impacts associated with the 1991 deepening at Miami Harbor where anchors and cables were used in concert with surge buoys, the impact of placement and utilization of each anchor was 0.02 acres. If a contractor proposes a similar method as was used in 1991 during the RFP process, the impact per anchor site would be decreased by approximately 93%.
- Restricted anchor placement, which restricts placement of the anchors for the cutter-suction dredge to within the channel edge limits. That method reduces impacts but almost doubles dredging time since only half of the channel can effectively be dredged at a time.

Rock Pre-treatment/ Confined Underwater Blasting. A literature review of the effects of open-water blasts on invertebrates (including corals and *Millepora sp*.) by Keevin and Hempen (1997) states the following:

> "The results of all the studies reviewed indicate that invertebrates are insensitive to pressure related damage from underwater explosions. This may be due to the fact that all the invertebrate species tested lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates. Underwater explosion produce a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs. In fish, the swim bladder, a gas-

containing organ, is the most frequently damaged organ (Christian 1973; Faulk and Lawrence 1973; Kearns and Boyd 1965; Linton *et al*. 1985a; Yelverton *et al*. 1975). It is subject to rapid contraction and overextension in response to the explosive shock waveform (Wiley *et al*. 1981). Species lacking swim bladders or with small swim bladders are highly resistant to explosive pressures (Aplin 1947; Fitch and Young 1948; Goertner 1994). For example, Wiley *et al*. (1981) and Goertner *et al*. (1994) noted that hogchokers (*Trinectes maculatus*), which lack swim bladders, were extremely tolerant of underwater explosions, and greatly exceeded the tolerance of any species with swim bladders that they had tested. Goertner *et al*. (1994) found that hogchokersa were not killed beyond a distance of one meter from a 4.5 kg charge of pentolite.

"Gas-containing organs have also been implicated as a causative factor of internal damage and mortality in other vertebrate species exposed to underwater explosions. Sailors exposed to depth charges and torpedo explosions, while escaping their sinking ships during World War II, suffered damage to gas-containing organs (Cameron *et al*. 1944; Ecklund 1943; Gage 1945; Palma and Uldall 1943; Yaguda 1945). The lungs, stomach, and intestines, all gas-containing organs, were ruptured or hemorrhaged, while other organs were relatively unaffected. Similar results have been observed in underwater explosion tests with other mammalian species (Richmond *et al*. 1973)."

Based on the fact that acroporid corals are invertebrates, and lack gas containing organs like swim bladders, lungs, etc., and that no acroporid corals have been documented in the channel proper (either on the walls or in the bottom), USACE concluded that pre-treatment of hard rock in the outer entrance channel with confined blasting would not have any impact on acroporid corals. Planes *et al.* (2005) demonstrated this by showing that when shock waves from nuclear testing extirpated the reef-fish assemblages of Mururoa Atoll in French Polynesia, the living coral assemblages remained entirely intact. NMFS concurred with this determination in the September 2011 Biological Opinion issued for the expansion of Miami Harbor where *Acropora cervicornis* has been documented directly adjacent to the channel.

Additionally, the USACE will be conducting sedimentation and turbidity monitoring in the project area, adjacent to the blast sites that will detect any potential effects of blasting on small acroporid colonies discovered during pre-construction surveys, yet not transplanted out of the project area before construction due to size. This data will be recorded and could be utilized by NMFS and USACE for future consultations where pre-treatment of hard rock is needed throughout the range of acroporid corals.

4.5.10.2.3 Indirect Impacts

Although there is published literature concerning the effects of sedimentation and turbidity on coral reefs throughout the world, there is a paucity of peer reviewed published data specific to the recent dredging events that have taken place in southeast Florida. There are numerous published papers specific to Caribbean coral reefs that in context can be applied to corals in Florida (Rogers 1983; Rogers 1990; Dodge and Vaisnys 1977, Bak 1978). However, peer-reviewed literature specific to monitoring of dredging projects in south Florida is very limited. USACE reviewed four monitoring reports and two peer reviewed studies from recent projects in documented *Acropora* habitat between 1980 – 2007 where sedimentation and turbidity data were collected not only at sites adjacent to the channels or borrow sites, but also from background sites so that potential indirect impacts associated with dredging could be detected in addition to background impacts from natural events.

The four projects that were reviewed were: (1) Port Everglades entrance channel widening and deepening project conducted in 1980-1981; (2) Broward County Shore Protection Project conducted in 2005; (3) Key West Harbor O&M dredging 2004-2006 and (4) Key West Harbor O&M dredging 2007 (Jordan *et al*. 2010; Gilliam *et al*. 2006; Fisher *et al.* 2008; CSA 2007; and CSA 1981). These projects utilized cutterhead, hopper, and clamshell dredges (or a combination thereof) for their operations. To further inform potential impact-reduction methods, BMPs, monitoring protocols, and mitigation feasibility, and results from the recent Miami Harbor project (discussed above in Section 4.4.2.2) will be considered during the PED phase of the Port Everglades project.

From a turbidity and/or sedimentation standpoint, a hopper dredge has the highest likelihood of adverse effect due to the overflow of water being returned from the hopper to the surrounding environment. With this overflow, "fines" (usually clays or silts which are light enough not to have settled out in the hopper) are returned to the water during dredging operations. The clamshell or bucket dredge ranks second since the material may or may not be enclosed in a bucket, and if it is not enclosed, material may escape that bucket into the surrounding environment. The dredging method with the lowest level of associated sedimentation or turbidity is the cutterhead dredge. This dredge has suction that removes the sediment, transports it to the surface where it is either pumped into the receiving disposal site, or placed in a scow for transport to a disposal site. The Key West O&M projects in 2004-2006 and 2007 utilized both a clamshell dredge and a hopper dredge. The Broward County Shore Protection Project utilized a hopper dredge and the Port Everglades expansion project in 1980 utilized a cutterhead dredge. Understanding which types of equipment were utilized allows for a comparison across projects of results regarding turbidity and/or sedimentation monitoring.

A review of these four projects found that using BMPs for turbidity and sedimentation control (e.g. ceasing dredging when turbidity levels exceed permitted standards) are protective of the coral and hardground environments surrounding south Florida sand borrow sites and navigation channels. Impacts associated with storms can have sedimentation rates in excess of 400 times those seen with a dredging project. The following information is provided from the Key West Harbor O&M project. (CSA 2007):

> "Average daily sedimentation rates at the monitoring sites fluctuated based on weather conditions and ambient suspended sediment load in the surrounding waters. This was especially evident during periods of winter cold-front activity during November 2005 and January 2006, with associated rough seas and high turbidity. During these periods, average daily sedimentation rates were more than twice as high as during the previous November and January, and up to 25 times above levels observed during June 2004 at several sites. The passage of hurricanes during August and September of 2004 and July, September, and October of 2005 provided the most dramatic increase in levels of sediment re-suspension... Average daily sedimentation rates at several of the Hawk Channel seagrass sites and the bank reef sites were up to 400 times higher than levels noted during June 2004. Following Hurricane Dennis in July 2005, nearly every sediment trap site had at least a ten-fold increase in the average daily sedimentation rate compared to the previous month.
>
> "Site BP-41, a bank reef monitoring site adjacent to the Main Ship Channel, had an average daily sediment deposition rate of 18 $mg/cm^2/day$ for August 2005, while in the following month when Hurricanes Katrina and Rita impacted the area, the average daily sediment deposition rate recorded in the traps increased to 1,219 $mg/cm^2/day$, 67 times the previous month's level. For Site SP-37, a seagrass site located adjacent to the Main Ship Channel, there was an increase in average daily sediment deposition rate during this

same period from 14.4 mg/cm^2/day up to 3,529.7 mg/cm^2/day, 245 times the August levels."

Additionally, Gilliam *et al.* 2010 and Fisher *et al.* 2011, found there to be no detectable impacts to corals living on the hardgrounds adjacent to the borrow areas utilized for the Broward County shore protect project. While the Key West and Broward County projects were required by regulatory permit to maintain a lower turbidity threshold (15 NTUs), a review of the monitoring from the Port Everglades channel widening and deepening from 1980-1981 continues this trend in showing little to no effect of dredging operations on corals adjacent to dredging areas (CSA 1981). The Port Everglades deepening project in 1980-1981 was not bound by any state or federal agency issued turbidity level that required the dredge to cease operations. USACE did monitor turbidity and sedimentation levels throughout the dredging operations, which is most similar in nature to the dredging currently proposed, and the final report for the Port Everglades deepening conducted states, "Due to the powerful suction ability of the dredge, only a small fraction of the dredged material entered the water column. No significant increase in turbidity levels was detected during daily monitoring of the dredging operations by U.S. Army Corps of Engineers environmental contractor" (CSA 1981).

The examples of the adverse effects of turbidity or sedimentation on coral species often cited by resource managers are commonly projects in third world countries without the strict water quality protections that are in place in the U.S. (Bak 1978); or are studies where the material used to simulate dredged material is not the same sediment size or mineral composition of the material proposed to be dredged (Telesnicki and Goldberg 1995) and thus are not a good substitute for the effects of projects bound by the water quality restrictions required by the State of Florida under the Clean Water Act. These restrictions are protective of water quality by limiting turbidity; they are also protective of coral species, including *Acropora* spp. and its designated critical habitat, located near dredging operations where material is being removed from the bottom by a dredge. Dredging projects take place in a spatially and temporally finite area and thus impacts associated with them, if present, should be detectable within this same finite footprint. A review of these four projects, three of them in the very recent past, demonstrates that no adverse effects of dredging were detectable (or in the case of Broward county were detectable as monitoring continues) (Gilliam *et al.* 2006; Fisher *et al.* 2011; Jordan *et al.* 2010; CSA 2007; CSA 1981).

Of the four projects, only the Key West O&M project documented any acroporid corals adjacent to dredging areas, which may be attributable the lack of focus on *Acropora* on the other (and, indeed, most) projects prior to the listing of the two species under the ESA. Between the two dredging projects in Key West, *A. cervicornis* was documented along the east side of the Key West entrance channel near station BP-41. The 2007 dredging event took approximately four months between May and August. These colonies did not show any impacts different than control corals (CSA 2007) and none of the recorded changes were attributed to the dredging.

To protect hardgrounds in project areas including those that support *A. cervicornis*, USACE requires turbidity monitoring with all of its projects. It is a standard practice for USACE to monitor sedimentation associated with dredging projects where corals and coral habitats are adjacent to the project area. This has been standard practice for more than 30 years.

In a Biological Opinion (BO) for dredging associated with sand mining (Consultation # F/SER/2009/00879), a review of effects of sedimentation associated with *A. cervicornis* was provided. NMFS (2009a) stated the following:

> "Additionally, Rogers (1983) tested sedimentation rates on *A. cervicornis*, among other coral species, and determined that daily doses of sediment at a rate of 200 mg/cm2/day had no effect (Rogers 1990)."

Given the strong similarities between the proposed action and the Key West and Port Everglades projects previously reviewed, we believe it is reasonable to assume the impacts documented at the Key West and Port Everglades sites will be similar to those likely to occur during the proposed action. Adverse affects from sedimentation are also less likely to occur in the presence of strong oceanographic currents (Rogers 1990) because sediments are swept off corals. This phenomenon was also observed at the Port Everglades project in 1980. The influence of the relatively strong Gulf Stream in the action area is also likely to reduce any adverse affects from sedimentation. Concern has been raised that USACE is utilizing data from a project (Key West) that had restrictions on the maximum allowable NTUs (15) that are lower than those that will be required for Port Everglades (29 NTU). The concern has been raised that higher turbidity values allow for higher sedimentation rates on adjacent habitats, however, the scientific literature does not support this concern. There is no direct correlation between turbidity and sedimentation rates, or between turbidity and total suspended solids that can be uniformly applied across differing projects (Davies-Colley and Smith 2001; Clarke and Wilber 2008). The effects of sedimentation are a dose-response relationship, and the results of that relationship specific to dredging projects in SE Florida has been reported here – both at the 15 NTU and 29 NTU levels, and for both levels, the effects of sedimentation, with proper *in situ* monitoring, showed no adverse effect on coral species in general (Port Everglades and Broward County), and specifically *Acropora sp.* (Key West) near dredging projects.

Additionally, in the Biological opinion for Miami Harbor (NMFS 2011), NMFS stated:

> "In addition to the amount of sedimentation, the source of sediments can affect coral growth. In a study of three sites in Puerto Rico, Torres (2001) found that low-density coral skeleton growth was correlated with increased resuspended sediment rates and greater percentage composition of terrigenous sediment. In sites with higher carbonate percentages and corresponding low percentages of terrigenous sediments, growth rates were higher. This suggests that resuspension of sediments and sediment production within the reef environment does not necessarily have a negative impact on coral growth while sediments from terrestrial sources increase the probability that coral growth will decrease, possibly because terrigenous sediments do not contain minerals that corals need to grow (Torres 2001)."

The rock being dredged at Port Everglades is high carbonate content, a majority of it being limestone from ~6,000 year old reefs offshore of Port Everglades. This means that based on Torres findings cited by NMFS, the effect of small amounts of sediments from the dredging operations that settle close to the channel on or near coral colonies may not be adverse.

Since the rates of sedimentation observed during the Key West and Port Everglades deepening monitoring were within the bounds of sedimentation documented to be occurring naturally, and those were far less than this 200 mg/cm^2/day threshold set by Rogers (1983) cited by NMFS (2009a), USACE concluded that adverse effects to *A. cervicornis* and designated critical habitat from increased sedimentation will be insignificant. This determination is consistent with NMFS' previous findings in NMFS biological opinions (2008c, 2011) for *Acropora sp*. near dredging projects.

<u>Dredged Material Disposal Impacts</u>. Potential barge environmental impacts could occur as the barge is loaded if material is allowed to spill over the sides and during transport if the barge leaks

material. Operational controls eliminate spilling material during loading by monitoring the dredge operator to make sure that the dredge bucket swings completely over the barge prior to opening the bucket. Requiring barges in good repair with new seals minimizes leaking during transport. Hauling rock is often damaging to transport barges, so intermediate inspection and repairs may be required during the project to maintain the barges in good working condition. Seals may require replacement. Proper use of the ODMDS minimizes the environmental impacts during disposal. The barges will be required to use positioning equipment to place dredged material within the designated ODMDS and inspectors may be required to monitor disposal activity. The USACE's required monitoring of vessels in ullage and location ensure that the dredged material is being disposed of in the approved location. Disposal of dredged material will have no impact on *Acropora sp*. corals or DCH. The ODMDS is not within the boundaries of DCH as the site is located offshore of Fort Lauderdale, beyond the edge of the continental shelf in greater than 500 feet of water.

Sedimentation and Turbidity Monitoring. Monitoring during construction of the Port Everglades expansion project will target several parameters and activities, including monitoring scow and dredge locations relative to reefs and other mapped resources and turbidity and sedimentation levels. Monitoring protocols will also adapt aspects from other monitoring projects previously referenced, including Key West O&M (CSA 2007); Port Everglades (CSA 1981); Broward County SPP (Gilliam *et al*. 2006 and Fisher *et al.* 2011) and the ongoing Miami Harbor deepening. USACE will develop detailed monitoring plans prior to construction with federal, state and local resource agencies, as well as the local sponsor and experts in the field of coral reef monitoring.

4.5.10.2.4 Critical Habitat

The DCH requires the presence of ''substrate of suitable quality and availability'' is equivalent to consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover as a "Primary Constituent Element" (PCE) that must be present for the physical area to be considered DCH. NMFS has not published a standard protocol for assessing the amount of "substrate of suitable quality and availability" to assess the presence of this PCE.

The proposed project's OEC component will permanently remove 14.62 acres of middle and outer reef to extend the entrance channel and create the flare. Only the top of this area is considered Designated Critical Habitat (DCH). The channel walls and channel bottom are not designated critical habitat (NMFS 2008c) since they are considered part of a "maintained channel" as detailed in 50 CFR §226.216 (c) (2). There are five hardbottom habitat types found in and adjacent to the existing federal channel and proposed extension and flare (based on NSUOC & NCRI 2007) that may be classified as designated critical habitat for acroporid species under the ESA:

- Shallow colonized pavement
- Deep colonized pavement
- Linear reef: middle tract
- Linear reef: outer tract
- Spur and groove reef: outer tract

The Florida Unit of DCH comprises 3,442 sq km. If the Recommended Plan is constructed, 0.0018% of DCH in the Florida Unit will be permanently removed by the channel extension and widening (Table 23). This percentage assumes that 100% of the substrate within the impact footprint is available for colonization: as NMFS defines it in the final rule designating critical habitat, ''substrate of suitable quality and availability'' meant consolidated hardbottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover" (73 FR 72210 –

11/26/2008). However, data show that there is 56% biotic coverage on middle reef (45% turf algae) and 73% biotic coverage on outer reef (55% turf algae) (USACE 2009). This results in only 44% of the middle reef being available for settlement of acroporid larvae and 27% of the outer reef. Therefore, given the percentage of available colonizable habitat, as defined by NMFS above, less than 0.0006% (0.02 sq km) of the Florida Unit of DCH would be permanently removed by the implementation of the Recommended Plan (Table 23). This is roughly two-thirds less than would be predicted due to on-site benthic habitat conditions.

Table 23 Relative Amount of *Acropora* spp. Habitat to be Removed from Florida-Unit Designated Critical Habitat Due to Construction of Recommended Plan

Habitat type	% of Florida Unit DCH removed by project assuming removed habitat comprised only clean, colonizable substrate*	% of Florida Unit DCH removed by project based on actual % of clean, colonizable substrate to be removed by dredging**
Middle reef	0.0005927	0.00026078 (44% available substrate)
Outer Reef	0.0011883	0.00032083 (27% available substrate)
Total	0.0017809 (0.0613 sq km)	0.00058161 (0.0200 sq km)

"Based on Florida-Unit Designated Critical Habitat comprising 3,442 sq km
**Based on *in situ* surveys

4.5.11 Corals Listed Under ESA in 2014

Stony coral species listed under ESA in 2014 include members of the *M. annularis* complex (*Montastrea annualaris* was divided into three species and the genus was changed to *Orbicella*), *D. cylindrus*, and *M. ferox*, In coral surveys conducted for the proposed navigation improvements (most recently, DC&A 2009a), *M. annularis* complex species colonies were relatively common and conspicuous, but never abundant. The implementation of the Recommended Plan is likely to result in the removal of some of these colonies during dredging. However, many of the colonies of these species will be translocated during preconstruction to mitigation/recipient sites and will provide ecological functions (including maintenance of coral genetic diversity) nearby the impact zone. No colonies of *D. cylindrus* were encountered in any of the USACE-contracted surveys in the vicinity of the project. This coral is exceedingly rare in Broward County (FWS personal communication). *M. ferox* was extremely rare; only three individual colonies were observed in the project area. These two species were not known from the impact area or were so rare in surveys that the implementation of the Recommended Plan is likely to have no effect whatsoever on the species or local populations. If the NED Plan is constructed in lieu of the Recommended Plan, slightly fewer *M. annularis* complex species colonies would be removed. These species are discussed in the ESA Section 7 consultation materials in the appendices.

4.6 Coastal Barrier Resources

There will be no impacts to coastal barrier resources under the No-Action Alternative, the NED Plan, or the Recommended Plan. However, Lloyd Beach, the landscape feature on which JUL is located, is an "Otherwise Protected Area." That management area/unit extends to the centerline of the SAC. Hence, although the beach and dune habitats (and the vast majority of upland habitats in the unit) will not be impacted by the Recommended Plan, certain resources within the unit on the leeward side of the island will be affected. Along the SAC and proposed Widener (western shoreline of JUL and properties just to the north of the park), the proposed construction will remove approximately one acre of mangrove habitat and approximately 4.0 acres of seagrass beds. Structures (bulkheads) will be constructed where these resources are removed. These will effectively prevent erosional loss of the barrier island in these areas. Furthermore, approximately two acres of developed upland property (mostly owned by the USCG) along the eastern shore of the Widener area and SAC will be removed; those facilities will be constructed to the east. Again, this action will involve the construction/replacement of bulkheads to prevent erosion of the barrier island.

4.7 Water Quality

4.7.1 Surface Water

All action alternatives would have similar impacts to water quality due to construction activities. A State Water Quality Certificate will be obtained under Section 401 of the CWA prior to construction and state water quality standards will be met during construction. The project alternatives will cause temporary increases in turbidity where dredging is taking place. The State of Florida water quality regulations require that water quality standards not be violated during dredging operations. The standards state that turbidity outside the mixing zone shall not exceed 29 NTU's above background. Various protective measures and monitoring programs will be conducted during construction to ensure compliance with state water quality standards. Should turbidity exceed state water quality standards during construction, as determined by monitoring, the contractor will be required to cease operations until conditions return to normal.

Impacts associated with disposal activities at the USEPA designated and authorized ODMDS have been reviewed and addressed in USEPA's 2005 EIS for the designation of the Port Everglades ODMDS. The USACE was a cooperating agency on the designation EIS, and hereby incorporates those analyses into this EIS (USEPA 2005). The EA for the expansion of the ODMDS includes an analysis of the effects on water quality in the ODMDS and surrounding waters. The EA states the following:

> "The selection of either alternative will have only temporary and minor impacts to water quality. During periods of dredged material disposal there will be temporary, localized increases in water column turbidity and concentrations of dissolved and particulate constituents. Dissolved oxygen concentrations may decrease in the dump plume. Chemically reduced inorganic compounds associated with particles sinking through the upper water column may be oxidized, causing a transient increase in the chemical oxygen demand. Oxidation of labile organic material may consequently reduce dissolved oxygen concentrations in the water. However, because the water column is well oxygenated, offsite impacts are not expected and any onsite impacts should be of short duration. Plumes of suspended sediments would result in increases in turbidity levels, suspended particulate concentrations, and decreased light transmittance. These effects will be

dissipated by natural dispersion, mixing, and eventual sinking of particles. Based on dispersion modeling conducted for the Port Everglades Harbor ODMDS, any temporary perturbations in water quality resulting from disposal of dredged material would be reduced to ambient or undetectable levels within a short distance of the release point (USEPA 2004)."

4.7.2 Ground Water

A survey of the Port Everglades area for municipal water supply well fields shows wells located no closer than 4 miles from the Port. A literature review shows that saltwater intrusion in the coastal areas of the Biscayne Aquifer has been observed and studied since the 1950's. These studies indicate that saltwater intrusion in this area has been caused by the construction and operation of a flood control / water supply canal network and the extraction of freshwater supplies from the Biscayne Aquifer. Dausman and Langevin (2004) speculate that the saltwater intrusion zone may still be equilibrating as a result of drainage actions taken in the 1950's. They also indicate that sea level rise will result in gradual relocation of the salinity transition zone westward though they state that it appears that the rate of movement due to sea level rise is less than that caused by construction of the drainage canal network. They estimate that sea level rise may move the saltwater intrusion zone as much as 1,500 meters westward over the next 100 years.

Deepening the Port Everglades Harbor may have some impact on the location of the freshwater/ saline water interface in the immediate vicinity of the harbor; however, the nearest municipal water supply well field is in Dania approximately four miles south of the Port. It is unlikely that deepening the Port would impact groundwater quality significantly at the Dania well field since it is located much closer to the tidal portion of the Dania Cutoff Canal which has a much greater influence on the well field's groundwater quality. Similarly, the Dixie and 3A well fields are at least five miles from the Port and also separated hydro-geologically from the Port by the South and North New River Canals.

Deepening the Port might result in periodic increases in water salinity to eastern portions of the drainage canal network that are directly connected to the Port Everglades entrance channel; however, the impact to water supplies is expected to be minimal since salinity in the canal is already well in excess of drinking water limits. For instance, at the confluence of the North and South New River Canals which is 3 miles west of the Port and east of the Dixie and 3A well fields, the salinity at this site is routinely measured as high as 10,000 mg/L chloride which is well in excess of the 250 mg/L secondary limit for drinking water. It is more likely that the projected gradual increase in sea level rise will result in more impact to canal water quality and groundwater salinity than Port deepening since the zone of impact from sea level rise is the entire coastline and tidal portion of the drainage canal network rather than a limited portion of the area effected by Port deepening.

Deepening the Port entrance offshore of the barrier island will have no impact on the freshwater / saltwater interface within the Biscayne Aquifer because the fresh groundwater does not extend eastward of the Broward shoreline at any depth within the Biscayne Aquifer. Deepening the channel offshore would increase conductivity in the vicinity of the channel cut but this is unlikely to have any measurable effect to onshore groundwater quality conditions given that the new channel depth would not change either the on-shore groundwater surface elevation or the mean sea level which together control the location of the saltwater interface.

In conclusion, the deepening of Port Everglades is likely to result in minimal impacts to groundwater quality in the immediate vicinity. Given that the aquifer within three miles of the Port

is not presently used as a public water supply source, no substantial impact to water supplies is expected to occur as a result of this project.

4.8 Hazardous, Toxic, and Radioactive Waste

None of the project alternatives is anticipated to result in increased HTRW issues within the project area.

4.9 Air Quality

4.9.1 Recommended Plan

4.9.1.1 Emission Sources

Direct emissions from construction of the proposed Port Everglades Navigation Project would be confined to exhaust emissions of labor transport equipment (on land and in water) and construction equipment (dredge, barges, tugs, etc.). As described in Section 3.11, pollutants considered in this air quality section are O_3; SO_x; VOCs; NO_x; CO; PM_{10}; and $PM_{2.5}$. Volatile organic compounds, sulfur oxides, and nitrogen oxides are precursors to ozone generation, and are generated by activities (e.g., construction and mobile source operations) associated with dredging/construction.

The marine emission estimates for the Project's temporary sources such as dredges and associated support equipment were derived from USEPA's extensive assemblage of air emission factors for various types of equipment/processes (Compilation of Air Emission Factors, AP-42, 5th Edition, USEPA 1995). The latest USEPA technical report for developing load and emission factors for large compression-ignition marine diesel engines is given in the *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data*; USEPA 420-R-00-002, published February 2000. The technical report is a review of engine and fuel usage test data from various types of marine vessels including bulk carriers, container ships, dredges, tankers, and tugboats. This report was employed in the determination of the load factors and emission factors for the various types of marine equipment that would be operational during construction of the proposed Port Everglades Recommended Plan. The marine emission factors can be found in Table 24 below.

Table 24 Marine Emission Factors

Marine Engine Emission Factors		
Pollutant	Emission Rate (g/kW-hr)	lb/hp-hr
PM	0.272	0.0004
NO_x	10.805	0.0175
NO_2	16.058	0.0260
SO_2	1.832	0.0030
CO	1.676	0.0027
VOC	0.189	0.0003

USEPA 2000

4.9.1.2 Equipment Use Parameters

USACE estimated air pollution emissions from construction operations within each channel reach location. The equipment deployed is the same under each scenario but the duration to complete construction in each reach varies. In estimating the project's potential marine emissions, a marine equipment list (dredges and support equipment) including individual engine specifications [horsepower (hp)] was developed. The marine operations are comprised of the following equipment: one hydraulic dredge (1,256 hp), one work tugboat (250 hp), one crew/survey vessel (100 hp), one derrick (200 hp), two tow vessels (3000 hp each), and a dump scow (250 hp). Emission rates for each applicable criteria pollutant CO, NO_x, $PM_{2.5}$, PM_{10}, SO_x, and VOCs (which is not a criteria pollutant) were calculated in tons per hour. Each sources' (engine) emission rate was derived from the following formula:

Emission Rate (tons/hr) = Engine Horsepower × Engine Load Factor × Emission Factor

The marine equipment's engine load factors were estimated from the USEPA technical report *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data* incorporating each source's suggested operating mode. A conservative time-averaged load factor of 75% of total power capacity was used for likely deployed vessels during dredging operations. The duration in months for each construction reach is displayed in Table 25. After applying the project schedule for each reach, the annual hours of operation were developed for each piece of marine equipment over the construction period. Potential criteria air pollutant quantities emitted were calculated based on the following formula:

Emission Amount (tons/year) = Emission Rate (tons/hour) × Working Hours (hours/year)

Table 25 Estimated Project Duration by Reach

Location	Duration (Months)
Outer Entrance Channel (OEC)	13
Inner Entrance Channel (IEC)	4
Widener (WID)	10
Modified Main Turning Basin (MTB)	12
Southport Access Channel (SAC)	19
Turning Notch, Turning and Berthing (TN)	8
Total	**66**

4.9.1.3 Emission Estimates per Project Reach

The criteria air pollutant emissions presented below in Tables 26 - 31 represent the potential direct and indirect emission estimates occurring per project reach during the proposed Port Everglades' Recommended Plan construction.

Table 26 Estimated Emissions (tons) for the OEC Reach

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	3,684	4.68	30.37	0.69	0.69	5.21	0.52
Work Tug	250	3,684	0.93	6.04	0.14	0.14	1.04	0.10
Crew/Survey	100	3,684	0.37	2.42	0.06	0.06	0.41	0.04
Derrick	200	3,684	0.75	4.84	0.11	0.11	0.83	0.08
Tow Vessel	3,000	1,584	4.81	31.19	0.71	0.71	5.35	0.53
Dump Scow	250	8,760	2.22	14.37	0.33	0.33	2.46	0.25
Tow Vessel (Mobilization)	3,000	8,760	26.61	172.46	3.94	3.94	29.57	2.96
Total			**40.37**	**261.68**	**5.98**	**5.98**	**44.86**	**4.49**

Table 27 Estimated Emissions (tons) for the IEC Reach

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	1,326	1.69	10.93	0.25	0.25	1.87	0.19
Work Tug	250	1,326	0.34	2.18	0.05	0.05	0.37	0.04
Crew/Survey	100	1,326	0.13	0.87	0.02	0.02	0.15	0.01
Derrick	200	1,326	0.27	1.74	0.04	0.04	0.30	0.03
Tow Vessel	3,000	609	1.85	11.99	0.27	0.27	2.06	0.21
Dump Scow	250	3,154	0.80	5.17	0.12	0.12	0.89	0.09
Tow Vessel (Mobilization)	3,000	3,154	9.58	62.09	1.42	1.42	10.64	1.06
Total			**14.65**	**94.97**	**2.17**	**2.17**	**16.28**	**1.63**

Table 28 Estimated Emissions (tons) for the WID Reach

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	3,091	3.93	25.48	0.58	0.58	4.37	0.44
Work Tug	250	3,091	0.78	5.07	0.12	0.12	0.87	0.09
Crew/Survey	100	3,091	0.31	2.03	0.05	0.05	0.35	0.03
Derrick	200	3,091	0.63	4.06	0.09	0.09	0.70	0.07
Tow Vessel	3,000	1,470	4.47	28.94	0.66	0.66	4.96	0.50
Dump Scow	250	7,351	1.86	12.06	0.28	0.28	2.07	0.21
Tow Vessel (Mobilization)	3,000	7,351	22.33	144.72	3.31	3.31	24.81	2.48
Total			**34.31**	**222.37**	**5.08**	**5.08**	**38.12**	**3.81**

Table 29 Estimated Emissions (tons) for the Modified MTB Reach

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	3,684	4.68	30.37	0.69	0.69	5.21	0.52
Work Tug	250	3,684	0.93	6.04	0.14	0.14	1.04	0.10
Crew/Survey	100	3,684	0.37	2.42	0.06	0.06	0.41	0.04
Derrick	200	3,684	0.75	4.84	0.11	0.11	0.83	0.08
Tow Vessel	3,000	1,800	5.47	35.44	0.81	0.81	6.08	0.61
Dump Scow	250	8,760	2.22	14.37	0.33	0.33	2.46	0.25
Tow Vessel (Mobilization)	3,000	8,760	26.61	172.46	3.94	3.94	29.57	2.96
Total			**41.03**	**265.93**	**6.08**	**6.08**	**45.59**	**4.56**

Table 30 Estimated Emissions (tons) for the SAC Reach

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	3,684	4.68	30.37	0.69	0.69	5.21	0.52
Work Tug	250	3,684	0.93	6.04	0.14	0.14	1.04	0.10
Crew/Survey	100	3,684	0.37	2.42	0.06	0.06	0.41	0.04
Derrick	200	3,684	0.75	4.84	0.11	0.11	0.83	0.08
Tow Vessel	3,000	2,124	6.45	41.82	0.96	0.96	7.17	0.72
Dump Scow	250	8,760	2.22	14.37	0.33	0.33	2.46	0.25
Tow Vessel (Mobilization)	3,000	8,760	26.61	172.46	3.94	3.94	29.57	2.96
Total			**42.01**	**272.31**	**6.22**	**6.22**	**46.68**	**4.67**

Table 31 Estimated Emissions (tons) for the TN Reach

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	2,327	2.96	19.18	0.44	0.44	3.29	0.33
Work Tug	250	2,327	0.59	3.82	0.09	0.09	0.65	0.07
Crew/Survey	100	2,327	0.24	1.53	0.03	0.03	0.26	0.03
Derrick	200	2,327	0.47	3.05	0.07	0.07	0.52	0.05
Tow Vessel	3,000	1,205	3.66	23.73	0.54	0.54	4.07	0.41
Dump Scow	250	5,533	1.40	9.08	0.21	0.21	1.56	0.16
Tow Vessel (Mobilization)	3,000	5,533	16.81	108.94	2.49	2.49	18.68	1.87
Total			**26.12**	**169.32**	**3.87**	**3.87**	**29.03**	**2.90**

4.9.1.4 Annual Emission Estimates

The criteria air pollutant emissions presented in Table 32 represent the estimated total of direct and indirect emissions that would occur within any one calendar year of the construction of the Recommended Plan.

Table 32 Estimated Annual Construction Emissions (Recommended Plan)

Port Everglades Project Year	Emissions (tons/year)					
	CO	NO_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
1	18.04	116.91	2.67	2.67	20.04	2.00
2	37.23	241.32	5.52	5.52	41.37	4.14
3	40.82	264.55	6.03	6.03	45.41	4.54
4	39.12	253.54	5.86	5.86	44.73	4.35
5	26.56	172.17	3.94	3.94	29.51	2.95
6	32.73	212.12	4.85	4.85	36.36	3.64
7	10.34	67.02	1.53	1.53	11.49	1.15
Total	**204.83**	**1,327.62**	**30.39**	**30.39**	**228.92**	**22.77**

4.9.1.5 County-wide Emission Comparison

Emissions associated with the Recommended Plan would result in minor, localized, temporary increases in concentrations of NO_x, SO_x, CO, VOC, and PM when compared to the county-wide annual emissions (Table 33). Since the project is located in an attainment area, there is no requirement to prepare a conformity determination. However, estimates were tallied determining the level of emissions that would potentially occur due to the proposed actions. On an annual basis, the project would result in NO_x emissions exceeding the General Conformity threshold (100 tons/year) in six of the seven construction years. However, as stated earlier, since Broward County is in an attainment area, there is no CAA requirement to meet this threshold or to mitigate for potential exceedances. As stated in Section 3.11, a region's air quality is influenced by many factors including the emission types, locations, size, duration, and local prevailing meteorological conditions. Considering all emission attributes and the county wide emissions comparison, the NO_x estimates are not considered permanent nor significant.

Table 33 - Countywide Air Emissions - Broward County 2008

	NO_x	SO_x	CO	VOC	$PM_{2.5}$	PM_{10}
2008 Countywide Emissions Nonpoint + Mobile t/yr	51,014	10,356	279,174	42,142	3,343	14,258
Seven-Year Project Emission Percentage	2.6	2.2	0.07	0.05	0.91	0.21

Broward County 2008 emissions from EPA National Emission Inventory http://www.epa.gov/air/data/

The temporary increases in the project-related emissions are relatively minor compared to the existing point, nonpoint, and mobile source emissions in Broward County. Effects from project emissions and other construction equipment associated with the Recommended Plan would not significantly affect air quality within the local air-shed. Short-term loadings of internal-combustion engine exhaust gasses are expected to be negligible, not posing a threat to workers, local populations, or the area's attainment status. As mobile and temporary sources, no air quality permit would be required for this project. Because the project is located within a designated attainment area, USEPA's general conformity rule Section 176 (c) of the CAA does not apply and a Conformity Determination Analysis would not be required.

Calculations of carbon dioxide (CO_2) emissions were calculated based on the Intergovernmental Panel on Climate Change (IPCC) guidelines for calculating emission inventories (Table 34). An oxidization factor was applied to the carbon content accounting for the small fuel percentage that would not oxidize into CO_2. For all oil and oil products, the oxidation factor used is 0.99 (99% of the carbon in fuel is eventually oxidized, while 1% remains un-oxidized).

Table 34 Estimated Annual CO2 Construction Emissions (Recommended Plan)

Port Everglades Construction Year	Fuel Consumption (gal/year)	Emissions CO_2 (lbs)
1	289,193	6,420,081
2	582,346	12,928,086
3	602,885	13,384,041
4	614,034	13,631,550
5	657,603	14,598,790
6	635,431	14,106,557
7	151,097	3,354,358

CO_2 emissions from a gallon of diesel = 2,778 grams x 0.99 x (44/12) = 10,084 grams/gallon = 10.1 kg/gallon = 22.2 pounds/gallon. Note: These calculations and the supporting data have associated variation and uncertainty. USEPA may use other values in certain circumstances, and in some cases it may be appropriate to use a range of values.

CO_2 is emitted to the atmosphere in a number of ways, including through the natural carbon cycle (e.g., involving decomposition of plant material), volcanic eruptions, or through human activities such as the use of fossil fuels. Billions of tons of such atmospheric CO_2 are removed from the atmosphere by oceans and growing plants (referred to as "sinks"') and are emitted back into the atmosphere annually through natural processes. When in balance, the total carbon dioxide emissions and removals in the entire carbon cycle are roughly equal. However, during the past three centuries, the cycle appears out of balance. In 2005, global atmospheric concentrations of CO_2 were 35% higher than they were before the industrial revolution.

4.9.1.6 Vessel Calls

As cited in the Feasibility Report's Economic Appendix, "with-project" construction is not expected to significantly change the number of vessels calling Port Everglades; however, the vessel classes will take advantage of the additional depth. Growth projections showed increase use of the Port with or without the deepening project; however, the amount of cargo and liquid bulk on the vessels is expected to increase as the vessels add more cargo in response to the additional water depth available for use, allowing for more efficient use of the vessels. The existing number of vessel calls (2012) to the port is 4,000 (container, cruise, cargo, petrol, military, and others; see Appendix B of the Feasibility Study). For years 2060 through 2073, in the "without-project" condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. The 2060/2073 (years are not predicted to differ appreciably) the "with-project" vessel call total is estimated to be 5,061, i.e., a decrease of 191 calls compared to the "without-project" condition. Additionally, newer generations of cruise ships will add more passengers as the ships get larger. The project allows for a shift from smaller, less efficient ships; to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls. In fact, calls are anticipated to decrease. This vessel class response (Panamax to Post-Panamax) is consistent with national trends detailed in IWR 2012 Table 35. Table 36 provides a summary of historic and projected future vessel calls.

Table 1: Forecast East Coast Container Fleet 2012-2035

	2012	2015	2020	2025	2030	2035
0.1 - 1.3 k TEU	24	11				
1.3 - 2.9 k TEU	34	12	6	4	3	3
2.9 - 3.9 k TEU	28	12	10	4	4	2
3.9 - 5.2 k TEU	140	95	78	58	42	29
5.2 - 7.6 k TEU	86	114	153	156	159	168
7.6 - 12.0 k TEU	26	61	96	155	227	322
12.0 k TEU +		3	13	42	82	136

Note: post-Panamax vessel bands shaded in yellow. *Source: Maritime Strategies International, Limited*

This East Coast container fleet forecast shows the number of container vessels (by TEU range) being deployed on trade routes that include the U.S. East Coast ports. Vessels above 52k TEU are considered *post-Panamax* vessels.

Table 35 Anticipated Shift from Panamax to Post-Panamax Vessels from 2012-2035 (IWR 2012)

Table 36 Vessel Call Analysis for With- and Without-Project Conditions in 2073

	2012	Future Without Project (Years 2060 through 2073)			Future With Project (2060 through 2073)			
Vessel Type	Baseline Calls	Future Calls w/o project	Change from base	Percentage change from base	Future Calls w/ project	Change from base	Percentage change from base	Difference: with- vs. without-project
Cruise Ships / Ferry	838	1,099	261	+24%	1,099	261	+24%	**0**
Container Ships	1,867	3,332	1,465	+44%	3,272	1,405	+43%	**-60**
General Cargo/ Bulk Ships	194	229	35	+15%	223	29	+13%	**-6**
Petroleum Tankers/ Barges	618	503	(115)	-23%	473	(145)	-31%	**-30**
Navy/USCG	16	N/A			N/A			**-**
Other (Bunkers/ Tugs)	467	N/A			N/A			**-**
Total excl. Navy/USCG/ Other	3,533	5,163	1,646	+32%	5,067	1,550	+30%	**-96**

4.9.1.7 USEPA and IMO Regulations and Standards Changes

USEPA has issued more stringent diesel particulate matter (DPM) and NO_x emission standards for marine diesel engines (USEPA 2008). The three-part program aims to (1) tighten emission standards for large marine diesel engines when they are remanufactured; (2) set near-term engine-out emission standards referred to as Tier 3 standards for newly built marine diesel engines, and (3) set longer-term standards referred to as Tier 4 standards or newly-built marine diesel engines that reject the application of high-efficiency after-treatment technology.

In October 2008, the International Maritime Organization (IMO) adopted new stringent standards to control harmful exhaust emissions from the engines that power ships. The IMO is the United Nation's agency concerned with maritime safety/security and the prevention of marine pollution from international shipping. The standards are found in Annex VI to the International Convention on the Prevention of Pollution from Ships (MARPOL).

MARPOL Annex VI is a program that consists of two sets of standards controlling emissions from ships. The global standards for sulfur fuel content and NO_X emissions apply to ships at all times. In recognition that some areas may require further control, Annex VI also contains geographic-based standards. Ships operating in designated Emission Control Areas (ECAs) are required to comply with more stringent fuel sulfur and engine NO_X limits.

On March 26, 2010, the IMO amended the MARPOL designating specific portions of U.S. waters as part of the North American ECA (Figure 83). The North American ECA became enforceable in August 2012.

4.9.1.8 USEPA and IMO Emission Standards' Effects

Ships are significant contributors to the U.S. mobile-source emissions inventories, though most are flagged or registered elsewhere. Ships complying with ECA standards will reduce their emissions of NO_x, SO_x, and fine particulate matter ($PM_{2.5}$). In 2020, emissions from ships operating in the ECA are expected to be reduced annually by 320,000 tons for NO_x, 90,000 tons for $PM_{2.5}$, and 920,000 tons for SO_x; which is 23%, 74%, and 86% respectively below predicted levels in 2020 absent the ECA. The overall cost of the North American ECA is estimated at $3.2 billion in 2020; while its benefits are expected to prevent as many as 14,000 premature deaths and relieving respiratory symptoms for nearly five million people each year in the U.S. and Canada. The 2020 monetized health-related benefits are estimated to be as much as $110 billion in the U.S. (USEPA 2010).

The North American ECA includes waters adjacent to the Pacific Coast, the Atlantic/Gulf Coast, and the eight main Hawaiian Islands. The ECA extends up to 200 nautical miles from coasts of the United States, Canada, and the French Territories. The ECA does not extend into marine areas subject to the sovereignty or jurisdiction of other states.

Table 37 summarizes the global and geographic-based international standards and their phase-in schedule.

Figure 83 IMO US and Canadian ECA Boundary

Table 37 International Ship Engine and Fuel Standards (MARPOL Annex VI)

	Year	Fuel Sulfur	NO_x
Emission Control Area	2008 to July 2010	15,000 ppm	
	2010	10,000 ppm	
	2015	1,000 ppm	
	2016		Tier 3 After treatment*
Global	2008 to January 2012	45,000 ppm	
	2012	35,000 ppm	
	2020	5,000 ppm	
	2011		Tier 2 Engine Controls*

* Today's Tier 1 NO_x standards range from approximately 10 to 17 g/kW-h, depending on engine speed. The Tier 2 standards represent a 20% NO_X reduction below Tier 1, and the Tier 3 standards represent an 80% NO_X reduction below Tier 1.

As a result of USEPA rulemaking, the IMO standards and the ECA designation; emissions from diesel ships visiting Port Everglades will decrease significantly from historic levels and all ships arriving to Port Everglades will have to meet the new more stringent emission standards. This means that even with more ships arriving at the Port, the levels of emissions for $PM_{2.5}$, SO_x and NO_x will be greatly reduced and remain below historic levels. These projected emission levels are well below resulting concentrations potentially jeopardizing USEPA's attainment criteria.

4.9.1.9 General Conformity Determination

Pursuant to USEPA's General Conformity Rule within the CAA, a federal agency must make a General Conformity Determination for all federal actions in non-attainment or maintenance areas. The analysis confirms the proposed action will not cause new air quality violations, worsen existing violations, or delay timely attainment of the relevant NAAQS in areas of nonattainment or within maintenance areas. Since Broward County (and all the counties in the air-shed) is considered by USEPA to be in attainment for all criteria pollutants, the CAA Conformity Determination requirements are not applicable to the proposed project.

4.9.1.10 Project Area and Community Clean Air Efforts and Effects

Port Everglades completed a retrofit of its diesel engines under a grant from FDEP and USEPA's National Clean Diesel Campaign in September 2011 (Port Everglades 2011). The implementation of this project resulted in the estimated reduction of 254 metric tons of greenhouse gas (GHG) emissions, 19,437 pounds of NO_x emissions, 733 pounds of PM emissions, 46 pounds of PM_{10}, and 7,373 pounds of CO emissions. Annual projected gallons of fuel saved by the program: 28,500 gallons of diesel for the pilot boats and 22,403 gallons for Port equipment. The USEPA states "DERA returns are as high as $20 for every $1 invested through environmental and public health benefits." Using this projection, the implementation of this grant translated into a $29,494,879 health investment for the Port Everglades/Broward County community (Port Everglades 2011).

Broward County has undertaken efforts to improve energy efficiency within the county government, including Port Everglades. The project's benefits, specific to Port facility's energy conservation, would result in an annual reduction in greenhouse gas emissions of 9,749,5643 pounds of CO_2, 61,101 pounds of SO_2, and 17,091 pounds of NO_2 (Port Everglades 2011).

Florida Power and Light is in the process of replacing the Port Everglades power plant by completely demolishing the existing structure and building a new plant on the existing plant's footprint. The plant was originally built in the 1960s and is in need of efficiency improvements. FP&L has stated that by retrofitting the plant, the CO_2 emissions will be cut in half and the warm water effluent released from the plant will also be cut in half. Construction of this retrofitted plant is planned for 2014-2016 and the plant should be operational in 2016 (FP&L 2012).

As a result of the new IMO US/Canadian ECA efforts in reducing vessel emissions, Port Everglades air quality associated with ship movements in and out of the Port will be improved in the future-with-project condition compared to the future-without-project condition. This is based on new on-board technology as well as estimated vessel calls (year 2073 without project: 5,252; year 2073 with project: 5,061). The efforts underway at Port Everglades to reduce emissions associated with Port activities such as equipment improvements and pilot boat operations will also affect both the "with- and without-project" alternatives. Broward County is currently in attainment, based on the existing vessel fleet makeup, which includes smaller, older, less efficient

vessels that may not be in compliance with the new IMO requirements. The “with-project” alternative results in a fleet shift to larger more efficient vessels that are in compliance with the IMO requirements. Coupling international, national and local efforts with continued Port Everglades efficiency improvements; the Port Everglade’s air-shed would retain an USEPA attainment status.

4.9.2 National Economic Development Plan

The long-term affects on air quality under the NED Plan would be similar to those of the Recommended Plan. Construction impacts may be slightly less under the NED Plan, however. This is because slightly less time would be required to dredge to the shallower authorized depth (-47 MLLW) than the Recommended Plan. In essence, the less time equipment is running, the fewer emissions will be contributed to the local airshed.

4.9.3 No-Action Alternative

The No-Action alternative would involve a continued increase in ship calls from the 4,000 vessel-call 2012 baseline. For years 2060 through 2073, in the “without-project” condition, vessel calls are estimated to be 5,252 vessel calls, i.e., an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. Many of these ships will be light-loaded and not operating in the most fuel/cargo efficient manner. The "with-project condition" will continue to accrue the improvements undertaken by Port Everglades, the FP&L retrofit, and other major local sources reducing emissions and fuel consumption. Broward County is currently in attainment, based on the existing fleet makeup, which includes smaller, older, less efficient vessels and is anticipated to remain in attainment under the No-Action Alternative. The Port Everglades servicing fleet may remain the same or there may be some shift to more light-loaded vessels complying with the IMO requirements. The No-Action Alternative would result in the status quo for air quality being maintained, when specifically addressing vessel fleet effects.

4.10 Noise

None of the project alternatives (including the NED Plan and the Recommended Plan) is expected to have a significant impact to noise levels. The urban setting of the Port produces noise not necessarily related to the operation of the Port. One of the major contributors to noise on an intermittent basis is the Fort Lauderdale/Hollywood International Airport. Other sources of noise within the jurisdictional boundaries of the Port related to the transportation sector are trucks associated with the movement of petroleum product, containerized cargo, and private vehicles.

There is little to no noise produced as a result of vessel traffic except for the engine noise associated with vessel transit and tug operations. Port tariff restricts the blowing of whistles and horns by vessels while in Port, and the only intermittent whistle blowing are signals between tugs while assisting vessels in their movement within the Port.

With the implementation of the proposed project there would be a slight and temporary increase in noise levels during construction. Construction equipment would be properly maintained to minimize the effects of the noise and the distance of the activity from residential areas would also reduce any noise impacts associated with construction.

Excavation of massive hard rock formations would require special methods to ensure removal. Blasting is being proposed as the preferred method. An alternative method of hard rock removal is through the use of a punch barge. Reviewing the literature provides very little information about noise specific to the use of a punch barge; however, there is substantial data available concerning the use of pile drivers, which are very similar to a punch barge in design and use. The studies concerning pile driving indicate that noise levels from the pile drivers (Laughlin 2005; MacGillivray 2007) would be significantly greater, and therefore, this method is not USACE's preferred pre-treatment methodology.

As previously discussed, under the MMPA, any activity that may result in causing Level B harassment must undergo a consultation with the appropriate agency. NMFS has promulgated regulations to obtain authorization under the MMPA for Level B harassment through a process called an "Incidental Harassment Authorization" (IHA). The IHA allows the activity to go forward with the unintentional harassment of non-ESA listed marine mammals in a project area (50 CFR 216).

The USACE has previously obtained IHAs for blasting pre-treatment activities associated with the Miami Harbor Phase II deepening project in 2005-2006, and currently has recently submitted an application for an IHA for the ongoing deepening at Miami Harbor. The Port Everglades project will also gain this authorization before the project can advertise for contractors to submit proposals, accept a proposal or initiate construction. With the application for an IHA for Miami Harbor Phase II, the USACE indicated, and NMFS concurred, that the blasting activities were likely to cause Level B harassment and that an IHA was warranted. As part of the 2005 renewal of the IHA for Miami Harbor, NMFS also concurred with the USACE determination that dredging activities themselves (operations of a cutterhead or clamshell dredge for that project) and the overall operations of dredges, tugs and scows were not likely to result in harassment of marine mammals in the project area and did not require an IHA (NMFS 2005c).

Recent studies from Europe (OSPAR Commission, 2009a; OSPAR Commission 2009b) have reviewed previous studies that documented potential adverse effects of noise from underwater dredging and construction activities. The following relevant text is transcribed from those sources:

> "Dredging, for example to extract geological resources such as sand and gravel, to maintain shipping lanes, and to route seafloor pipelines, emits continuous broadband sound during operations, mostly in the lower frequencies. In one investigation, estimated source levels ranged from 160 to 180 dB re 1 μPa at 1 m (maximum ~ 100 Hz). Bandwidth was between 20 Hz and 1 kHz (limited by the recording equipment; most energy was below 500 Hz; Richardson *et al.* 1995). In a recent study Defra [the United Kingdom's Department for Environment, Food & Rural Affairs] (2003) measured sound spectrum levels emitted by an aggregate dredger at different distances and found most energy to be below 500 Hz.
>
> "Richardson *et al.* (1995) provide an overview of investigations into behavioural responses of cetaceans to dredging. Bowhead whales (*Balaena mysticetus*) did not apparently respond to a suction dredge in one study, but individuals avoided these dredges when exposed to 122 - 131 dB re 1 μPa (or 21-30 dB above ambient noise) in another investigation (see also Richardson *et al.* 1990). Gray whales (*Eschrichtius robustus*) ceased to use a particular breeding lagoon after an increase in industrial activities, including shipping and dredging (Bryant *et al.* 1984). However, it is not clear if this was due to sound or the increased presence of ships; no studies were made of the increase in sound or of received sound pressure levels. There are, to our knowledge, no recent studies (post 1995) on the effects of dredging noise on marine mammals.

> "Moulton *et al.* (2003) found no effects of the development of an artificial island including construction and drilling noise on the abundance of ringed seals nearby. Received levels were ~ 120 dB re 1 μPa. Activities included pile driving during construction and the authors did not look at effects separately (see also Blackwell *et al.* 2004b for results on pile driving on the same population). Richardson *et a.l*'s (1995) account of studies relating to behavioural effects of drilling in toothed whales is very equivocal showing both avoidance and attraction. Also, in some circumstances it is not apparent if dredging or some other factor induced the observed behaviour. Finally, in most cases, no received sound pressure levels are being reported so the results are very difficult to assess. In an experimental study using four animals, and also documenting received sound pressure levels, Thomas *et al.* (1990) could not detect any short-term behavioural or physiological effects of drilling noise playbacks on captive beluga whales (*Delphinapteras leucas*). Bowhead whales did show avoidance in some cases at received levels around 115 dB re 1 μPa (~20 dB above ambient noise level; for a detailed discussion, see Richardson *et al.* (1995). Gray whales showed avoidance responses to drilling sounds at received levels of 120 dB re 1 μPa, with considerable variation between individuals (Malme *et al.* 1984)."

Thomsen *et al*. 2009, specifically looked at dredging aggregate materials from waters in the UK with regard to sound impacts to marine mammals within the vicinity of the dredging operations. These analyses have been reviewed and the cited effects on marine mammals in the project vicinity have been adopted by some federal agencies in their NEPA analyses for projects in U.S. waters. To date, three characterizations of dredge noise have been conducted by the USACE Engineering Research and Development Center: Clarke *et al* (2002); Reine *et al.* (*2012a*); and Reine *et al.* (*2012b)*.

It is not clear how noise associated with one class of vessels (dredges) can be separated from all others in an active harbor. Other classes of vessels (large cargo vessels, oil tankers, bulk vessels, and cruise ships) generate similar noise profiles and have not been singled out for potential impacts to marine mammals under the MMPA. To date, NMFS has not made a determination that sound generation associated with dredging operations, or any other vessel operations, will be considered type B harassment and will require an IHA for operations. As previously stated, NMFS has concurred with the USACE' determination that dredging activates do not result in take of marine mammals under the MMPA (NMFS 2005b, NMFS 2012c).

4.11 Aesthetic Resources

The No-Action Alternative would not alter the existing aesthetic resources. The Recommended Plan is expected to have slight impacts to aesthetic resources within the project area (which are not anticipated to differ from the NED Plan's impacts). These include removal of reef habitat and mangrove habitats (as described above). These impacts would be compensated through mitigation; namely, installation of artificial reef habitats and restoration of mangrove habitat in West Lake Park.

Temporary aesthetic impacts would occur due to construction activities. Construction equipment including dredges, dredge pipes, survey vessels, construction barges, scows, etc. would be visible to the public. Temporary aesthetic impacts due to construction of staging areas, access roads and the like may also occur. Aesthetic impacts due to work sites can be reduced through proper periodic site management measures such as prompt removal of trash and debris. Construction fences around work areas can provide a visual as well as safety barrier.

It should be noted that with the completion of the project, some of the largest cruise ships in the world will call at the Port. Some consider the sight of these massive vessels (in daylight or at night against the city's landscape) to be of substantial aesthetic value.

4.12 Recreation Resources

The Recommended Plan (or the NED Plan, if selected) will have minor and temporary impacts to recreational resources during construction. Recreational activities adjacent to the harbor (including at JUL) should not be adversely affected by construction activities. During dredging and construction operations, recreational boaters may be temporarily inconvenienced by having to avoid the work areas. Construction areas will move spatially and temporally, and as a result, the areas impacted by construction will move through time and space, only impacting a small area of the harbor at any one time.

4.13 Cultural Resources and Historic Properties

The proposed project will have no effect on the Port Everglades resources group (8BD180). Proposed changes, consisting only of channel deepening, will have no effect on the port's elements that define its significance or eligibility for listing on the National Register of Historic Places (NRHP). Within the Port Everglades resource group boundaries, a previous submerged cultural resources survey covering a large portion of the project area was conducted in 2002 (Hall). This survey included additional areas outside the resource group and approximately one mile of the current entrance channel. However, this survey did not cover an additional 2,200 feet of Outer Entrance Channel (OEC) associated with the eastern most portion of the project.

Hall's investigation (2002) identified four magnetic anomalies located in the channel and turning basin areas of the facility. Archeological diver identification determined that the anomalies were modern and not associated with historic properties (shipwrecks) (SHPO File No. 2022-03860; See Appendix I). An updated cultural resource survey of the additional 2,200 feet of the outer entrance channel (OEC) was conducted in November 2011 (Lydecker, et al. 2012) and two magnetic targets, potentially indicative of historic properties, were identified. Subsequent archeological diver identification of the two magnetic anomalies in 2012 (Lydecker, et al. 2013) indicated that both anomalies were modern ferrous debris. The Corps determined no historic properties affected for the outer channel expansion project area and the Florida SHPO concurred on February 4, 2013 (DHR File No. 2013-00187).

4.14 Native Americans

No Native American community or any tribal lands are known to exist within the project or mitigation area. Therefore, the project should not adversely impact Native Americans or any tribal lands.

4.15 Adjacent Properties

There will be no impacts to adjacent real property under the No-Action Alternative.

Impacts to adjacent properties under the Recommended Plan would result from deepening and widening the SAC and widener. Implementation of the NED Plan would result in identical impacts.

Loss of some wetlands and developed and undeveloped uplands along the properties east of Port Everglades would occur. Specific properties potentially affected are listed below.

John U. Lloyd Beach State Park. A total of 2.26 acres of JUL property is situated within the project (SAC) footprint, 1.16 acres of which comprise mangrove wetlands. However, construction of the project based on one of the initial designs of the SAC would have resulted in nearly 65 acres being removed from JUL (this represents a 98% reduction of impacts). For the construction of the currently proposed Recommended Plan, construction of an environmentally friendly bulkhead design will allow for JUL mangroves to recruit adjacent to the channel.

Nova Southeastern University Oceanographic Center. Due to construction of the Recommended Plan, the existing breakwater protecting NSUOC vessels would have to be removed, as it is currently in the Port's right-of-way and would be an obstacle to proposed Port operations. It is recommended that a new NSU breakwater be constructed outside of the port's right-of-way pending construction of the proposed navigation improvements. The new breakwater would be constructed by NSU prior to construction of the project to protect vessels berthed in the NSU boat basin from wave impacts. USACE, via the Port, has coordinated with NSU regarding this breakwater's location on Port property and the need for it to be removed from the project footprint prior to construction.

U.S. Navy Facility. No impacts to the Navy property would occur due to construction of the Recommended Plan.

U.S. Coast Guard Facility. Approximately 1.5 acres of the USCG facility would be affected by the Recommended Plan. Based on recommendations of the ship simulation study, several alternatives for modifying the USCG station were investigated. Two overall options were evaluated: reconfiguration of the outer protective bulkhead and total reconfiguration of the entire USCG basin.

During the plan formulation process, multiple harbor designs were created and evaluated. Some focused on moving the outer breakwater of the existing basin, others on reconfiguring the basin eastward on existing USCG property. Subsequent ship simulation testing, numerical harbor wave response modeling, and coordination with USCG personnel showed that the majority of new configurations either conflicted with the Port expansion project, caused increased wave amplification throughout the USCG basin, included structural aspects that would create undue navigational hazards to larger vessels, or did not meet the operational requirements of the station.

Initially, at the request of USCG personnel, some buildings were not eligible for reconfiguration in the creation of a new boat basin. This limited the orientation of the new basin resulting in a preliminary reconfiguration plan that extended significantly eastward and impacted a large portion of the USCG property. While this resulted in a reconfiguration plan with a suitable level of protection for moored vessels, it reduced the footprint of the USCG station to a degree that station operations were adversely impacted. It was determined that a simple reconfiguration of the existing basin configuration 180 feet to the east would limit the extent of USCG property impacted and would be the optimal plan (figures available in the main report/Feasibility Study). Because the new basin has a slightly different entrance channel orientation, it was necessary to employ wave dissipating breakwaters in some locations to reduce the wave energy inside of the basin to acceptable levels.

In addition to loss of land, concern has been expressed that existing structures, particularly old or historic structures could be affected by vibration resulting from blasting activities during

construction. Based on the experiences at Miami harbor in 2005, no adverse impacts from the confined blasting are expected to occur to any adjacent property. The blasting and vibration monitoring contractors will work with each property owner to establish monitoring sites on their property, identifying specific areas of concern for monitoring, should the property owner/trustee express concern about certain facilities.

4.16 Economics and Logistics

Both the Recommended Plan and the NED Plan would have *positive* regional and national economic impacts beyond those that would occur under the No-Action Alternative (Section 2.4), due to the increase in containerized and bulk cargo throughput, petroleum delivery, and cruise passenger capacity. Construction of the Recommended Plan (as detailed in Section 2.3.2) would result in

1. Decreased costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies at Port Everglades through the year 2073.
2. Decreased transportation costs through increasing economies of scale for cargo and petroleum vessels at Port Everglades through the year 2073.

Under both the Recommended Plan as well as the NED Plan, all project objectives for container, bulk, petroleum, and cruise would be met. The detailed economic data for this future-with-project condition is located in the Economic Appendix of the Feasibility Study.

4.17 Infrastructure

Under the Recommended Plan, the following would be completed to improve the federal infrastructure supporting the Port's operations and project objectives:

- removal of approximately 5.24 million cubic yards of dredged material from channels and basins;
- deepen and widen the OEC from an existing 45-foot authorized depth over a 500-foot channel width to 48 feet (plus one-foot required overdepth and one-foot of allowable overdepth, i.e., +1+1 and additional depth for squat and underkeel clearance) by 800 feet and extend 2,200 feet seaward;
- deepen the IEC from 42 feet to 48 feet (+1+1);
- deepen the MTB from 42 feet to 48 feet (+1+1);
- widen the rectangular shoal region to the southeast of the MTB (Widener) by about 300 feet and deepen to 48 feet (+1+1);
- widen the SAC in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and reconfigure the USCG facility, a General Navigation Feature (GNF), easterly on USCG property;
- shift the existing 400-foot wide SAC about 65 feet to the east from approximately berth 26 to the south end of berth 29 to provide a transition back to the existing federal channel limits;
- deepen the SAC from about berth 23 to the south end of berth 32 from 42 feet to 48 feet (+1+1);

- deepen the TN, including the expanded portion from 42 feet to 48 feet (+1+1) (following local sponsor dredging of the same area to 42 feet) with an additional 100-foot north-south widening parallel to the SAC channel on the eastern edge of the SAC over a length of about 1,845 feet and widen the western edge of the SAC for access to the TN from the existing federal channel edge near the south end of berth 29 to a width of about 130 feet at the north edge of the TN.

The above would bring about the necessary federal infrastructure to support project objectives (decreasing delays and increasing economies of scale) for container, bulk, petroleum, and cruise vessels. With these improvements, the Port plans to further improve its berths (dredge to match improved channels) and associated land-based infrastructure to maximize Port operational efficiency. Construction of the NED Plan would result in the same infrastructure improvements, but the authorized channel depths would be -47 feet MLLW.

Without implementation of the Recommended Plan, the No-Action Alternative (Section 2.4) would not affect these changes. In that case, only the Port's Master/ Vision Plan and federal O&M dredging would be implemented, and project objectives would not be met through year 2073.

4.18 Navigation Safety

By implementing the Recommended Plan or the NED Plan, USACE and the local sponsor will address navigational safety concerns such as (1) having adequate width and depth of the channel to accommodate future vessel fleets and avert collisions, allisions, and groundings, and (2) providing safe maneuverability and routine operation of the Port with the existing fleet; while (3) avoiding and minimizing accidental vessel impacts to environmentally sensitive resources adjacent to harbor channels.

Implementation of the Recommended Plan would resolve safety problems by doing the following:

1. Extending the OEC out to deeper water and widening the eastern end of the OEC in order to allow for pilots to enter the channel at wider angles and slower speeds. Currently, Port Pilots have to enter at higher speeds to compensate for vessel crabbing, and have difficulty entering the channel parallel to the north and south channel limits due to cross-currents, especially during times of high winds and seas;
2. Widening the SAC at the Knuckle to allow for safe passing and maneuvering, especially when vessels are at Berths 25 and 26;
3. Eradicating the shoal in the area of the USCG facility/ creating the Widener in order to allow for safe maneuverability and passing operations for transit down the SAC, especially when vessels are at Berths 24 and 25;
4. Straightening the SAC to allow for safe two-way traffic;
5. Deepening several channels and basins to ensure that larger ships do not run aground.

The Recommended Plan would also serve to decrease the risk of ship collisions with other vessels in transit, allisions with stationary vessels and reefs, and groundings in the Port and vicinity. It is difficult to estimate the degree of effect, but it is anticipated that construction of the Recommended Plan would decrease the number of future casualties due to allisions, collisions, and groundings.

4.19 Energy Requirements and Conservation

The energy requirements for this project would be confined to fuel for dredges, vehicles, and other construction equipment. The No-Action Alternative would reduce these requirements (maintenance dredging would still be carried out), but would allow a continuation of, and possible increase in, navigational safety issues and economic problems.

4.20 Natural or Depletable Resources

No depletable resources would be used other than fossil fuels to power equipment and produce materials or equipment needed for dredging, disposal site construction, and pipeline construction.

4.21 Scientific Resources

Extension and widening of the OEC will permanently remove a small fraction of the extensive hardbottom habitats that may be of interest to marine scientists. Mitigation is planned to compensate for the loss of this habitat. Monitoring data and analysis from mitigation activities will provide scientific information regarding the newly created and restored habitat areas and associated species.

4.22 Reuse and Conservation Potential

Alternative plans had been previously investigated concerning the potential use of dredged material as construction material for the expansion efforts at Fort Lauderdale International Airport. However, the plans for the airport expansion and the timeline for Port expansion did not mesh, and the potential use of the dredged material was dropped as a proposal.

4.23 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. Irreversible loss of certain habitats would occur under the Recommended Plan in certain areas due to widening and deepening of channels and basins. However, losses of many habitat functions would be recovered through mitigation.

4.24 Compatibility with Federal, State, and Local Objectives

The State Clearinghouse responded to scoping with comments and concerns from FDEP and the FWC. The letter concluded that “Based on the information contained in the notice of intent and the enclosed comments provided by our reviewing agencies, we have determined that the referenced project is, at this stage, consistent with the Florida Coastal Management Program.” The letter also indicated that the South Florida Regional Planning Council has identified goals and policies in its Strategic Policy Plan, which may apply to the project.

4.25 Conflicts and Controversy

It is anticipated that there will be controversy regarding the ecological significance and amount of impacts to natural resources and the proposed mitigation for those impacts, even given the avoidance and minimization efforts previously detailed in this document. USACE, the Port, and its pilots have actively engaged regulatory/resource agencies via various coordination activities (including Section 7 Consultation, PERG meetings, alternative review during early stages of the Feasibility Phase, and HEA coordination) in order to alleviate conflicts and controversy. USACE offered Cooperating agency status under NEPA to all interested federal, state and local resource agencies. NMFS, USEPA, FDEP, FWC, and Broward County accepted the USACE offer and have played integral roles in shaping this EIS and the project.

4.26 Uncertain, Unique, or Unknown Risks

4.26.1 Mitigation Success

Some mitigation activities may involve uncertainty. For example, reestablishment of seagrasses involves some risk of failure. However, such risk was taken into account when the acreage of mitigation necessary for compensation was calculated (temporal loss and risk factors affect necessary mitigation), and monitoring will be conducted to ensure success. The mitigation for seagrass and mangrove impacts has already been permitted by USACE and local agencies. Additionally, mitigation construction will occur concurrently or before impacts for all resource types (seagrasses, mangroves, and hardbottom habitats), so that any failures may be identified early via monitoring, and can be rectified, if necessary.

4.26.2 Cultural Resources

No cultural resources are known in the project footprint or immediately adjacent areas. The "unanticipated finds" clause will be in effect during dredging activities to ensure no cultural resources are impacted as a result of the project.

4.26.3 Rate of Sea Level Rise

While the future rate of relative sea level rise (RSLR) at Port Everglades Harbor is very uncertain, it must be considered in project planning. Current USACE guidance (ER1165-2-212; November 2011) stipulates that NRC (1987) should be used to determine the potential impacts of sea level rise on plan formulation and engineering structures. RSLR consists of two components: global (eustatic) sea level rise and local subsidence. The uncertainty inherent in the rates of eustatic sea level rise is evident in the variability of the different modeled rates given for the NRC (1987) projections and the Intergovernmental Panel on Climate Change (IPCC 2007). A similar degree of uncertainty exists with the rate of local subsidence.

"*Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*" (U.S. Climate Change Science Program [USCCSP], 2009) synthesizes the state of knowledge regarding possible effects of RSLR on coastal ecosystems and communities. Areas of the nation's coast are experiencing submergence of low-lying lands, erosion of shores, and conversion of wetlands to open water as a result of RSLR. Studies suggest the rate of RSLR has increased recently and is likely to continue to increase in vulnerable areas. Forecasting impacts of RSLR on specific

coastal areas is difficult because of the complexity of coastal ecosystems and ecological processes and uncertainty about regional variation in RSLR. According to USCCSP (2009), "Existing studies of sea-level rise vulnerability based on currently available elevation data do not provide the degree of confidence that is optimal for local decision making."

Considerations in Civil Works Programs (USACE 2009a), requires the USACE to incorporate "the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects…" In fulfillment of this requirement, the sensitivity of project alternatives to the full range of potential future-without-project (FWOP) changes in sea level has been evaluated. There are a wide range of potential effects related to the full range of RSLR, but the sensitivity of project alternatives would be more limited. In particular, alternatives were evaluated to determine if the purpose and function of navigation features could be undermined, if environmental impacts might be exacerbated and how economic benefits and costs might be affected by sea level change. Nonstructural alternatives were evaluated but eliminated in the second screening; they are therefore not addressed in this analysis.

In order to meet the requirements of Circular No. 1165-2-211, this section evaluates effects of the full range of possible RSLR rates, which were developed in accordance with a specific methodology prescribed in the guidance. Following procedures outlined in EC 1165-2-211, Appendix B, baseline, intermediate, and high sea level rise values were estimated over the life of the project.

Sustainability thresholds are determined by local physical, chemical, climatologic, and hydrologic conditions and cannot be extrapolated to other regions. However, as an example, studies in the mid- Atlantic region indicate that the "tipping point" for coastal ecosystems could range from a RSLR of as low as 2.0 mm/year to as high as 10 mm/year (USCCSP 2009).

Based on historical sea level measurements taken from NOS gage 8723170 at Miami Beach, Florida, the historic sea level rise rate was determined to be 2.39 mm/year (0.0078 ft/year) (http://tidesandcurrents.noaa.gov/sltrends/index.shtml); the project base year was specified as 2017; and the project life was projected to be 50 years. Figure A-6 of the Engineering Appendix shows the three levels of projected future sea level rise for the life of the project. From these curves, the baseline, intermediate, and high sea level rise values at the end of the 50-year life of the project were projected to be 0.39, 0.83, and 2.24 feet, respectively (Figure 84).

An intermediate rate of RSLR (1.1 feet by year 2069) was used as the "most likely" estimate of RSLR in the alternative analysis for this project, in accordance with the USACE planning guidance. The following discussion describes possible ways that high and low RSLR might affect the project alternatives and the recommended action. There is relatively little data and analysis currently available which would permit a detailed, quantitative, analysis of the impacts of each of the possible RLSR scenarios on the project alternatives. Ways in which different RLSR rates might affect project design and impacts are presented in the Engineering Appendix (Section 2.3.4) of the Feasibility Report.

The primary impact of RSLR on this project may be its potential impact on mitigation measures proposed for mangroves and seagrasses at West Lake Park. These mitigation measures are planned for wetlands and SAV beds. The mangroves are inside a protected lagoon, with limited water flow and currents. Utilizing the three levels of predicted sea level rise at the end of the 50-year life of the project, the USACE expects that with a gradual rise in sea level for all three projected final values, mangrove trees will continue to capture sediments in the mitigation areas, creating land with their prop-root structures and continue to thrive.

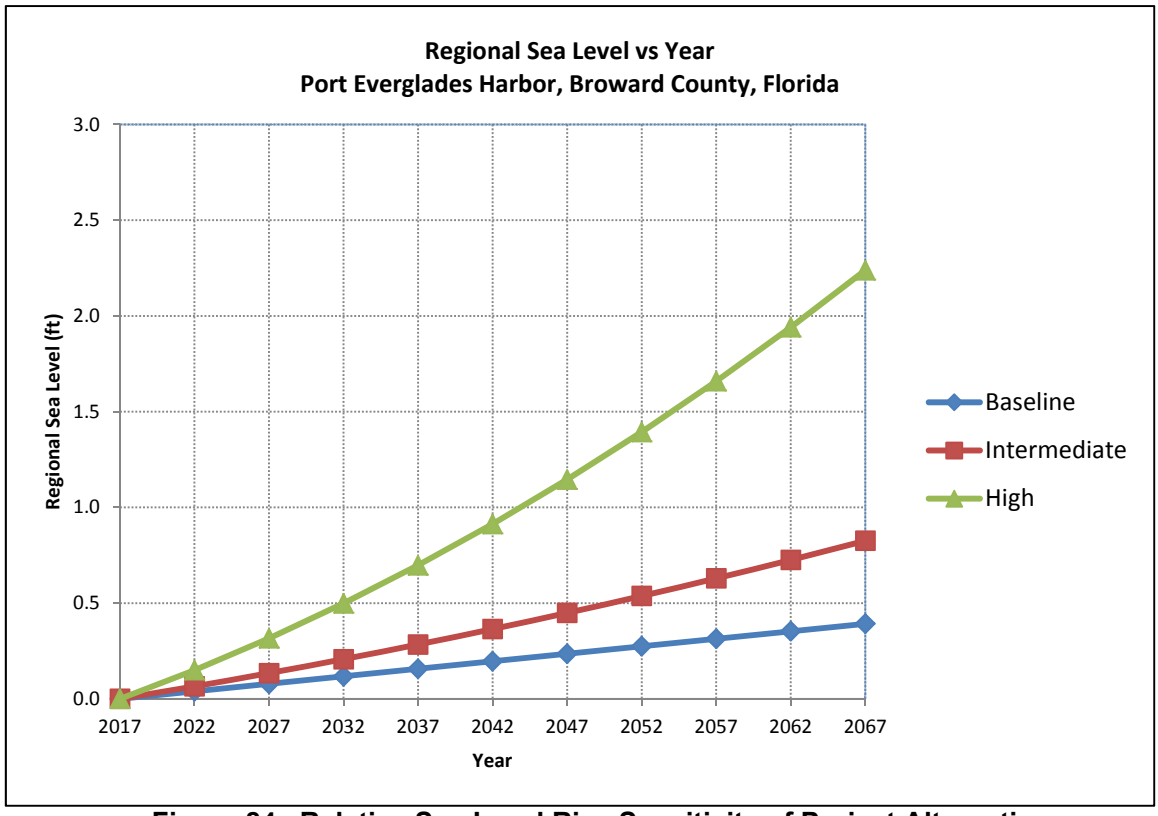


Figure 84 Relative Sea Level Rise Sensitivity of Project Alternatives

Seagrasses are found in the IWW and Port Everglades vicinity in water depths up to 12 feet in depth. The proposed seagrass mitigation has a target elevation of -3 feet MLLW. With an additional 2.2 feet of water on them, this would make the bed depth approximately 5.25 feet MLLW, within the current range of seagrass distribution of the port. As a result, it is expected that the seagrass beds will continue to exist, although photosynthetic efficiency may decrease with increasing depth.

The offshore reef mitigation are planned in water depths in excess of 40 feet. An additional 2.25 feet of water (using the maximum predicted rise in sea level as a worst case scenerio) should have no effect on reef resources at Port Everglades, as the habitats being mitigated for are also found in waters deeper than 40 feet.

4.27 Precedent and Principle for Future Actions

The proposed project is an integral part of the Port's Master/Vision Plan, and as such, land-based improvements in infrastructure will be associated with the completion of the Recommended Plan. These improvements can be reviewed in the Master/Vision Plan. Notable future improvements include the Intermodal Container Transfer Facility (ICTF) and dredging of berths to match associated channel depths. Implementation of either the Recommended Plan or the NED Plan would not conflict with the local government's (Broward County) goals, but would further and enhance its goals by increasing trade into the port.

4.28 Cumulative Impacts

4.28.1 Methodology

This section discusses potential impacts resulting from other facilities, operations, and activities that in combination with potential impacts from the Recommended Plan may contribute to cumulative impacts in the Proposed Action's Region of Influence (ROI). Cumulative impacts are impacts on the environment that result from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions regardless of the agency (federal or non-federal) or person that undertakes such other actions (40 CFR § 1508.7). For this FEIS, the existing conditions of each alternative location as described in the affected environment sections earlier in this chapter reflect the cumulative effects of past and present actions. A description of regional development trends for each alternative location is provided to show the basic progression of how the baseline conditions were altered over time and how they may continue to change with or without the Proposed project.

An inherent part of the cumulative effects analysis is the uncertainty surrounding actions that have not yet been fully developed. The CEQ (1997) regulations provide for the inclusion of uncertainties in the EIS analysis, and state that "(w)hen an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an EIS and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking" (40 CFR Part 1502.22). The CEQ regulations do not say that the analysis cannot be performed if the information is lacking. Consequently, the analysis contained in this section includes what could be reasonably anticipated to occur given the uncertainty created by the lack of detailed investigations to support all cause and effect linkages that may be associated with the Proposed Action.

4.28.2 Past, Present, and Future Actions

Past Actions in the area of Port Everglades. Port Everglades was authorized as a Federal Navigation Project in 1930. The Port has experienced modest growth over the past 20 years. Table 38 lists permitted expansion activities during the past two decades. Most of the individual expansion projects have been minor and have involved deepening pier and berth facilities, or expanding waterways/berths into Port property. Except for the 1987 TN project, past impacts have been limited to minor wetland impacts, dredging existing channels, or creating additional channel, piers, and berths from uplands. The Port has undergone numerous maintenance events and various navigation improvements. USACE fully expects the Port to remain viable for many years and to continue undergoing maintenance and navigation improvements.

Past Actions in the nearshore from Beach Nourishment Activities. Projects in areas adjacent to the proposed project include a beach fill project in 1977 (1,980,000 cubic yards) and a beach renourishment project in 1991 (1,110,000 cubic yards), both south of the Port between FDEP Monuments R-86 and R-93 (JUL). These actions were authorized as the Broward County, Florida, Shore Protection Project (Broward County SPP) by Section 301 of Public Law 89-298, passed on 27 October 1965. A Cumulative impacts review relative to placing sand on the Broward County shoreline has been conducted and can be found in Section 4.25 of the BCSPP EIS and is hereby incorporated by reference.

Present Actions. Aside from the proposed navigational improvements at the Port, concurrent actions in the vicinity of the proposed project that may impact the environment include the completion of Segment II of the Broward County SPP, for which federal participation was extended to 50 years beyond initial construction. The *Broward County, Florida, Shore Protection Project Segments II and III General Re-Evaluation Report with Final Environmental Impact Statement* (Jacksonville District- USACE, February 2002) addresses the Recommended Plan for the renourishment of JUL beaches from R-86 to R-94. The Plan includes the maintenance of shoreline with periodic nourishment, the installation of two T-head groins and a jetty spur along the northern 700 feet of the JUL shoreline, and the implementation of sand-bypass plans. Impacts to hardbottom habitats associated with the project reach along JUL and another reach, farther to the south, comprise 7.6 acres. These impacts have been mitigated with placement of limestone boulders (i.e., artificial reef/hardbottom). Therefore, for both the Broward County SPP and Port Everglades Navigation Improvement Projects (Appendix E), sufficient mitigative measures would ensure that overall habitat resource loss in the area would be minimal and temporary. In 2012, the Florida Inland Navigation District (FIND) dredged a section of the DCC west of the Port, but that action was not related to the Federal project in any known manner. The local sponsor (Broward County) is not dredging the DCC adjacent to the Port, nor does USACE have any information indicating that there are plans to do so.

Future Actions. The Port is likely to dredge berths adjacent to the project area if the Recommended Plan is implemented. Also, there are approximately 270 acres of newly acquired property near the SAC which is either in the process of being developed or would be developed as a result of this study. Plans for this area include additional container yard facilities, a possible Intermodal Container Transfer Facility, and a 4,200 linear foot bulkhead needed to accommodate cargo vessels up to 525 feet LOA (length overall). Occasional operations and maintenance dredging of federal channels and basins will occur as necessary in the future to maintain proposed depths. It is estimated that this O&M dredging will take place every 25-years. Material from O&M operations will be disposed of at the USEPA's authorized ODMDS, along the beaches at JUL or at an approved disposal location in the channel, per FDEP permit #0220509-001-JC issued on April 22, 2005 (or a subsequent permit for O&M operations within the boundaries of the Port) and evaluated in the Environmental Assessment titled *Maintenance Dredging Port Everglades; Broward County, Florida, Final Environmental Assessment and Finding of No Significant Impact* (USACE 2005). As part of its Master Plan, the local sponsor will dredge/remove up to 8.6 acres of mangrove wetlands adjacent to the TN in order that it may be expanded. This is a separable action from the Federal project as it yields benefits to the local sponsor. However, if the work is achieved, USACE will include the TN component as described in Section 2.0 above in its Recommended Plan. The Port is providing enhancement of 16.5 acres of upland and wetland habitat to enable release of the existing conservation easement that currently prevents development on those lands. However, mitigation for the loss of wetland function has not yet been disclosed. Finally, it is anticipated that periodic renourishment of beaches near the Port, under Broward County SPP, will occur in the future as they have in the past.

Table 38 Past and Present Actions at Port Everglades Harbor

Past Actions					
Authorization Year*	**Project**	**Permit Number/ Auth Document**	**Type of Action**	**Impact****	**Mitigation**
1926-1929	Dredging of "Hollywood Harbor"	N/A	Dredging of Entrance Channel and turning basin by private interests	Channel 7,300 ft long, 210 ft wide, 35 ft deep; Turning Basin 1,200 ft square; 1,200 ft, 300 ft slip.	N/A
1930	Adoption of Hollywood Harbor as a Federal Project	H. Doc. 357; 71st Congress			
1935	Port Expansion	Rivers & Harbor's committee Doc 25, 74th Congress	Enlarge entrance channel to 40 ft deep and 500 ft wide	Not documented	N/A
1938	Expansion of turning basin	H. Doc. 545, 75th Congress	Widening of turning basin by add a trapezoidal area 350 ft wide on north side	Not documented	N/A
1946	Port Expansion	H. Doc 768, 78th Congress	Widening of turning basin and flare of the entrance channel at the turning basin	Not documented	N/A
1958	Port Expansion	H. Doc 346, 85th Congress	Deepening & Widening entrance channel on new alignment, increase turning basin in size & depth	Not documented	N/A
1979-1981	Port Expansion	H. Doc 93-144; 93rd Congress	Widening of entrance channel on a new alignment (shift centerline 75 ft north)	Not documented	Creating of Fishing Reef in SW Corning of "old" ODMDS in ~125 ft of water

1983	Berth 29 Bulkhead and Channel	USACE 81L-0624 FDER 060419139	Berth deepening and bulkhead construction	Dredge 311,000 cy material from unvegetated bottom	0.4 acres mangrove creation
1984	Pier 7 Channel Dredging	USACE 83D-2441 FDER 060257779	Channel deepening	Dredge 242,222 cy material from unvegetated bottom	None
1984	East Channel Dredging	USACE 84D-0385 FDER 060748269	Channel improvements	Dredge 46 acres unvegetated bottom, fill 4.73 acres of unvegetated bottom	None
1987	Construct Turning Notch	USACE 84R-4146 FDER 060924019	Port expansion	Removal of 18.27 acres of mangrove wetlands	Creation of 23 acres of mangroves, preservation of 48 acres of mangroves, creation of manatee refuge
1989	Construct Berth 33	USACE 84Y-4246 FDER 061407349	Port expansion	Removal of 2.0 acres of mangrove wetlands	Creation of 4.5 acres of mangroves
2004	Dredging of North Turning Basin		Operations and Maintenance Dredging	N/A	N/A
2005	Dredging of Entrance Channel		Operations and Maintenance Dredging – placement on JUL Beach as part of Broward SPP Segment III	Removed 40,523 cu yd of beach quality sand from inner entrance channel	N/A
2005-2006	Broward County Shore Protection Project, Segment 3	SAJ-1999-5545	Renourishment of Segment 3 of the Broward SPP from Beach fill extended from FDEP R-86 to R-92 within John U. Lloyd State Park, and R-99 to R-128 (Dade County line).	Burial of 7.6 acres of nearshore hardbottom (direct burial of 0.9 acres in John U. Lloyd State Park and 1.1 acres of worm rock habitat in Hollywood).	FDEP required the placement of 8.9 acres of mitigative artificial reef.

(Continued on next page)

Present/Forseeable Actions					
Year*	**Project**	**Permit Number/ Authorizing Document**	**Type of Action**	**Impact**	**Mitigation**
2012	Dredging of Port Everglades – Federal Channel and Port berths and basins	NA	Operations and Maintenance Dredging	NA	NA
2012	Dredging of Western Portion of the DCC by FIND	unknown	Dredging	unknown	unknown
TBD	Expand Turning Notch	FDEP- 06-0314301-003; ACOE - SAJ-1984-04146 (SP-GGL)	Port expansion	Removal of 8.6 acres of mangrove wetlands	Enhancement of 16.5 acres of upland/ wetland habitat for release of conservation easement; 3.81 credits for on-site creation, restoration, and enhancement; and 1+ credit at West Lake Park for mitigation
TBD	Broward County Sand Bypass	Pending, not yet permitted	Shoreline protection	1.46 acres of shoal crest; 11.97 acres of rubble/sand; 7.69 acres of rubble/ colonized pavement; 8.04 acres of colonized pavement; 0.39 acres of channelized wall; 41.01 acres of unconsolidated sediments	unknown
TBD	Broward County Shore Protection Project	Pending, not yet permitted	Renourishment of Segment II	Currently unknown	Currently unknown

*Some dates are authorization dates, while others are construction dates, depending on data available.
**N/A in mitigation column refers to either than mitigation was not required by law (the action pre-dated the Clean Water Act or that mitigation for the action was not considered necessary in the permits issued for the action.

4.28.3 Geographic and Temporal Limits of the Analysis

The geographic areas used for the scope of this analysis varies for each affected resource, For example, air quality is generally evaluated on a county by county basis by USEPA, so the cumulative effects for air quality would be evaluated by this bounding area. Marine resources, however, are affected only within the nearshore areas off of the Broward County coastline and marine inshore waters. Mangrove wetlands are distributed throughout south Florida including Broward County. Revelevant past, current and future projects have been included in the cumulative impact analysis.
In assessing past, current, and future actions for the alternatives, a time period beginning with the initial opening of Lake Mabel to the Atlantic Ocean and construction of the present inlet now known as Port Everglades to the end of the projected 50-year life of the Proposed Action. However, the uncertainty of future trends and lack of detailed planning documents for the various alternative locations allows for only a general evaluation of future trends.

4.28.4 Potentially Affected Resources

The analysis of impacts must focus on specific resources or impact areas. The resources and impact areas that were identified with the potential of such impacts are marine resources including hardground communities, seagrass, Johnson's seagrass, staghorn and elkhorn corals, EFH, and mangrove wetlands. The USEPA has expressed concerns that air quality may be cumulatively affected by the proposed action and so is included on this list.

4.28.5 Resources Not Likely to be Cumulatively Affected

Based on current available information, there are some resources that are not likely to experience measurable cumulative effects, although this Environmental Impact Statement has addressed the specific effects of the proposed project in accordance with NEPA. Also, as additional information becomes available or as a result of public or agency comments received, the need for cumulative impact analysis for these resources will be addressed. The resource areas and the basis for not including a cumulative impact analysis for these areas at this time are as follows:

- *Land Use*. The project would result in a relatively small change in land use, and there are no additional reasonably foreseeable projects other than those included in this analysis..

- *Geology and Sediments*. Rock material removed with project construction would either be placed in the ODMDS or used in the artificial reef mitigation site. Other dredged sediments from the deepening and sediments from regular maintenance dredging currently occurring in Port Everglades harbor would be placed in the ODMDS, along the beaches at JUL or at an approved disposal location in the channel, similar to maintenance dredging activities in the past. A small amount of increased shoaling is expected in the seaward portions of the entrance channel due to the increased footprint; however, since sediment transfer across the inlet is effectively zero in the current condition, no decrease in sediment transfer is expected. Erosion rates along adjacent shorelines would be similar both with and without the project. Thus, there would be no cumulative adverse effect on the geology or coastal sediment budget/transfer for the area.

- *Terrestrial Resources*. The direct and indirect effect of the project on terrestrial resources would be minor (less than two acres would be directly affected), and the project would not

result in additional future impacts to terrestrial resources such as forests or undeveloped lands following project construction. The Port's Master plan may result in changes to Port infrastructure and previously developed lands.

- *Threatened or Endangered Species*. Impacts to listed species were evaluated under the Endangered Species Act and for all species in the project area. For all such species but sea turtles, the project "may affect, but is not likely to adversely affect" them. If USACE is to utilize a hopper dredge for the project, the potential exists for adverse affect to sea turtles via impingement or entrainment in the draghead. All other dredge types will not result in adverse effects on sea turtles directly. Both foraging habitat for sea turtles and designated critical habitat for Acroporid corals will be removed by the project, however the impacts to both species by this removal has been documented (in Section 4.0) to be minimal relative to available habitats throughout Broward County and adjacent areas. NMFS determined that any hardground habitat located in Florida south of the Martin/Palm Beach County line in waters less than 33 meters in depth has the potential to support staghorn and elkhorn corals. No staghorn or elkhorn coral colonies were identified in the project impact area during four surveys conducted by the USACE between 2001 and 2010, or by the Navy in 2011. Staghorn coral is known to occur both north and south of the entrance channel (USN 2011, DC&A 2010b, and NSUOC 2008). While no documented incidents of impacts to staghorn or elkhorn corals have occurred during the projects listed in Table 38, the potential that these species have been impacted by previous actions is possible. Although, as previously stated, no colonies were identified during the surveys conducted for this project, small, isolated corals could have been missed and could be impacted by the project. No projects in the foreseeable future that could directly affect staghorn or elkhorn corals have been identified. However, additional future impacts could result from events out of the jurisdiction or control of the USACE such as ship groundings or habitat degradation. NMFS will continue to monitor these events and develop recovery measures to limit any cumulative effects that would jeopardize the species. Additionally, NMFS has listed five new coral species which are found near the project area and may be in the project area. NMFS conducted a worst case analysis for these five species as part of their conference opinion on the species and determined that the removal of these corals from the project area would not result in jeopardy to the proposed species (the ESA standard for a proposed spcies). Also, the loss of seagrass and mangrove habitats used by any of the above species will be mitigated. Due to avoidance and minimization of impacts associated with the project, no significant increase to cumulative effects for threatened and endangered species are expected to occur.

- *Other Fish and Wildlife*. Impacts to non-listed fish and wildlife are minimal and not expected to result in a significant cumulative effect. Corals will be relocated from the impact area thus reducing impacts to the reproductive population, and mitigation constructed which will result in a potential net gain of corals as new juvenile corals settle from the water column onto the mitigation reef. Losses of fishes associated with dredging and blasting have been shown to be minimal and below the population level.

- *Coastal Barrier Resources*. Lloyd Beach is designated as an "Otherwise Protected Area" and would be affected by removal of approximately 2.7 acres of wetland and uplands along the SAC. Along the SAC, environmentally friendly bulkheads, which perform the required structural function (holding material back from slumping into the channel) while allowing for marine-life use of mangroves behind the bulkhead, will be used. No future actions are anticipated to result in effects to coastal barrier resources.

- *Water Quality*. Water quality impacts would only be temporary due to construction activities, and there are no additional reasonably foreseeable projects other than those included in this analysist.

- *Hazardous, Radioactive, and Toxic Wastes*. The project would not result in any a release of any hazardous, toxic, or radioactive waste and there are no additional reasonably foreseeable projects other than those included in this analysis.

- *Air Quality*. As previously discussed in Section 4.9.6 the operational changes anticipated with the project is not expected to significantly change the number of vessels calling Port Everglades; however, the vessel classes will take advantage of the additional depth. Growth projections showed increase use of the Port with or without the deepening project; however, the amount of cargo and liquid bulk on the vessels is expected to increase as the vessels add more cargo in response to the additional water depth available for use, allowing for more efficient use of the vessels. The 2073 "without the project" vessel estimates are 5,252 vessel calls, an increase of 1,252 vessel calls into Port Everglades over FY2012 totals. The 2073 "with-project" vessel calls are estimated to be 5,061, i.e., a decrease of 191 compared to the "without the project" condition. Additionally, newer generations of cruise ships will add more passengers as the ships get larger. The project allows for a shift from smaller, less efficient ships; to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls. Section 4.9.7 describes the implementation of the new IMO US and Canadian ECA efforts for reducing emissions due to shipping traffic. As stated, the future Port Everglades air quality associated with ship movements in and out of the Port will be the same "with- or without- project" based on the estimated vessel calls. The efforts underway at Port Everglades to reduce emissions associated with Port activities such as equipment improvements and pilot boat operations will also affect both the with- and without-project alternatives. Broward County is currently in attainment, based on the existing vessel fleet makeup, which includes smaller, older, less efficient vessels that may not be in compliance with the new IMO requirements. The with-project alternative results in a fleet shift to larger more efficient vessels that are in compliance with the IMO requirements. Coupling international, national and local efforts with continued Port Everglades efficiency improvements; the Port Everglade's air-shed would retain an USEPA attainment status. Any impacts to air quality would result from construction and would be temporary. The total increases in air pollutants would be relatively minor to the existing point- and mobile-source emissions in Broward County. Broward County is in a designated attainment area and a conformity statement would not be required. No foreseeable future actions leading to an increase in emissions would result from project. (See additional details in the Air Quality text of Section 4.0).

- *Noise*. Noise impacts would be temporary with construction activities and the project would not result in any foreseeable future actions that would result in a cumulative effect.

- *Aesthetic Resources*. Only temporary adverse effects to aesthetic resources would occur during construction; therefore, there would be only a minor incremental impact of the project on aesthetic resources and as a result a minor increase in cumulative impact is expected.

- *Recreation*. Only temporary adverse effects to recreation would occur during construction; therefore, only a minor incremental impact of the project on recreational resources and as a result a minor increase in cumulative impact is expected..

- *Cultural and Historic Resources*. It is anticipated that no cultural or historic resources would be affected by the project. Therefore, no cumulative effect to these resources would result from this project.

- *Native American Resources*. The project would have no effect on Native American resources. and would not influence any foreseeable future actions that could adversely affect Native American tribes.

- *Adjacent Properties*. Although the project would impact approximately 2.7 acres of property within JUL Beach SRA and approximately 1.5 acres of USCG property, it is not likely that any additional impacts to adjacent properties would occur with foreseeable future projects.

- *Environmental Justice*. The project would have no effect and would not influence any foreseeable future actions that could adversely affect minority and low-income populations..

4.28.6 Analysis of Cumulative Effects on Resources

Mangrove Wetlands. Worldwide, mangrove ecosystems have declined by approximately 35 percent (Valiela *et al.* 2001). In Florida, where most U.S. mangroves are located, current mangrove coverage represents a significant reduction from coverage that existed 100 years ago (Gilmore and Snedaker 1993). Specifically, in southeast Florida (Monroe to Martin counties) mangrove acreage declined 11% from 1987 to 2000 (Ueland 2005). Nearshore mangrove habitats along the southern Florida coast also contribute substantially to regional reef fish resources, which also supports a tourist industry and recreational and commercial fisheries valued in billions of dollars (Bohnsack and Ault 1996). Mangrove habitats directly benefit the fishery resources of estuaries and coral reefs within and adjacent to Port Everglades and the Atlantic Ocean by providing nursery habitat. The cumulative loss of these habitats continues to reduce fisheries production within Florida waters.

As previously described in Section 3.5.2, the largest mangrove habitats in the project area occur along the western shore of JUL and north and west of the TN. Some fringing mangrove wetlands in JUL comprise habitat created by the Port as mitigation for previous impacts to native areas of mangrove. Mangroves to the north and west of the TN fall under a FDEP conservation easement. Sloughs, both manmade and natural, are associated with both of these major mangrove areas.

Previous actions described in Table 38 have resulted in losses of mangrove wetlands. Although mangrove wetlands were certainly removed during the early stages of the development of Port Everglades, there were no requirements to document or mitigate for such impacts. Previous impacts to mangrove wetlands due to Port activities total 28.95 acres of direct impacts, with associated mitigation as follows: 27.9 acres of created mangroves, 16.5 acres of enhancement, and 48 acres of preservation.

The current project would impact approximately 1.16 acres of mangrove wetlands along the eastern edge of the SAC. This comprises approximately 0.08% of the existing mangrove acreage within Broward County (which currently has within its boundaries approximately 1409.42 acres of mangroves, based on the county's GIS data obtained from E. Myers). Compensatory mitigation would be provided at West Lake Park, where the county has already been approved and

permitted to offset wetland impacts due to the Port's expansion. Therefore there would be no net loss of Broward County mangrove wetlands.

Seagrass Communities. Seagrass communities within the Port Everglades ROI have been investigated on numerous occasions (see discussion of seagrasses in Section 3.0). The seagrass occurs mainly as isolated patches adjacent to deeper water of the federal channel (i.e., on the channel sideslopes) and are particularly prominent in the IWW adjacent to and below the DCC as well as both north and south of the USCG basin. Since the 1999-2000 seagrass survey noted in Section 3.6.1.3, seagrass coverage has increased from 8.71 acres in the project area to 11.98 acres.

None of the projects noted in Table 30, including the 2005 maintenance dredging of the Entrance Channel indicates impacts to seagrass. The initial development of Port Everglades was initiated with construction of the inlet to Lake Mabel, and it is unclear whether or not seagrass was present in the lake of the New River at the time. Therefore, no documented past impacts to seagrass communities have occurred in the ROI.

Future impacts to seagrass communities within the ROI could occur with actions not currently identified. However, future maintenance dredging of the IWW and DCC could impact existing seagrass beds, although some recolonization is expected. Because seagrass has been shown to colonize shallow areas adjacent to navigation channels, it is expected that patches of seagrass would colonize areas behind the environmentally friendly bulkheads or other protected areas once construction of the project has been completed.

Protected Species: Johnson's Seagrass. Seagrass communities, including those with Johnson's seagrass within the Port Everglades ROI have been investigated on numerous occasions (see Section 3.6.1). The majority of the Johnson's seagrass occurs as two major patches north and south of the USCG basin. Additional patches occur both along the IWW channel margins near the entrance to the DCC and in Port Everglades harbor north of the Entrance Channel. As with seagrass in general, coverage of Johnson's seagrass in the ROI has increased from 3.29 acres in 1999 to 6.58 acres in 2009.

None of the projects noted in Table 30, including the 2005 maintenance dredging of the Entrance Channel documents impacts to Johnson's seagrass. Future maintenance dredging of the IWW and DCC could impact existing Johnson's seagrass (beds frequently swell and dissipate in size over time), although some recolonization is expected. Because seagrass has been shown to colonize shallow areas adjacent to navigation channels, it is expected that patches of Johnson's seagrass would colonize areas behind the environmentally friendly bulkheads or other protected areas once construction of the project has been completed.

Hardground Communities. Impacts to hardground communities in Broward County have occurred since at least the original construction of the "Hollywood Harbor" entrance channel between 1927 and 1928. Prior to construction, there were approximately 14,053 acres of hardground habitat in the county (Figure 85), comprising perhaps 3,657 acres on the outer reef, 2,147 on the middle reef, and 8,249 acres on the inner reef. Approximately 100 acres of habitat has been impacted by the dredging and expansion of the Port Everglades Entrance Channel since 1927. This includes approximately 60 acres of hardbottom and reef habitats. There may also have been additional impacts associated with the disposal of dredged material, but the records associated with disposal prior to the 1970s are very limited or non-existent. Walker (2012) conducted an analysis of the impacts of port construction on the southeast Florida coral reef system and stated that Port Everglades has the highest percentage of impacts associated with habitat burial adjacent to the channel. As the documentation of disposal locations for dredging projects prior to the early 1970s

is very limited, Walker's analysis may include burial that was not linked to port development. Notwithstanding, it is the most complete analysis that is available based on current information. The Recommended Plan would impact an additional 15.33 acres of hardbottom habitat from among these areas. This comprises approximately 0.1% of the offshore historic reef coverage of Broward County.

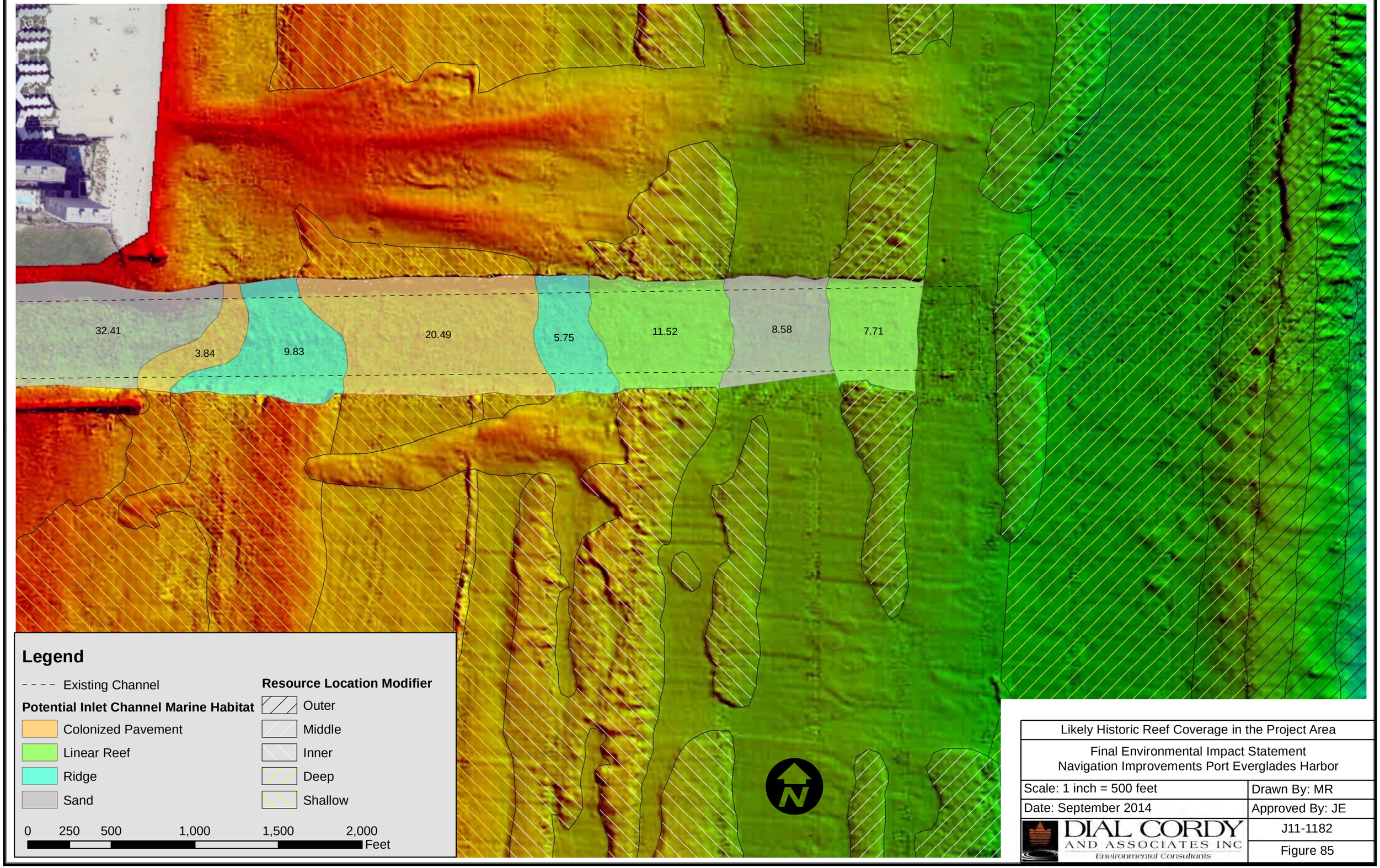
If permitted and constructed, the proposed Port Everglades Inlet Sand Bypass Project would impact additional 1.46 acres of shoal crest; 11.97 acres of rubble/sand; 7.69 acres of rubble/colonized pavement; 8.04 acres of colonized pavement; and 0.39 acres of channelized wall (Broward County 2008). The Broward County Shore Protection Project Segment III completed in 2006 was estimated to bury up to six acres of nearshore hardbottom offshore of the beaches south of Port Everglades (USACE 2003) and Segment II is expected to bury up to 4.9 acres of hardbottom habitats offshore of the beaches north of the Port, when it is constructed (Broward County 2013).

The proposed project at Port Everglades will result in several acres of abandoned channel-related hardbottom surfaces that may be used by reef organisms for attachment and subsequent colonization. This will be due to a relocation of the channel centerline to the north.

Essential Fish Habitats. A loss of EFH would occur with the project with respect hardbottom/reef habitat, seagrass communities, and wetlands, as discussed above. Other impacts to EFH (i.e., water column, softbottom habitat) would be temporary in nature and in situ habitat recovery would occur reasonably quickly. Previous impacts to EFH have been described above, and with the appropriate mitigation, the proposed action would not result in a functional cumulative effect to EFH. The only foreseeable action that may affect EFH would be the dredging of unvegetated softbottom in berthing positions along channels. As is the case regarding the current project, such future work is not anticipated to result in cumulative effects on managed species utilizing such EFH. Section 3.2 of the USEPA's EFH Assessment for the Designation of the Port Everglades ODMDS (found in Appendix H) provides an additional review of cumulative impacts of projects taking place near Port Everglades and offshore of Broward County and is hereby incorporated by reference. The information in this and above paragraphs of this sub-section serves as a cumulative impact assessment for EFH under the May 3, 1999 finding between NMFS and USACE.

4.28.7 Cumulative Effects Assessment Conclusion

Due to efforts to avoid and minimize the environmental impact of the proposed action within the project area and its vicinity, and due to mitigative actions that have been carried out for past projects, will be carried out for the proposed project, and those that are likely to be required for any future actions, USACE anticipates that any cumulative impacts at the Port and within its vicinity are no significant incremental impacts and therefore no significant cumulative impacts. .



Likely Historic Reef Coverage in the Project Area

Final Environmental Impact Statement
Navigation Improvements Port Everglades Harbor

Scale: 1 inch = 500 feet	Drawn By: MR
Date: September 2014	Approved By: JE
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	Figure 85

5.0 MITIGATION AND ENVIRONMENTAL COMMITMENTS

5.1 Introduction

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts (after those impacts have been minimized to the maximum extent practicable) to resources affected by a given project. “Ecological services” refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The amount of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to return to their baseline conditions. Factors relevant in that regard include the quantity of affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services (King 1997). The functional assessment methodologies used included the Florida Uniform Mitigation Assessment Methodology (UMAM) for seagrasses and mangroves and the Habitat Equivalency Analysis (HEA) for hardbottoms/reefs. Details pertaining to the use/application of these methods are found in Appendix E (including sub-appendices).

5.2 Mitigation for Unavoidable Impacts to Reefs and Hardbottom Habitats

5.2.1 Plan Formulation and Agency Coordination

USACE developed a mitigation plan for unavoidable impacts to reef and hardbottom resources over the course of the plan formulation process (see Section 5.2.2). This plan underwent review through the regional and headquarters levels of USACE, as well as through the USACE National Ecosystem Planning Center of Expertise. The functional assessment (HEA) on which the reef/hardbottom mitigation plan is based also underwent an independent peer review to ensure it is technically correct and scientifically sound. Between August and September 2012, USACE was asked by various cooperating agencies to accept mitigation alternatives for evaluation through USACE’s process. Submittals were received from FDEP, Broward County, and NSUOC even though NSU is not a cooperating agency. These submittals were vetted through USACE’s review process: the costs and functional benefits were assessed in order to provide quantitative data to be used in the comparison among all viable alternatives. In addition to the provision of the above mitigation alternatives by various parties, in April 2013 and on other occasions, USACE requested that NMFS (a cooperating agency) identify additional mitigation alternatives. In response to this request, NMFS provided a coral mitigation alternative. Elements of the plan have been incorporated into a “blended” mitigation plan, since it incorporated some elements of the original USACE mitigation plan as well. It is described in detail in the Mitigation Plan and Incremental Cost Analysis (Appendix E), where it is listed as Alternative 11. It is also summarized below.

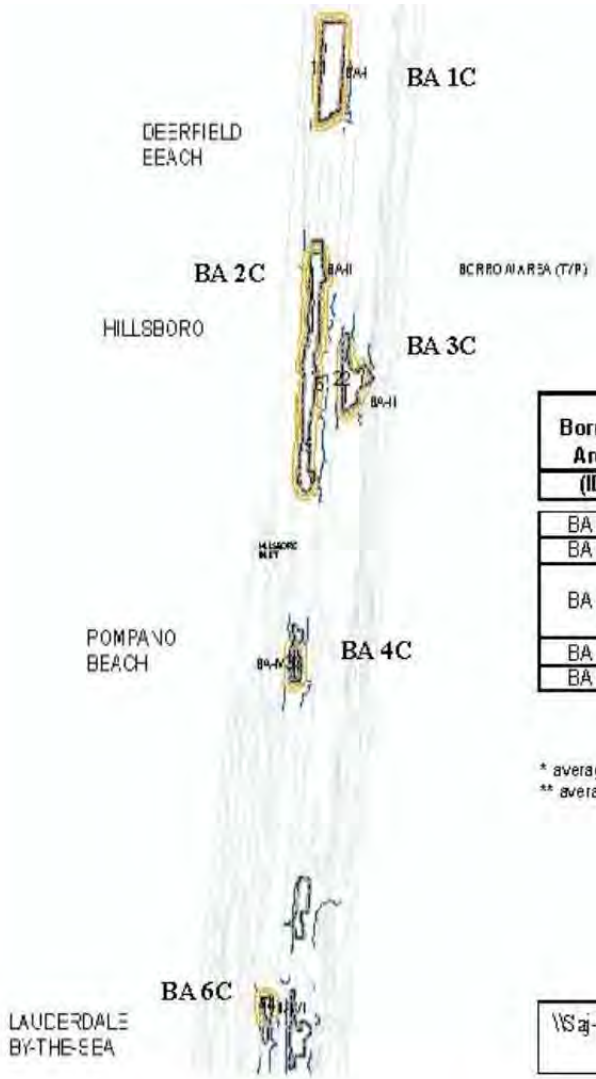
5.2.2 Recommended Reef Mitigation Plan

USACE evaluated 11 potential mitigation alternatives to offset unavoidable impacts to reefs and hardbottom habitats due to implementation of the Recommended Plan. Of those 11 alternatives, five were found to be feasible. Those five alternatives were subsequently subject to an incremental cost analysis. One alternative was determined to be the "best buy" plan; that was Alternative 11. That alternative was a hybrid of the following other alternatives: Alternative 6, repair of grounding sites and subsequent coral installation; Alternative 8, artificial reef creation using quarried or dredged rock; and NOAA's recommended plan, i.e., Alternative 10, coral propagation and active species enhancement).

Under this hybrid plan, at least five (5) acres of boulder-based artificial reef would be constructed (Figure 86 shows some of the candidate locations for placement, but precise and/or alternate locations will be determined in coordination with Broward County and NMFS). Approximately 2.03 acres would receive coral transplants that have been relocated from dredging impact areas and transplanted to boulders at a density commensurate with the impacts (1.4 corals/m²). In addition, 2.97 acres of boulder-based artificial reef would be constructed without coral transplants. The remaining mitigation would comprise direct enhancement of partially degraded reef sites proximate to, but not directly in or adjacent to, the impacts associated with the Port Everglades navigation improvements. The proposed reef mitigation project would enhance degraded reefs by outplanting regionally-appropriate coral colonies and sponges at a density commensurate with those impacted. The organisms for outplanting would be sourced from corals and sponges of opportunity (damaged or rescued colonies from events potentially unrelated to the federal project) or propagated in ocean- or land-based coral nurseries during an 11-year period. As discussed in detail in *Mitigation Requirements Analysis for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements* (USACE and NMFS 2014), the artificial reef sites receiving relocated corals are expected to reach 90% function 35 years after placement and attachment of relocated corals. The bounders without coral relocation are expected to reach 50% function 50 years after placement and enhancement areas are expected to reach 80% function 35 years after placement.

In addition to the five acres of reef creation described above, approximately 18 acres of reef will be enhanced via installation of approximately 103,000 coral colonies (calculated via HEA) outplanted from coral nurseries. These colonies would improve local reef structure and function. More importantly, the outplanted corals would increase the likelihood of successful sexual reproduction (necessary for, and indicative of, a healthy and diverse benthic community) and contribute directly to the pool of coral larvae available to colonize adjacent reefs. In order to maximize the return of lost services, the agencies propose to outplant a regionally appropriate mix of both fast- and slow-growing massive, branching, and octocorals, as well as habitat-forming sponges, as part of the mitigation project.

USACE and NMFS expect the mitigation to be successful based on information provided by NMFS's Acropora propagation program. Specifically, the reefs off Broward County, like many areas, are subject to multiple anthropogenic stressors. However this is one of the few areas where the Acropora population is actually growing or stable; not contracting. It is home to the only large, naturally occurring thickets of *A. cervicornis* in Florida outside of the Dry Tortugas, and multiple new healthy sites being discovered every year. These conditions, along with the proven success of multiple in-situ and ex-situ population enhancement programs in the area, provide a high degree of confidence in the proposed mitigation.



PORT EVERGLADES BORROW AREAS FOR REEF MITIGATION

Borrow Area (ID)	Acreage (acres)		Av. Widths* (ft)	AV. Depths** (ft)	Depth Range (ft)	Distance from center of Borrow Pit to Channel Entrance (ft)	(miles)
BA 1C	112		1000	36	35-48	81250	15.39
BA 2C	224		600	35	30-45	67800	12.84
BA 3C	78	top	150	40	36-45	67400	12.77
		mid	1050				
		bot	430				
BA 4C	46		300	40	36-47	53800	10.19
BA 6C	36		400	40	35-45	38500	7.29

* average widths obtained from GIS mapping tool
** average depths obtained using borrow area post dredge survey maps and GIS mapping tool

GIS Map Location

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Figure 86 Potential artificial reef sites and restoration sites

5.3 Mitigation for Unavoidable Impacts to Mangrove Wetlands and Seagrass Habitats

Three mitigation alternatives were evaluated to compensate for functions of seagrass habitats lost due to the implementation of the Recommended Plan, but only one alternative to compensate for functions of mangrove wetlands was feasible (see Mitigation Plan and Incremental Cost Analysis for details). Following detailed analysis and cost assessments, USACE proposed the following: (a) mitigate for the removal of approximately 4.21 acres of seagrass and (b) the loss of approximately 1.16 acres of mangroves in the project footprint through compensatory use of an on-going habitat enhancement and restoration project at West Lake Park (WLP). To offset impacts due to implementation of the Recommended Plan, 2.5 seagrass functional units and approximately one (1) mangrove functional unit will be provided by WLP, respectively.

The WLP project includes previously permitted restoration, enhancement, and preservation of like habitats in this county-operated, state-owned natural area located to the south of the project area (Figure 87). Details can be found in Appendix E comprising the mitigation plan and related sub-appendices. The WLP project does not comprise a mitigation bank, and its use for mitigation is not available for purchase by the public or private entities. Credits (units of increased ecological functional value) compiled in association with the existing WLP permit (for restoration/enhancement activities) are specifically limited for use as mitigation for Broward County projects (and further, specifically the Port and airport expansions). Broward County (the local sponsor) will bear the responsibility for construction, monitoring, and success of mitigation at WLP. The estimated costs of actions at WLP for mangrove wetland enhancements and seagrass restoration are $238,000 and $4.84M, respectively.

In the event that the number of mitigation credits available at the West Lake Park property/project is lower than the required number of credits necessary to offset impacts to seagrasses, three alternative options are available. One off-site location is available for mitigation in Palm Beach County, another is available in Miami-Dade County, and another may be available on-site within Port Everglades Harbor. The on-site option would occur just north of the TN on the west side of the SAC (Figures 88), and involves positioning the proposed bulkhead (EFB) farther away from the existing mangrove shoreline. Fill could be placed behind the bulkhead (but not in jurisdictional wetlands) to a depth of between -4 and -5 MLLW which, while too deep for mangrove colonization, is within the depth range of existing seagrass habitats located along the edge of the IWW's federal navigation channel. This potential seagrass colonization area has a maximum surface area of approximately 0.9 acres. It would not be planted, as the seagrass species in the impact area (mainly *H. johnsonii* and *H. decipiens*) have not been found to have successful transplantation, but do colonize areas stochastically if conditions are conducive. The EFB in front of the new grass area would protect it from wave action and scour, increasing the potential for grass colonization. Details of the design of this area are dependent upon additional engineering and geotechnical analysis that will be conducted in the PED phase of the project.

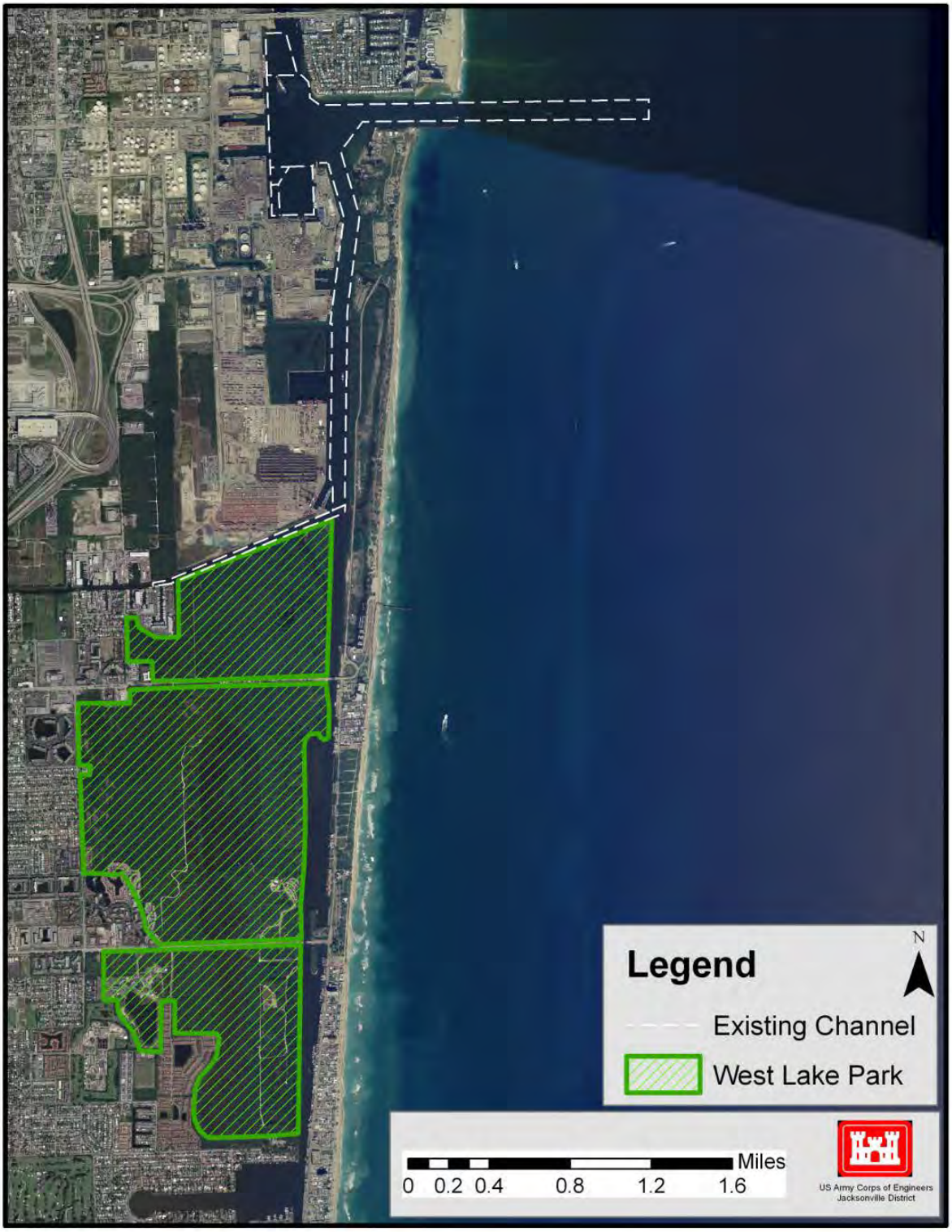
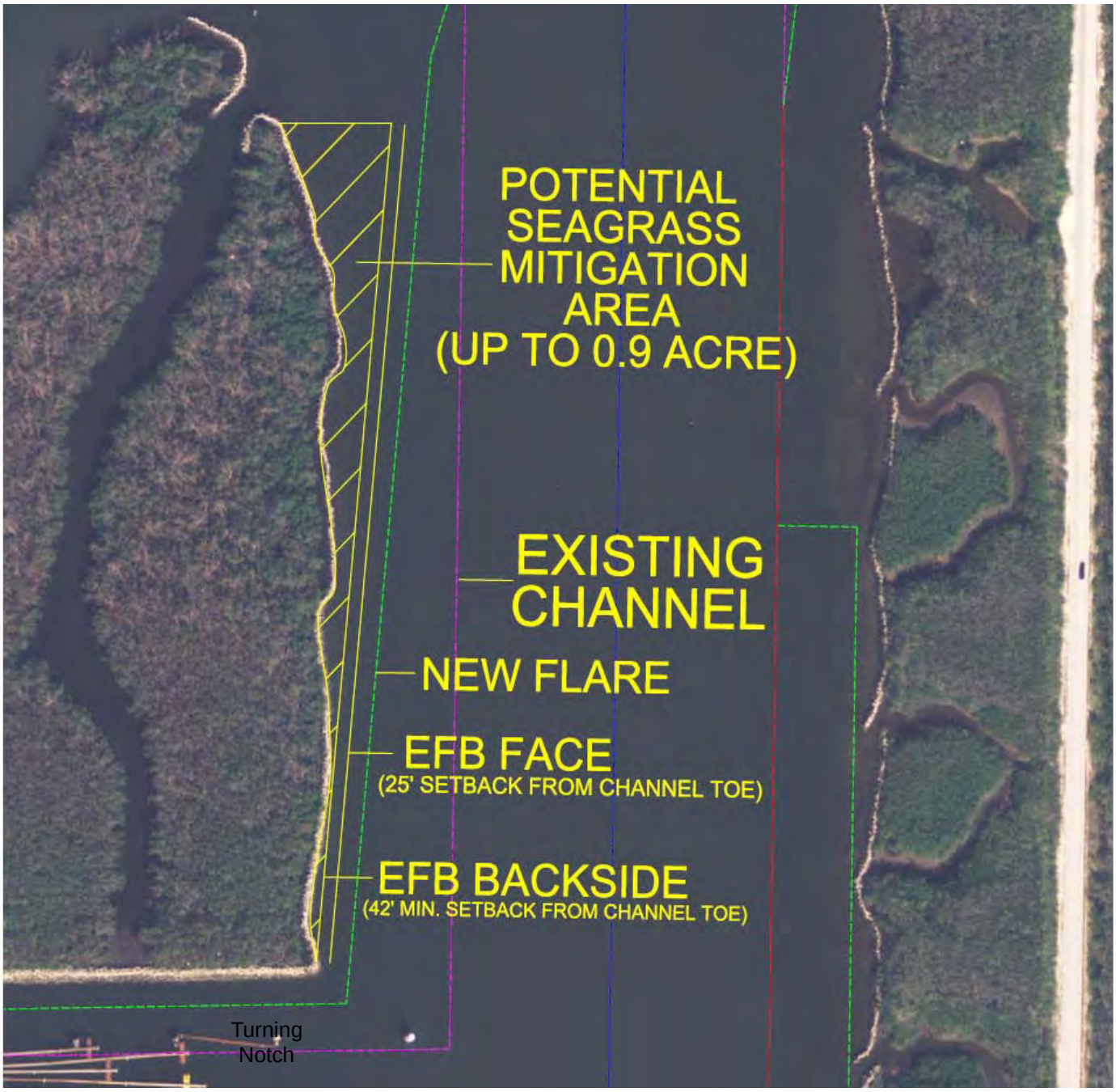
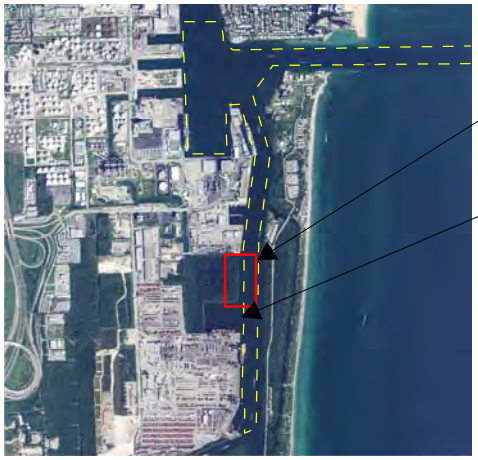


Figure 87 West Lake Park location





SAC Supplemental Seagrass Mitigation Site	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: NTS	Drawn By: MR
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	Figure 88

5.4 Environmental Commitments

Environmental commitments include the following:

1. Mitigate (for resources that were impacted) as proposed and utilize the monitoring plan for the mitigation areas;
2. Implement monitoring and protective measures for endangered, threatened and protected species for impacts associated with blasting;
3. Implement a monitoring plan during construction for determining impacts to fisheries during blasting activities;
4. Abide by the terms and conditions in final endangered species consultations;
5. Follow applicable requirements of the Water Quality Certificate, when issued;
6. Review the plan during PE&D detailing the number of corals to be relocated from the impact areas, specific relocation sites, and monitoring and performance measures associated with the relocation;
7. If FAA restrictions prevent aerial surveys for blasting, coordinate with USFWS, FWC, NMFS (HQ-OPR and SERO-PRD), BCEPD and USEPA, as appropriate, for alternative protected species blasting methodologies.
8. Incorporate, to the maximum extent practicable and applicable, the best management practices detailed in *Best Management Practices for Construction, Dredge and Fill, and Other Activities Adjacent to Coral Reefs* (PBS&J, 2008), prepared by FDEP in partnership with USACE and other resource agencies under the U.S. Coral Reef Task Force. Best Management Practices specific to project construction will be developed during the PE&D phase of the project when the project specific plans and specifications are developed. While generalized BMPs can be cited and incorporated in the EIS, the project details needed for specific, effective BMPs are not developed for the project until the PE&D phase.
9. Incorporate, to the maximum extent practicable and applicable, results from monitoring and impact assessment studies conducted for recent Port of Miami dredging. Results from documentation of that action will be used to avoid and minimize potential impacts, reduce risk, estimate potential direct and indirect impacts, guide development of BMPs, and ensure proper compensation of any lost ecosystem functions due to actions of the Government.
10. Develop resource monitoring and impact assessment plan during PE&D to be used to determine impacts associated with construction activities (including, but not limited to, sedimentation, vessel movements, anchor and cable movements).
11. Organize and coordinate a multi-agency working group to identify concerns, further develop natural resource management planning documents during the PED phase, and assist in the adaptive management process during construction and monitoring.

6.0 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

6.1 National Environmental Policy Act of 1969

Environmental information on the project has been compiled and this Environmental Impact Statement (EIS) was prepared. The project is in full compliance with the National Environmental Policy Act.

6.2 Endangered Species Act of 1973

Consultation was initiated with the USFWS and NMFS upon completion and submittal of the Biological Assessments (Appendix F). The Biological Assessment to USFWS may appear dated, but does not require an update, as there have been no changes in the status of the species under USFWS jurisdiction. An updated Biological Assessment was provided to NMFS in order to include listed *Acropora* (coral) species and the smalltooth sawfish on 5 Sept 2012 and was deemed complete by NMFS on Oct 11, 2012. The USACE requested formal consultation under the ESA and NMFS issued a Biological Opinion for this action on 7 March 2014. In addition to the species requested in the Biological Assessment, NMFS also included the newly listed corals while they were still proposed. It is located in Appendix F of this Final EIS. This project has been fully coordinated under the ESA and will, therefore, be in full compliance with the ESA.

6.3 Fish and Wildlife Coordination Act of 1958

This project will continue to comply with the Fish and Wildlife Coordination Act. This project has been coordinated with the USFWS. A Draft Coordination Act Report (CAR) was received from the USFWS on 5 April 2005 (Appendix G). USACE has coordinated with the USFWS regarding need for a revised CAR. USFWS stated that it will not issue a new CAR prior to the release of Draft EIS by the District, but that after the Draft EIS has been released, the USFWS provided a final CAR letter updating their CAR on August 23, 2013, ensuring USACE compliance with the FWCA.

6.4 National Historic Preservation Act of 1966 (Inter ALIA)

Consultation with the Florida State Historic Preservation Officer (SHPO) was initiated in 2002 and is ongoing in accordance with the National Historic Preservation Act of 1966, as amended, and as part of the requirements and consultation processes contained within the National Historic Preservation Act implementing regulations of 36 CFR 800. This project is also in compliance, through ongoing consultation, with the Archeological Resources Protection Act (96-95), American Indian Religious Freedom Act (PL 95-341), Executive Orders (E.O) 11593, 13007, & 13175 and the Presidential Memo of 1994 on Government to Government Relations. Consultation with SHPO and the tribes was completed in April 2002, with an update in November 2012. The concurrence letters are located in Appendix I.

6.5 Clean Water Act of 1972

The project is in compliance with the Clean Water Act. A Section 401 water quality certification will be obtained prior to construction from the State of Florida. All state water quality standards will be met. A Section 404(b)(1) evaluation is required (and included in Appendix B) because of the projected impacts to approximately 1.16 acres of jurisdictional wetlands.

6.6 Clean Air Act of 1972

The short-term impacts from dredge emissions and other construction equipment associated with the project would not significantly impact air quality. No air quality permits would be required for this project. Broward 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.

6.7 Coastal Zone Management Act of 1972

A federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as Appendix C. Concurrency was granted by FLDEP on July 2013, by the letter included in Appendix C.

6.8 Farmland Protection Policy Act of 1981

No prime or unique farmland would be impacted by implementation of this project. The Farmland Protection Policy Act is not applicable.

6.9 Wild and Scenic River Act of 1968

No designated Wild and Scenic river reaches would be affected by project related activities. The Wild and Scenic River Act is not applicable.

6.10 Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act (MMPA) prohibits takes of all marine mammals in the U.S. (including territorial seas) with a few exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) directs the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issued or, if the taking is limited to harassment. Notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for certain subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings are set forth. NMFS has defined “negligible impact" in 50 CFR 216.103 as: “an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.”

Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance which has the potential to: (i) injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). An Incidental Harassment Authorization (IHA) may be issued, except for activities that have the potential to result in serious injury or mortality (i.e., it may only authorize Level A and B harassment), for a period of no more than one year, following a 30-day public review period. Alternatively, regulations may be granted for a period of five years and may include takes by serious injury and mortality. Upon rulemaking (i.e., defining regulations), Letters of Authorization (LOAs) will be issued to the authorization holder. The rulemaking and associated LOAs cannot be valid for a period of more than five consecutive

years. For both an IHA and regulations, authorization shall be granted if the Secretary finds that the taking will have a negligible impact on a species or stock, and that the IHA or regulations are prescribed setting forth the permissible methods of taking, the means of effecting the least practicable adverse impact, and requirements pertaining to monitoring and reporting.

USACE has initiated consultation with NMFS and USFWS under the Marine Mammal Protection Act of 1972. For species under NMFS jurisdiction, an application for the IHA of marine mammals (for blasting activities associated with the project) will be prepared and submitted during the PE&D phase (after Feasibility and Authorization are completed, but prior to a contract being awarded to a contractor to begin construction). For manatees, consultation was completed in concert with the ESA Section 7 consultation completed with the USFWS.

Under authority of the Marine Mammal Protection Act, NMFS has proposed to issue a one-year IHA, which may be renewed several times depending upon project phasing, pursuant to Section 101(a)(5)(D) of the MMPA to the USACE allowing the incidental take by Level B harassment of a small number of Atlantic bottlenose dolphins during blasting and dredging operations at Port Everglades. The mitigation, monitoring, and reporting measures described in the EIS and IHA application will be incorporated into the IHA.

The Jacksonville District USACE is in on-going coordination with NMFS regarding the IHA for Miami Harbor expansion. The District and contractor's experience there will further inform Port Everglades protective measures.

6.11 Estuary Protection Act of 1968

No designated estuary would be affected by the proposed project activities. The Estuary Protection Act is not applicable.

6.12 Federal Water Project Recreation Act

The project is consistent with the principles of the Federal Water Project Recreation Act, (Public Law 89-72) as amended.

6.13 Fishery Conservation and Management Act of 1976

The project is being coordinated with the NMFS and is in compliance with the Fishery Conservation and Management Act.

6.14 Submerged Lands Act of 1953

The project would occur on submerged lands of the State of Florida. The project has been coordinated with the state and is in compliance with the Submerged Lands Act.

6.15 Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990

The proposed project is being coordinated with the USFWS under the Coastal Barrier Resources Act (CBRA) and Coastal Barrier Improvement Act CBIA) and the USFWS has determined that impacts are exempt under Section 6(a)(2) of CBIA.

6.16 Rivers and Harbors Act of 1899

The proposed project would not obstruct navigable waters of the United States. The proposed action has been subject to the public notice, public hearing, and other evaluations normally conducted for activities subject to the Rivers and Harbors Act. The project is in full compliance.

6.17 Anadromous Fish Conservation Act

Anadromous fish species would not be affected. The project has been coordinated with the NMFS and is in compliance with the Anadromous Fish Conservation Act.

6.18 Migratory Bird Treaty Act and Migratory Bird Conservation Act

No migratory birds would be affected by project activities. The project is in compliance with the Migratory Bird Treaty Act and the Migratory Bird Conservation Act.

6.19 Marine Protection, Research, and Sanctuaries Act

The term "dumping" as defined in the Act does not apply 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 as currently proposed, however if any of the dredged material is disposed in the ODMDS, then this act will apply. Concurrence from USEPA under Section 103 of the Act would be required along with any required testing of the material for suitability for ocean dumping. More information on the ODMDS site can be found in the Final Environmental Impact Statement for the Designation of the Port Everglades and Palm Beach ODMDS' prepared by USEPA and completed in July 2004. The disposal activities addressed in this EIS have been evaluated under Section 404 of the Clean Water Act.

6.20 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires preparation of an Essential Fish Habitat (EFH) Assessment and coordination with the NMFS. An independent EFH Assessment may be used for coordination prior to preparation of the NEPA document. Alternatively, the NEPA document (EA or EIS) may serve as this assessment if it includes the required elements as follows: (1) a description of the proposed action (parts of Section 2.0 of this EIS); (2) analysis of individual and cumulative effects on EFH, federally managed fisheries, and associated species such as major prey species, including affected life history stages (Section 4.0 of this EIS); (3) the USACE's view regarding effects (Section 4.0 of this EIS); and (4) proposed mitigation, if applicable (Section 5.0 of this EIS). Information on EFH, managed species, and life

history stages can be obtained from the NMFS web site for the South Atlantic at http://www.safmc.noaa.gov/safmcweb/Habitat/habitat.html.

The EFH Assessment has been integrated within the EIS (as noted above) and has been coordinated with NMFS during the normal NEPA coordination per the 3 May 1999 Statement of Findings between NMFS and the Jacksonville District. Under the applicable provisions of the MSA, NMFS provided EFH Conservation Recommendations to USACE by letter dated August 13, 2013. Jacksonville District responded to those recommendations by letter dated October 11, 2013. In early 2014, the project and proposed mitigation underwent significant modifications, including an updated functional impact assessment and development of the blended (artificial reef construction plus coral propagation and outplanting) mitigation plan offsetting unavoidable impacts to hardbottom areas. In a letter dated August 14, 2014, USACE updated responses to the NMFS 's August 13, 2013 Conservation Recommendations, taking into account revisions to the project since that date, and concluding USACE's EFH coordination under MSA.

6.21 E.O. 11990, Protection of Wetlands

Wetlands would be affected by project activities. Approximately 1.16 acres of mangroves will be permanently removed by the project. Compensatory mitigation in an adjacent area would be provided to ensure that no net loss of wetland functions and values would occur. The E.O. requires federal agencies to avoid to the maximum extent possible adverse impacts associated with the occupancy and modification of flood plains. This project is in compliance with the goals of E.O. 11990, Protection of Wetlands.

6.22 E.O. 11988, Flood Plain Management

Terrestrial portions of the project area are within the 100-year floodplain or flood with greater frequency. These areas (some jurisdictional wetlands and some uplands along the SAC and TN) will be dredged, not filled. Therefore the project will not contribute to the adverse modification of the floodplain and is hence in accordance with E.O. 11988, Flood Plain Management.

6.23 E.O. 12898, Environmental Justice

This environmental justice assessment recognizes the issues addressed in the Environmental Justice Guidance under NEPA (CEQ 1997), and uses the USEPA Guidance for Incorporating Environmental Justice Concerns in USEPA's NEPA Compliance Analyses (USEPA 1998) as a guide.

An environmental justice assessment requires an analysis of whether minority and low-income populations (i.e., "the populations of concern") would be affected by a proposed federal action and whether they would experience adverse impacts from the proposed action at any of the site alternatives. If there are adverse impacts, the severity and proportionality of these impacts on populations of concern must be assessed in comparison to the larger non-minority or non-low-income populations. At issue is whether such adverse impacts fall disproportionately on minority and/or low-income members of the community and, if so, whether they meet the threshold of "disproportionately high and adverse." If disproportionately high and adverse effects are evident, then the USEPA Guidance advises that it should trigger consideration of alternatives and mitigation actions in coordination with extensive community outreach efforts (USEPA 1998).

The Port is located in a highly urbanized area with an International Airport located 2 miles west of the Port. In addition, an east/west Interstate (I-595), a north/south Interstate (I-95), and the Florida Turnpike are less than five miles from the Port. As such, there is heavy vehicular traffic within the Port area caused by these roadways. There are trucks leaving and entering the Port on a daily basis associated with the delivery of petroleum product as well as the transport of containerized and bulk cargos that produce emissions which contribute to the local air quality. To the east of the Port is a barrier island that contains the U.S. Navy facility, the NSU Oceanographic Center, USCG Station Fort Lauderdale, and John U. Lloyd Beach State Park and adjacent beaches. South of the DCC is an undeveloped coastal system encompassed by West Lake Park. West of the Port is Federal Highway (i.e., U.S. 1), which is flanked by the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development. Residential properties are limited to the north side of the Port, on the barrier island, and are characterized by high-value condominium properties and a few single-family homes.

The purpose of the proposed action is to provide increased safety, efficiency, and lower costs for navigation while protecting the environment. The proposed project would benefit shipping and the general economy including minority and low income populations. Furthermore, construction activities and any additional trucking/commerce that would be due to the project is not anticipated to disproportionately affect economically disadvantaged residential areas or persons belonging to minority groups. Construction traffic and logistic traffic use commercial traffic routes immediately adjacent to the Port, including U.S. highways and Interstate highways.

The project would not result in adverse human health or environmental effects that will disproportionately adversely affect any minority or low-income population. The low-income populations and minority populations are not disproportionately located within the region of influence of the proposed action (see Figures 89 and 90). The proposed activity would not (a) exclude persons from participation in, (b) deny persons the benefits of, or (c) subject persons to discrimination because of their race, color, or national origin, nor would the proposed action adversely impact "subsistence consumption of fish and wildlife." Therefore, the project is in compliance with this Executive Order 12898, Environmental Justice.

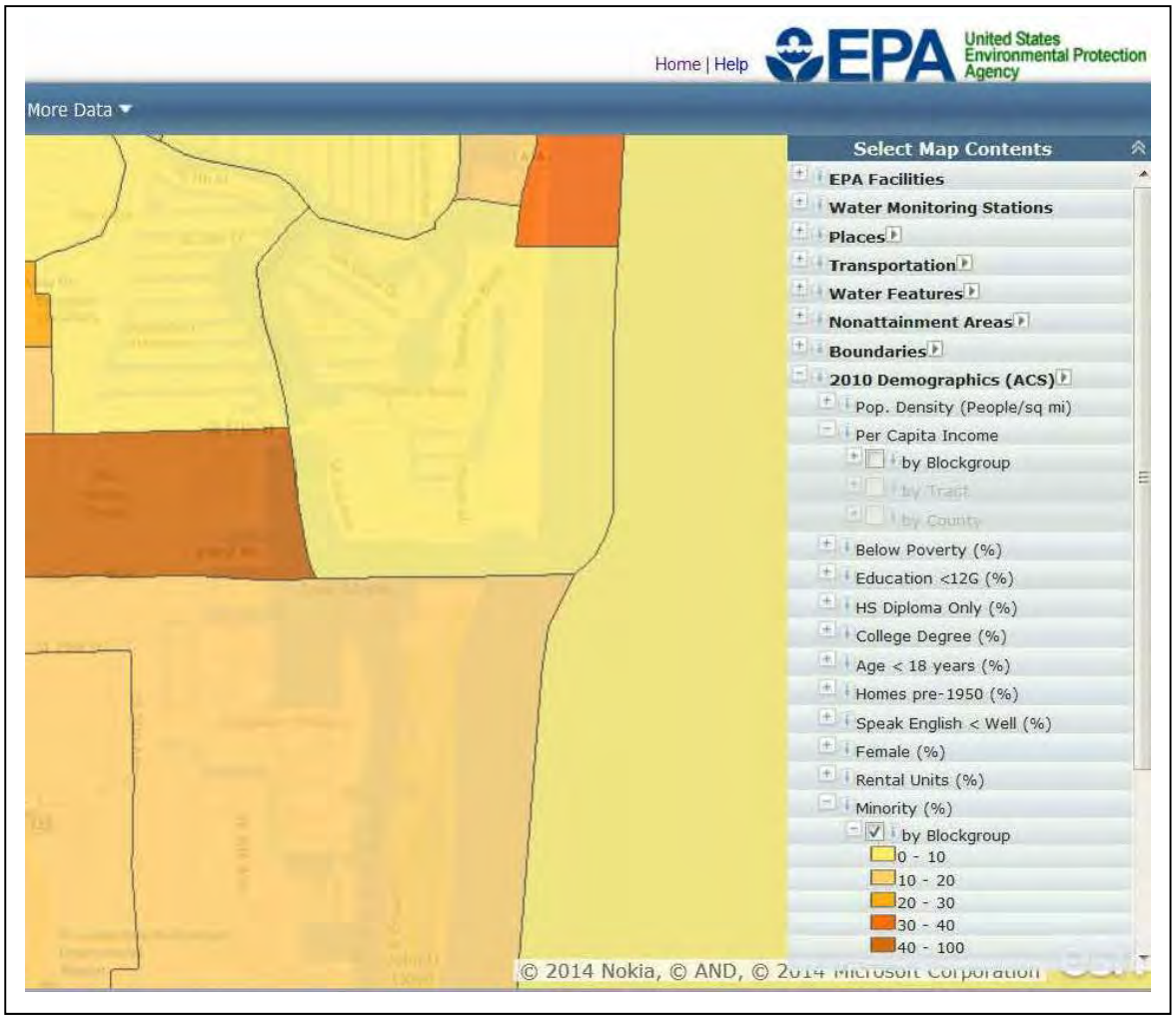

Figure 89 Minority representation within total population near project area

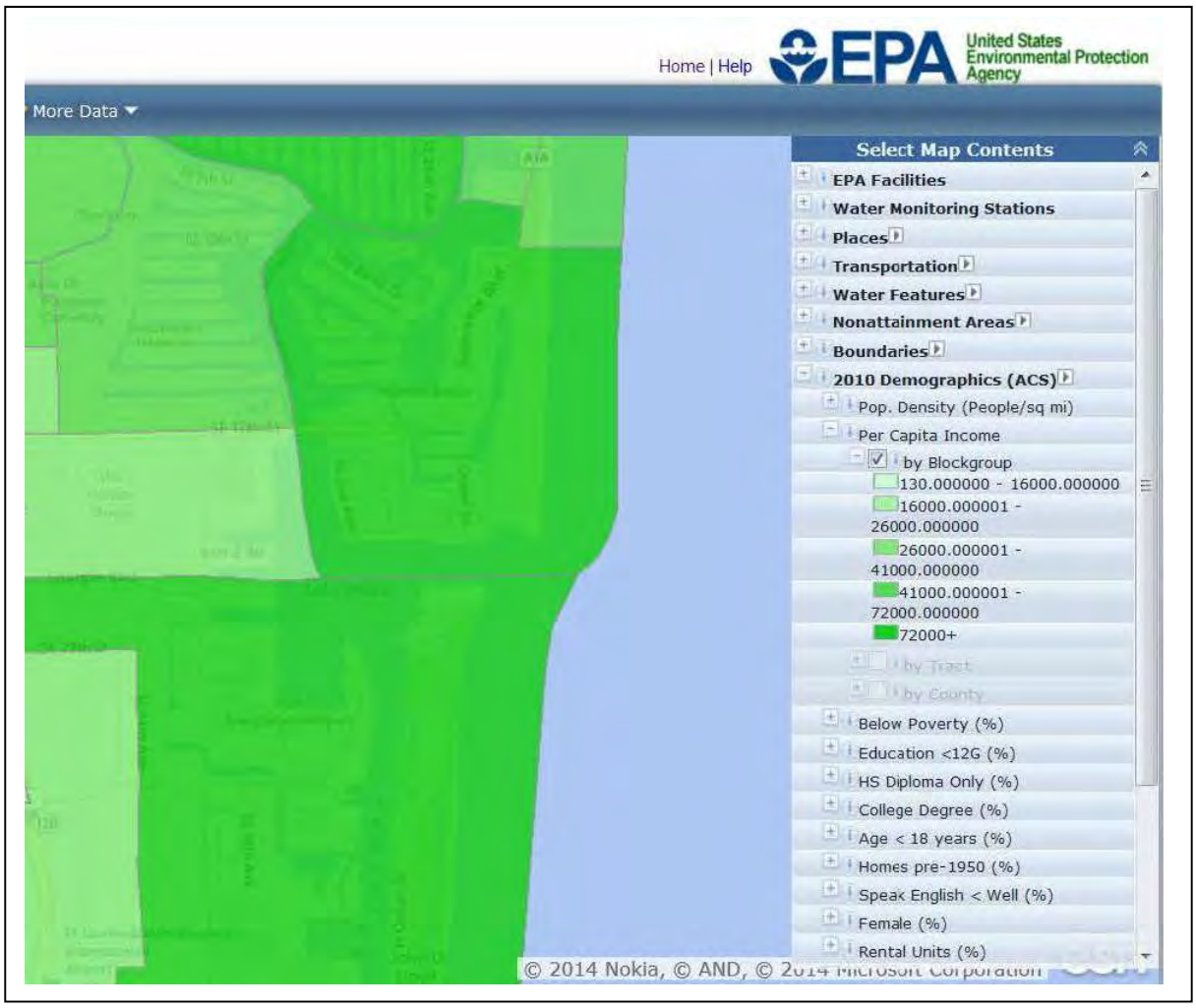

Figure 90 Personal income ranges near project area

6.24 E.O. 13089, Coral Reef Protection

The proposed project would affect United States coral reef ecosystems as defined in the Executive Order. USACE has minimized the impacts to the hardbottom and coral resources associated with the OEC to the maximum extent safe and practicable using ship simulation and consultations with the state-licensed pilots, and the USCG to reduce the width of the flare of the channel extension from 1,000 feet in width to 800 feet in width, thus reducing direct impacts by approximately three acres. USACE will utilize the RFP-contracting process to allow contractors to submit bids that target the least damaging, viable construction methodologies to decrease impacts associated with anchor-cable use for cutterhead dredging. Plans and specifications will have specific hardbottom and coral protection requirements included in the bid package. Monitoring of hardbottom resources will be implemented before, during, and after the project to detect indirect effects to the hardbottom resources surrounding the Port's entrance channel. Compensatory mitigation for any unavoidable impacts to resources is included in project plans and cost estimates. This project is in compliance with the goals of this Executive Order.

6.25 E.O. 13112, Invasive Species

The proposed project would affect the status of invasive species in and around the project area. Potential impacts on invasive species include, but are not limited to:

- Disturbances to the marine environment including in the channel where dredged material will be removed and the excavated dredged material will be placed in the ODMDS. This removal and placement of material will create areas of uninhabited structure allowing pioneer type species, or rapidly reproducing species, to colonize the area. Invasive species can be considered as pioneer species and when these species are allowed to colonize an uninhabited area they generally create an area of invasive species monoculture and lower species diversity, and prevent successional colonization by native organisms. However, previous history of dredging and recovery of the dredged channel has not shown this trend of colonization by invasive species. This historic trend is expected to continue into the future.

- Deeping the Port channel will allow larger vessels to call on the Port in a safer and more efficient manner than they will without the project. Larger vessels have larger volume ballasts allowing a larger volume of foreign ballast water to be pumped into the waters around ports. This increased ballast size also increases the possibility of introduction of an invasive species, particularly the larval or microscopic life stages of invasive species. Larger vessels are expected to call at the Port without the project being constructed, which would result in the same exposure of the harbor to invasive species being introduced by ballast water, with or without the project.

- Project equipment used (i.e. dredges, tender vessels, dump-trucks, backhoes, etc.) has the potential to introduce invasive species into the project area as the equipment is moved from the previous construction site to the Port Everglades project area by the dredging contractor. The path of introduction caused by project equipment is the equipment being transported from one job site to another without equipment undergoing pre and post project de-contamination.

- In addition to the channel and ODMDS impacts mentioned above, if the expansion of the ODMDS is not approved, and another off-shore disposal option is not possible, then remaining dredged material unable to be placed in the existing ODMDS would be placed in an upland disposal site or a commercial landfill. This upland disposal disturbance may create a barren environment which would allow for invasive plant species to colonize the area before native plants are able.

This project will use several methods to ensure compliance with the spirit of E.O. 13112, the CECW-ZA USACE Invasive Species Policy, and the USACE DRAFT CESAJ-SOP for Incorporating Invasive Species Management into the Civil Works Projects. Methods used in this project which allow compliance with E.O. 13112 fall into one of four general methods; preventing invasive introduction or spread, detecting and responding to invasive introduction or spread, restoring native species, and promoting public education. This project will utilize several specific methods to comply with E.O. 13112 including:

- Some of the unavoidable impacts associated with the Port Everglades Expansion Project are being mitigated for within West Lake Park, as part of Broward County's West Lake Park Master Mitigation Plan (WLPMMP), a project to restore degraded habitats within West Lake Park while providing mitigation credits to the Port Everglades Deepening and Fort Lauderdale International Airport expansion projects. The larger restoration project is removing invasive plant species; specifically it is focused on removing Australian pine (*Casuarina spp.*) and creating mud flat and/or sea-grass beds for native species. The WLPMMP includes a monitoring plan for after project completion and native plant species survival, and the WLP master plan details continued efforts by the park staff to control invasive species within the park. Additionally, the USACE permit issued for the restoration plan requires continued control of invasive species as special conditions of the permit (SC #12, SC 15). The WLPMMP project will create and/or improve habitat for native species to re-populate, however creating these habitat disturbances may allow for invasive species to migrate into and colonize the disturbed area. Without an invasive species monitoring and removal plan, the WLPMMP project will not be as successful as anticipated. Under permit special condition #12 issued to Broward County for the construction of the WMPMMP, "A maintenance program shall be implemented in accordance with Attachment 5 for the enhancement/creation areas on a regular basis to ensure the integrity and viability of those areas as permitted. Maintenance shall be conducted in perpetuity to ensure that the enhancement/creation areas are maintained free from Category 1 exotic vegetation (as defined by the Florida Exotic Pest Plant Council at the time of permit issuance) immediately following a maintenance activity. Coverage of exotic and nuisance plant species shall not exceed 5% of total cover between maintenance activities. In addition, the permittee shall manage the conservation areas such that exotic/nuisance plant species do not dominate any one section of those areas."

- Monitoring the mitigation sites (reef and mangrove) for colonization by native species and removal of invasive species, if found, is a key component for the evaluation of the success of the mitigation.

- The topic of invasive species introductions from ballast water is a complex issue that, while it impacts this project, is an issue of such magnitude that it cannot be fully addressed in respect to any single project. Instead there is legislation dictating that ballast water be exchanged 200 miles off-shore (16 U.S.C. Sect 4712) to reduce the number of invasive organisms introduced into a port. Also there is research being done into methods to treat ballast water to ensure that any invasive ballast hitch-hiker species

are eradicated prior to releasing the ballast water (Gregg *et al.* 2009). This research expands from treating ballast water to investigating new ship designs that don't have ballasts but instead continually pump in local water to balance the ships without transporting invasive species around the globe (Parsons and Kotonis 2007).

6.26 E.O. 13045, Protection of Children

Under this Executive Order, each federal agency (a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

The proposed expansion of Port Everglades will not result in environmental health risks or safety risks that may have a disproportionate affect on children. Children may be present at JUL during construction operations; however, since construction is taking place in the water, with no land side operations, none of the construction activities should have an impact on children in the vicinity.

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9.0 PUBLIC INVOLVEMENT

9.1 Scoping and Agency Coordination

The Port Everglades Feasibility Study initiated scoping in April 2000. Scoping and agency coordination were subsequently initiated. The public-at-large was invited into the process beginning with the 28 March 2001 public scoping meeting and associated announcement in the Federal Register (Vol 66, No 57 page 16191), mailings (USACE mailing 5 March 2001), and advertisement in local papers (Miami Herald 16 March 2001 and Sun Sentinel 17 March 2001).

Federal agencies involved included USACE, the USCG, the USN, the USEPA, the USFWS, and the NMFS. State agencies include the FDEP and the FFWCC. Local agencies include the Port, BCEPD, Broward County Aviation Department, Fort Lauderdale/Hollywood Airport, and the Broward County Department of Safety and Emergency Services. Non-Government Organizations/Institutions include NSU and the Port Everglades Pilots Association. Private interests include Hvide Marine, Maersk-Sealand, Coastal Fuels Marketing, and STAR. The first public meeting was held on 28 March 2001. A second public meeting, with agency staff present, was held in July 2013. Appendix L shows comments received following that meeting and the related DEIS release, and that appendix also contains responses to those comments.

9.2 List of Recipients

See Appendix K.

9.3 Comments Received and Response

Comments received during scoping and responses can be found in Appendices A and L.

10.0 REFERENCES

Acropora Biological Review Team (ABRT). 2005. Atlantic *Acropora* Status Review Document. Miami, Florida: Report to National Marine Fisheries Service, Southeast Regional Office, 152 pp.

Adams, William F. and Charles Wilson. 1995. The status of the smalltooth sawfish, *Pristis pectinata* Latham 1794 (Pristiformes: Pristidae) in the United States. *Chondros*. 6(4).

Alongi, D. M. 1990. The ecology of tropical soft-bottom benthic ecosystems. *Oceanography and Marine Biology: An Annual Review* 28: 381-496.

American Ornithologists' Union (AOU). 1998. Check-list of North American Birds. 7th Edition. American Ornithologists' Union, Washington, D.C. 829 pp.

Anonymous. 1978. Seismic primacord as an energy source. Technical bulletin of Primacord Seismic Services, Inc. Houston, Texas.

Aronson, R.B. and W.F. Precht. 2001a. Evolutionary paleoecology of Caribbean coral reefs. In Evolutionary Paleoecology. The Ecological Context of Macroevolutionary Change, eds. W.D. Allmon and D.J. Bottjer, 171-233. New York Columbia University Press.

Aronson, R.B., and W.F. Precht. 2001b. White-band disease and the changing face of Caribbean coral reefs. *Hydrobiologia* 460:25–38.

Aronson, R.B., A. Bruckner, J. Moore, B. Precht, and E. Weil. 2009a. *Acropora cervicornis* (staghorn coral). IUCN Red List: The IUCN Red List of Threatened Species, version 2009.1. http://www.iucnredlist.org/details/133381/0.

Aronson, R.B., A. Bruckner, J. Moore, B. Precht, and E. Weil. 2009b. *Acropora palmata* (elkhorn coral). IUCN Red List: The IUCN Red List of Threatened Species, version 2009.1. http://www.iucnredlist.org/details/133006/0.

Bak, R. P. 1978. Lethal and Sublethal Effects of Dredging on a Coral Reef. *Marine Pollution Bulletin* 9(1): 14-16.

Banks, K.W., B.M. Riegl, E.A. Shinn, W.E. Piller, and R.E. Dodge. 2007. Geomorphology of the Southeast Florida continental reef tract (Miami-Dade, Broward, and Palm Beach Counties, USA). Coral Reefs. Springer-Verlag 2007.

Banks, K., B. Riegl, V.P. Richards, B.K. Walker, K.P. Helmle, L.K.B. Jordan, J. Phipps, M.S. Shivji, R.E. Spieler, and R.E. Dodge. 2008. The reef tract of continental southeast Florida (Miami-Dade, Broward and Palm Beach Counties, USA). In: B.M. Riegl and R.E. Dodge (eds.), Coral Reefs of the USA. Netherlands: Springer, pp. 175-220.

Baums, I., Miller, M.W., Hellberg, M.E., 2005. Regionally isolated populations of an imperiled Caribbean coral, *Acropora palmata*. *Molecular Ecology* 14(5), 1377-1390.

Baums, I., Miller, M.W., Hellberg, M.E., 2006. Geographic variation in clonal structure in a reefbuilding coral, *Acropora palmata*. *Ecological Monographs* 76(4), 503-519.

Biggs, D.C. 1992. Nutrients, plankton, and productivity in a warm-core ring in the western Gulf of Mexico. *Journal Geophysical Research* 97(C2), 2143-2154.

Blaber, S.J.M. and T.G. Blaber. 1980. Factors affecting the distribution of juvenile estuarine and inshore fish. *Fish Biol*. 17: 143-162.

Blaylock, R. A., J. W. Hain, L. J. Hansen, D. L. Palka and G. T. Waring. 1995. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments. NOAA Tech. Memo. NMFS-SEFSC-363, 211 pp.

Bloetscher, F., J. Pire-Schmidt, D.E. Meeroff, T.P. Carsey, J. Stamates, K. Sullivan, and J.R. Proni. 2012. Farfield Modeling of the Boynton Inlet Plume. Environmental Management and Sustainable Development 1(2):74-89.

Bohnsack, J.A. and J.S. Ault. 1996. Management strategies to conserve marine biodiversity. *Oceanogr*. 9: 73-82.

Bowman, R. E., C. E. Stillwell, W. L. Michaels, and M. D. Grosslein. 2000. Food of Northwest Atlantic Fishes and Two Common Species of Squid. NOAA Technical Momorandum NMFS-NE-155.

Brainard, R.E., C. Birkeland, C.M. Eakin, P. McElhany, M.W. Miller, M. Patterson, and G.A. Piniak. 2011. Status review report of 82 candidate coral species petitioned under the U.S. Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-27, 530 pp.

Bright, Thomas J., George P. Kraemer, Gregory A. Minnery, and Stephen T. Viada. 1984. Hermatypes of the Flower Garden Banks, Northwestern Gulf of Mexico: A Comparison to Other Western Atlantic Reefs. *Bulletin of Marine Science* 34(3): 461-476.

Broward County Planning Council .1989. Broward County Land Use Plan. Broward County. Ft. Lauderdale, Florida.

Broward County Planning Division, 2000. Available online at http://www.broward.org/EnvironmentAndGrowth/EnvironmentalProgramsResources/Publications/Documents/DeliniationSaltWaterIntrusionGISMap.pdf

Broward County. 2001. Broward County Shore Protection Project Graphic Information Systems Database. Database and Instruction Manual for Complete 9 CD Version. December 2001.

Broward County. 2007a. Broward County Manatee Protection Plan. Broward County Environmental Protection Department, Biological Resources Division. Nov 2007.

Broward County. 2011. Manatee Population Surveys. Available online at http://www.broward.org/MANATEES/Pages/ManateeSurveys.aspx

Broward County. 2013. Broward County Florida, Shore Protection Project – Segment II. Limited Reevaluation Report (LRR) and Environmental Assessment (EA). August 2013.

Budd, A.F., H. Fukami, N.D. Smith, and N. Knowlton. 2012. Taxonomic classification of the reef coral family Mussidae (Cnidaria: Anthozoa: Scleractinia). Zool. J. Linnean Soc.166:465-529.

Burney, C. and W. Margolis. 1999. Broward County Department of Natural Resource Protection Technical Report 00-01. Sea Turtle Conservation Program, Broward County, Florida 1999 Report. 39pp.

Burns, T.P., 1985. Hard-coral distribution and cold-water disturbances in south Florida. *Coral Reefs* 4:117-124.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551- CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Chesapeake Biological Laboratory. 1948. Effects of underwater explosions on oysters, crabs and fish. Publication No. 70, pp. 1-43.

Christian, E.A. and J.B. Gaspin. 1974. Swimmer safe standoffs from underwater explosions. Technical Report NOLX 80, Naval Surface Weapons Center (formerly Naval Ordnance Laboratory), White Oak, Silver Spring, MD. July 1, 1974.

Clark, C. W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. *Rep.int. Whal. Commn.* 45: 210-212.

Clarke, D., C. Dickerson, and K. Reine. 2002. Characterization of Underwater Sounds Produced by Dredges. American Society of Civil Engineers, 2004.

Clarke, D and D Wilber. 2008. Compliance Monitoring of Dredging-Induced Turbidity: Defective Designs and Potential Solutions.

Coastal Systems International (CSI). 1997. Port Everglades Inlet Management Plan Addendum. Department of Natural Resource Protection, Broward County, Florida. 56 pp.

Continental Shelf Associates (CSA). 2009. Ecological Synthesis of Nearshore Hardbottom Habitats in Southeast Florida. 267 pp.

Continental Shelf Associates, Inc. (CSA)1981. Environmental Monitoring Associated with the Port Everglades Harbor Deepening Project of 1980. Final Report Volumes I and II. June 16, 1981.

Council on Environmental Quality (CEQ). 1997. Considering cumulative effects under the National Environmental Policy Act. Washington, D.C. DEP File # 0271815-001-EE.

CSA International, Inc. 2006. Post-Dredging Resource Impact Assessment Monitoring Survey Final Report for the Key West Harbor Dredging Project (2004-2006) 7 May 2007. Prepared for Department of the Navy, Southern Division Naval Facilities Engineering Command.

CSA International, Inc. 2007. During Dredging Resource Health and Sedimentation Surveys Report for May through August 2007 Hopper Dredging Activities for the Key West Harbor Dredging Project. November 2007. Prepared for Department of the Navy, Southern Division Naval Facilities Engineering Command.

Dausman and Langevin, 2005. Movement of the Saltwater Interface into the Surficial Aquifer System in Response to Hydrology, Stresses, and Water Management Practices. USGS Scientific Investigation Report 2004-55256.

Davies-Colley, R.J., and D.G. Smith. 2001. Turbidity, Suspended Sediment, and Water Clarity: a Review. *Journal of the American Water Resources Association* 37(5).

Davis, A.J., L.S. Jenkinson, J.H. Lawton, B. Shorrocks, S. Wood. 1998.. Making mistakes when predicting shifts in species range in response to global warming. *Nature* 391, 783-786.

Davis, R.A., Jr., 1997. Geology of the Florida coast. In: Randazzo, A.F. and Jones, D.S. (eds.), Geology of Florida. Gainesville: University of Florida Press, pp. 155-168.

Department of Environmental Resources Management (DERM) of Miami-Dade County. 2003. Memo from Luis Ajamil of PBS&J to Eric Myers, DERM dated September 9, 1991 regarding methods to lessen impacts associated with anchor and cable placement for cutterhead dredges. Provided from DERM to the Port of Miami via fax dated September 24, 2003.

Department of Environmental Resources Management (DERM) of Miami-Dade County. 2008. Presence, density and proximity of *Acropora cervicornis* and *A. palmata* in the project areas for the Miami-Dade Test Beach Nourishment- Contract E Project. 10pp.

Deutsch, C.J. 2000. Winter movements and use of warm-water refugia by radio-tagged West Indian manatees along the Atlantic Coast of the United States. Final Report prepared for Florida Power and Light Company and U.S. Geological Survey. 74pp.

Deutsch, C.J., J.P. Reid, R.K. Bonde, D.E. Easton, H.I. Kochman and T.J. O'Shea. 2003. Seasonal Movements, Migratory Behavior and Site Fidelity of West Indian Manatees along the Atlantic Coast of the United States. Wildlife Monographs. No 151. Pages 1-77.

Dial Cordy and Associates Inc. (DC&A). 1999. Marine Seagrass Survey of Port Everglades. Revised Final Report to U.S. Army Corps of Engineers Jacksonville District, Jacksonville, FL 26pp.

Dial Cordy and Associates Inc. (DC&A). 2000. Marine Seagrass Survey of Port Everglades, Final Report, January 28, 2000. Jacksonville Beach, Florida

Dial Cordy and Associates Inc. (DC&A). 2001. Environmental Baseline Study and Impact Assessment for Port Everglades Harbor, Final Report to USACE Jacksonville District. May 31, 2001. Jacksonville Beach, Florida

Dial Cordy and Associates Inc. (DC&A). 2006. Marine Seagrass Survey of Port Everglades. Revised Final Report to U.S. Army Corps of Engineers Jacksonville District, Jacksonville, FL. 15pp.

Dial Cordy and Associates Inc. (DC&A). 2009a. Benthic and Fish Community Assessment at Port Everglades Harbor Entrance Channel. Jacksonville Beach, Florida. 65 pp.

Dial Cordy and Associates Inc. (DC&A). 2009b. Seagrass Mapping and Assessment, Port Everglades Harbor. Prepared for U.S. Army Corps of Engineers Jacksonville District. Jacksonville Beach, FL.

Dial Cordy and Associates Inc. (DC&A) 2010a. Miami Harbor. *Acropora* Coral Survey. Final Report. May 2010.

Dial Cordy and Associates Inc. (DC&A). 2010b. Port Everglades. *Acropora* Coral Survey. Final Report. October 2010. Jacksonville Beach, FL.

Dial Cordy and Associates Inc. (DC&A). 2013. Seagrass Mapping and Assessment Between the Nearshore Hardbottom and Middle Reef on the South Side of Port Everglades Entrance Channel. Broward County Port Everglades Department. Ft. Lauderdale, FL. 12 pp.

Dial Cordy and Associates Inc. (DC&A) and U.S. Army Corps of Engineers (USACE). 2013. Draft Mitigation Requirements Analysis for Impacts to Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements. Jacksonville District USACE, Jacksonville, FL.

Dodge, R. E. and J. R. Vaisnys. 1977. Coral populations and growth patterns: Responses to sedimentation and turbidity associated with dredging. *Journal of Marine Research*, 35(4). Pgs. 715-730.

Dodge, R., S. Hess, and C. Messing. 1991. Final Report: Biological Monitoring of the John U. Lloyd Beach Renourishment: 1989. Prepared for Broward County Board of County Commissioners, Erosion Prevention District of the Office of Natural Resource Protection.

Dodge, R. S. Thornton, D. Gilliam, and R. Shaul. 2001. Biological Survey Report for the Calypso Natural Pipeline Shore Approach Route North of Port Everglades Entrance Channel with Landing South of Port Everglades Entrance Channel. Submitted to Calypso LLC.

Duane, D.B. and E.P. Meisburger. 1969. Geomorphology and sediments of the nearshore continental shelf, Miami to Palm Beach, Florida. USACE Coastal Engineering Research Center. Vicksburg, Mississippi. 47 pp.

Dunton K.H. (1996) Photosynthetic production and biomass of the subtropical seagrass *Halodule wrightii* along an estuarine gradient. *Estuaries* 19436-447.

Dustan, P., and J.C. Halas. 1987. Changes in the reef-coral community of Carysfort Reef, Key Largo, Florida: 1974 to 1982. *Coral Reefs* 6:91-106.

Edge, S. E., T.L. Shearer, M.B. Morgan, and T.W. Snell. 2013. Sub-lethal coral stress: Detecting molecular responses of coral populations to environmental conditions over space and time. Aquatic Toxicology. 128/129:135–146.

Eggleston, D.B. Recruitment in Nassau grouper *Epinephalus striatus*: post-settlement abundance, microhabitat features, and ontogenetic habitat shifts. 1995. *Mar Ecol Prog Ser* 124:9-22.

Erftemeijer, P. L., B. Riegl, B.W. Hoeksema, and P.A. Todd. 2012. Environmental impacts of dredging and other sediment disturbances on corals: a review. Marine Pollution Bulletin 64(9):1737-1765.

Evans, M.W., A.C. Hine, D.F. Belknap, and R.A. Davis. 1985. Bedrock control on barrier island development: west-central Florida coast. *Mar. Geol.* 63, 263-283.

Faulkner, S.G., M. Welz, W.M. Tonn and D. R. Schmitt. 2008. Effects of Simulated Blasting on Mortality of Rainbow Trout Eggs. *Transactions of the American Fisheries Society* 137(1):1-12.

Faunce, C. H. and J. E. Serafy. 2007. Nearshore Habitat Use by Gray Snapper (*Lutjanus griseus*) and bluestriped grunt (*Haemulon sciurus*): Environmental Gradients and Ontogenetic Shifts. *Bulletin of Marine Science* 80(3): 473-495.

Ferro, F.M, L. K.B. Jordan, and R.E. Spieler. 2005. The Marine Fishes of Broward County, Florida: Final Report of 1998-2002 Survey Results. NOAA Technical Memorandum NMFS-SEFSC-532.

Finkl, C.W., 1993. Pre-emptive strategies for enhanced sand bypassing and beach replenishment activities: a geological perspective. *Journal of Coastal Research*, Special Issue No. 18 (Conference on Beach-Inlet Interactions, Jacksonville, Florida, 1992), Pgs. 59– 89.

Finkl, C.W. (ed.). 1994. Coastal Hazards: Perception, Susceptibility and Mitigation. Charlottesville, Virginia: Coastal Education & Research Foundation. 372 pp.

Finkl, C.W., S.M., Khalil, and J.L. Andrews. 1997. Offshore sand sources for beach replenishment: Potential borrows on the continental shelf of the eastern Gulf of Mexico. *Marine Georesources and Geotechnology*. 15:155-173.

Finneran, J. J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whate (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. *J. Acoust. Soc. Am.* 108(1): 417-431.

Fisher, L., K. Banks, D. Gilliam, R. Dodge, D. Stout, B. Vargas-Angel, and B. Walker. 2011. Real-time coral stress observations before, during, and after beach nourishment dredging offshore SE Florida. Proceedings of the 11th International Coral Reef Symposium, Ft. Lauderdale, Florida, 7-11 July 2008. Session number 1.

Florida Department of Environmental Protection (FDEP). 2000. John U. Lloyd State Recreation Area Unit Management Plan, DEP Advisory Group, State of Florida, Department of Environmental Protection, Division of Recreation and Parks, September 28, 2000. Review Draft, 3900 Commonwealth Blvd., Tallahassee, Florida, 32399-3000.

Florida Department of Environmental Protection (FDEP). 2003. Water Quality Status Report: Lake Worth Lagoon-Palm Beach Coast. FDEP Division of Water Resource Management. Tallahassee, FL. http://ftp.dep.state.fl.us/pub/water/basin411/lwl_pbc/status/LakeWorthWEBX.pdf [Accessed September, 30, 2010].

Florida Department of Environmental Protection (FDEP). 2005. Florida Energy Forum 2005. http://www.dep.state.fl.us/energy/energyact/files/2005_Energy_Forum.pdf. Accessed 22 January 2008.

Florida Department of Environmental Protection (FDEP). 2008. http://bcs.dep.state.fl.us/env-prmt/palm_bch/pending/0250572_Town_of_PB_Reach_8_Restoration/001-JC/Completeness%20Review/Environmental%20Assesment/Appendices/Appendix%20H_Air%20Quality%20Measurements/Air%20Quality%20Offshore%20Emissions.pdf

Florida Fish and Wildlife Conservation Commission (FWC). 1997. Florida's endangered species, threatened species and species of special concern official lists. Website: http://www.floridaconservation.org//pubs/endanger.html, accessed 21 December 2001.

Florida Fish and Wildlife Conservation Commission (FWC), Florida Fish and Wildlife Research Institute (FWRI), and National Coral Reef Institute (NCRI). 2006. Southeast Florida Coral Reef Evaluation and Monitoring Project 2005 Year 3 Final Report. Final Report DEP #G0099. Office of Coastal and Aquatic Managed Areas, Florida Department of Environmental Protection.

Florida Fish and Wildlife Research Institute (FWRI), 2006. http://research.myfwc.com/features/category_sub.asp?id=2309, accessed 15 January 2008.

Florida Power and Light Company (FP&L), 2012. http://www.fpl.com/environment/plant/port_everglades.shtml. Accessed 6/26/2012

Fonseca, M.S. 1989. Sediment stabilization by *Halophila decipiens* in comparison to other seagrasses. *Estuarine, Coastal and Shelf Science* 29: 501-507.

Fonseca, M.S., W.J. Kenworthy, E. Griffith, M.O. Hall, M. Finkbeiner, and S.S. Bell. 2008. Factors influencing landscape pattern of the seagrass *Halophila decipiens* in an oceanic setting. *Estuarine, Coastal and Shelf Science* 76: 163-174.

Fonseca, M.S., W.J. Kenworthy, and G.W. Thayer. 1998. Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters. NOAA Coastal Ocean Program Decision Analysis Series, No. 12. NOAA Coastal Ocean Office, Silver Spring, MD.

Forward, K.A., Reinsel, D.S. Peters, R.A. Tankersley, J.H. Churchill, L.B. Crowder, W.F. Hettler, S.M. Warlen, and M.D. Green. 1999. Transport of fish larvae through a tidal inlet. Fisheries Oceanography 8(Suppl. 2), 153-172.

Futch, J.C., D.W Griffin, K. Banks, and E.K. Lipp. 2011. Evaluation of sewage source and fate on southeast Florida coral reefs. *Marine Pollution Bulletin*. 62: 2308-2316.

Gabriel, C. and A.C. Hirons. 2011. Evaluating the Role of Seagrass Beds as a Nursery Habitat and Food Source in Port Everglades, Floirda [Poster]. Nova Southeastern University Oceanographic Center, Dania Beach, FL.

Gallegos, M.E., M. Merino, A. Rodriguez, N. Marba, and C. M. Duarte. 1994. Growth patterns and demography of pioneer Caribbean seagrasses *Halodule wrightii* and *Syringodium filiforme*. *Marine Ecology Progress Series*. 109: 99-104.

Gilliam, D.S., R.E. Dodge, R.E. Spieler, L.K.B. Jordan, J.A. Monty. 2004. Marine biological monitoring in Broward County, Florida: Year 4 annual report. Technical Report DPEP 04-01. Fort Lauderdale, Florida: Broward County, Board of County Commissioners.

Gilliam, D.S., R.E. Dodge, R.E. Spieler, L.K.B. Jordan, J.C. Walczak. 2006. Marine biological monitoring in Broward County, Florida: Year 6 annual report. Technical Report DPEP 04-01. Ft. Lauderdale, Florida: Broward County, Board of County Commissioners.

Gilliam, D. S., R.E. Dodge, R.E. Spieler, L.K.B. Jordan, J.C. Walczak. 2010. Southeast Florida Coral Reef evaluation and monitoring project 2009: Year 7 Final Report. Florida DEP Report # RM085, Miami Beach, FL, 42.

Gilliam, D.S. and A.L. Moulding. 2011. A Study to Evaluate Reef Recovery Following Injury and Mitigation Structures Offshore Southeast Florida: Phase I. Nova Southeastern University Oceanographic Center. Dania Beach, Florida. 60 pp.

Gilmore, R.G., S.C. Snedaker. Mangrove Forests. 1993. John Wiley & Sons. 35 pp.

Goldberg, W.M. 1973. The Ecology of the coral-octocoral communities off the southeast Florida coast: geomorphology, species, composition, and zonation. Bulletin of Marine Science. 23(3):465-488.

Goreau T.F. 1959. The ecology of Jamaican coral reefs. I. Species composition and zonation. Ecology 40:67-90.

Govoni, J.J., M.A. West, L.R. Settle, R. T. Lynch, and M. D. Greene. 2008. Effects of Underwater Explosions on Larval Fish" Implications for a Coastal Engineering Project. Journal of Coastal Research 24(2B): 228-233.

Gregg M, G. Rigby, and G. Hallegraeff. 2009. Review of two decades of progress in the development of management options for reducing or eradication phytoplankton, zooplankton and bacteria in ship's ballast water. *Aquatic Invasions*, 4(3):521-565.

Hall, Wes. 2002. Historic Assessment and Remote Sensing Survey at Port Everglades, Broward County, Florida. Mid-Atlantic Technology and Environmental Research, Inc. Castle Hayne, NC.

Hammerstrom, K.K., and W.J. Kenworthy. 2003. Investigating the Existence of a *Halophila johnsonii* Sediment Seed Bank. NOAA Center for Coastal Fisheries and Habitat Research. Beaufort NC. 19 pp.

Hammerstrom, K.K., W.J. Kenworthy, M.S. Fonseca, and P.E. Whitfield. 2006. Seed bank, biomass, and productivity of *Halophila decipiens*, a deep water seagrass on the west Florida continental shelf. Aquatic Botany 84: 110-120.

Heidelbaugh, W.S. 1999. Determination of the ecological role of the seagrass *Halophila johnsonii*; A Threatened Species in Southeast Florida. Ph.D., Florida Institute of Technology, Melbourne, FL, 127 pp.

Hempen, G.L., T.M. Keevin and T.L. Jordan. 2007. Underwater Blast Pressure from a Confined Rock Removal. In *Proceedings of the Twenty-first Annual Conference on Explosives and Blasting Technique* (Volume 1), Nashville, Tennessee. International Society of Explosive Engineers, Cleveland, OH.

Hempen, G. L., T. M. Keevin, and H. J. Reuben. 2005. Underwater blast pressures from confined rock removal shots: The Kill Van Kull Deepening Project. Pp. 91-100. In *Proceedings of the Thirty-first Annual Conference on Explosives and Blasting Technique*, Orlando, Florida. International Society of Explosive Engineers, Cleveland, OH.

Hettler, Jr., W.F. and A.J. Chester. 1990. Temporal distribution of ichthyoplankton near Beaufort Inlet, North Carolina. *Marine Ecology Progress Series* 68:157-168.

Hubbs, C.L., and A. B. Rechnitzer. 1952. Report on experiments designed to determine effects of underwater explosions on fish life. *California Fish and Game* 38:333-366.

Institute of Water Resources (IWR). 2012. U.S. Port and Inland Waterway Modernization: Preparing for Post-Panamax Vessels. Institute for Water Resources, US Army Corps of Engineers.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: The Physical Science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, edited by S. Solomon et al., Cambridge University press, Cambridge U.K. 996 pp. Available at http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm

Iverson, R. L. and H.F. Bittaker. 1986. Seagrass Distribution and Abundance in Eastern Gulf of Mexico Coastal Waters. *Estuarine, Coastal and Shelf Science* 22:577-602.

Jaap, W.C., 1984. The ecology of the south Florida coral reefs: a community profile. FWS OBS-82/08 and MMS 84-0038. 138 pp.

Jensen, A.S. and G.K. Silber. 2003. (rereleased January 2004) Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR, 37 pp.

Johns, G.M., V.R. Leeworthy, F.W. Bell and M.A. Bonn. 2001. Socioeconomic Study of Reefs in Southeast Florida, Final Report. Broward County Environmental Protection Department, Technical Report 01-10. Available from the internet URL: http://www.broward.org/dni01200.htm.

Johns, E. and J. Lamkin. 2008. Connectivity of the south Florida coral reef ecosystem to upstream waters of the western Caribbean and Gulf of Mexico, in: Ritchie, K.B., Keller, B.D. (Eds.), A Scientific Forum on the Gulf of Mexico: The Islands in the Stream Concept. Marine Sanctuaries Conservation Series NMSP-08-04. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring.

Jones, G.P., D.J. Ferrell, and P.F. Sale. 1991. Fish Predation and its Impacts on the Invertebrates of Coral Reefs and Adjacent Sediments. In *The Ecology of Fishes on Coral Reefs*. Academic Press Inc. 754pp.

Jordan, T.L., K.R. Hollingshead and M.J. Barkaszi. 2007. Port of Miami Project – Protecting Marine Species During Underwater Blasting. In: Proceedings of the Twenty-first Annual Conference on Explosives and blasting Technique (Volume 1), Nashville, Tennessee. International Society of Explosive Engineers, Cleveland, OH.

Jordan, L.K.B., K.W. Banks, L.E. Fisher, K.B. Walker, and D.S. Gilliam. 2010. Elevated sedimentation on coral reefs adjacent to a beach renourishment project. *Marine Pollution Bulletin* 60: 261-271.

Jordan-Dahlgren, E., R.E. Rodriguez-Martinez. 2003. The Atlantic coral reefs of Mexico, in: Cortes, J. (Ed.) Latin American Coral Reefs. Elsevier, Amsterdam, pp 131-158.

Josselyn, M., M. Fonseca, T. and Niessen and R. Larson. 1986. Biomass, Production and Decomposition of a Deepwater Seagrass, *Halophila decipients* Ostenf. *Aquatic Botany* 25:47-61.

Keevin, T. M. 1995. The effects of underwater explosions on fish with techniques to mitigate those effects. Ph.D. Dissertation. University of Illinois, Champaign-Urbana.

Keevin, T.M., and G.L. Hempen. 1997. The environmental effects of underwater explosions with methods to mitigate impacts. U.S. Army Corps of Engineers St. Louis District, St. Louis, Missouri.

Keevin, T.M., G.L., Hempen, J.M. Pitlo and D.J. Schaeffer. 1997. Are Repelling Charge Effective in Mitigating the Impacts of Underwater Explosions? Pg 185-195. In: Proceeding of the Twenty-third Annual Conference on Explosives and Blasting Technique, Las Vegas, NV.

Keevin, T. M., Gaspin, J. B., Gitschlag, G. R., Hempen, G. L., Linton, T. L., Smith, M., and D. G. Wright. 1999. Underwater explosions: Natural Resource concerns, uncertainty of effects, and data needs. Pp. 105-116. *Proceedings of the Twenty-fifth Annual Conference on Explosions and Blasting Technique*, Nashville, Tennessee. International Society of Explosive Engineers, Cleveland, OH.

Kenworthy. W.J. 1997. An updated biological status review and summary of the proceedings of a workshop to review the biological status of the seagrass, *Halophila johnsonii* Eiseman. Report to the Office of Protected Resources. National Marine Fisheries Service, Silver Spring, MD. 23pp.

Kenworthy, J.W. 2000. The role of sexual reproduction in maintaining populations of *Halophila decipiens*: implications for the biodiversity and conservation of tropical seagrass ecosystems. Pacific Conservation Biology 5: 260-268.

Kenworthy, W.J., C.A. Currin, M.S. Fonseca, and G. Smith. 1989. Production, decomposition, and heterotrophic utilization of the seagrass *Halophila decipiens* in a submarine canyon. *Marine Ecology Progress Series*. 51: 277-290.

Ketten, D.R. 2004. Experimental Measures of Blast and Acoustic Trauma in Marine Mammals. Final Report to the Navy Office of Naval Research. Grant Number: N000149711030.

King, D.M. 1997. Comparing Ecosystem Services and Values. National Oceanic and Atmospheric Administration. Silver Spring, MD. Available online at: http://www.darp.noaa.gov/pdf/kingpape.pdf
Lin, P.C.-P. 1998. Stability analysis of artificial reefs. Pages 94-103 *in* William Horn, ed. Florida Artificial Reef Summit 1998. Florida Department of Environmental Protection. Tallahassee, FL.

King, S.P. and P. Sheridan. 2006. Nekton of New Seagrass Habitats Colonizing a Subsided Salt Marsh in Galveston Bay, Texas. *Estuaries* 29(2):288-296.

Klima, E.F., G.R. Gitschlag, and M.L. Renaud. 1988. Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. *Marine Fisheries Review* 50(3):33-42.

Kline, D.I., and S.V. Vollmer. 2011. White Band Disease (type I) of endangered Caribbean acroporid corals is caused by pathogenic bacteria. *Sci. Rep.* 1:7; doi:10.1038/srep00007.

Konya, C. J. 2001. Recommendations for blasting at Port Everglades Harbor. Precision Blasting Services. Montville, Ohio. 45 pp.

Konya, C.J. 2003. Rock Blasting and Overbreak Control. Second Edition. National Highway Institute. Publication Pub. No. FHWA A-HI-92-011.

Laist, D.A and J.E. Reynolds. 2005. Influence of Power Plants and Other warm-water refuges on Florida manatees. *Marine Mammal Science* 21(4):739-764.

Laughlin, J. 2005. Friday Harbor Ferry Terminal Restoration Project. Underwater Sound Levels Associated with Restoration of the Friday Harbor Ferry Terminal. Washington State Department of Transportation. Office of Air Quality and Noise.

Leatherwood, S. and R.R. Reeves. 1983. Sierra Club handbook of whales and dolphins. Sierra Club Books, San Francisco, CA. 302pp.

Lewis,F.G., III. 1984. Distribution of macrobenthic crustaceans associated with *Thalassia, Halodule* and bare sand substrata. *Marine Ecology Progress Series*. 19:101-113.

Lighty R.G., I.G. Macintyre, and R. Stuckenrath. 1978. Submerged early Holocene barrier reef southeast Florida shelf. *Nature* 275:59-60.

Lindeman, K.C., R. Pugliese, G.T. Waugh, and J.S. Ault. 2000. Developmental Patterns within a Multispecies Reef Fishery: Management Applications for Essential Fish Habitats and Protected Areas. *Bulletin of Marine Science* 66(3): 929-956.

Loya Y. 1972. Community structure and species diversity of hermatypic corals at Eilat, Red Sea. *Marine Biology* 13:100-123.

Lugo-Fernández, A., 2006. Travel times of passive drifters from the western Caribbean to the Gulf of Mexico and Florida–Bahamas. Gulf of Mexico Science 24, 61-67.

Lugo-Fernández, A., Deslarzes, K.J.P., Price, J.M., Boland, G.S., Morin, M.V., 2001. Inferring probable dispersal of Flower Garden Banks coral larvae (Gulf of Mexico) using observed and simulated drifter trajectories. Continental Shelf Research 21, 47-67.

Lydecker, A.D.W., J. Wallace, and S.R. James, Jr. 2012. Submerged Cultural Resources Remote Sensing Survey of the Port Everglades Channel and Ocean Dredged Material Disposal Site, Broward County, Florida. Panamerican Consultants, Inc. Memphis, TN.

Lydecker, A.D.W., J. Wallace, and S.R. James, Jr. 2013. Archeological Identification of Two Targets in the Port Everglades Channel Expansion, Broward County, Florida. Panamerican Consultants, Inc. Memphis, TN.

MacGillivray, A. 2007. Underwater Acoustic Measurements from Washington State Ferries 2006 Mukilteo Ferry Terminal Test Pile Project. March 2007.

Martinez-Pedraja, J.J., L.K. Shay, T.M. Cook, and B.K. Haus. 2004. RSMAS 2004-03. Technical Report: Very-High Frequency Surface Current Measurement along the Inshore Boundary of the Florida Current During NRL 2001.

Messing, C.G. and R.E. Dodge. 1997. Port Everglades Macroinvertebrate Monitoring. Monitoring of Benthic Macroinvertebrate Assemblages at the Southport Turning Basin and Adjacent Areas of John U. Lloyd State Recreation Area. NSUOC, Dania, FL. Prepared for Port Everglades Authority.

Mezich, R.R. 2001. Manatees and Florida Power and Light's Lauderdale and Port Everglades Power Plants. A Report Developed for the Florida Fish and Wildlife Conservation Commission, Office of Environmental Services. Bureau of Protected Resources.

Mitchell, E. 1975. Preliminary report on Nova Scotia fishery for sei whales (*Balaenoptera borealis*). *Rep. Int. Whal. Commn*. 25:218-225.

Mitchell, E. and D.G. Chapman. 1977. Preliminary assessment of stocks of northwest Atlantic sei whales (*Balaenoptera borealis*). *Rep. Int. Whal. Comm*, Special Issue 1:117-120.

Moffat and Nichol, International. 2006. Port Everglades Offshore Anchorage Feasibility Study Final Report. Calypso U.S. Pipeline, LLC.

Mora, C., Chittaro, P.M., Sale, P.F., Kritzer, J.P., Ludsin, S.A., 2003. Patterns and processes in reef fish diversity. *Nature* 421:933-936.

Moser, M. 1999a. Cape Fear River Blast Mitigation Tests: Results of Caged Fish Necropsies. 49 pages. Final Report to CZR, Inc under Contract to U.S. Army Corps of Engineers, Wilmington District.

Moser, M. 1999b. Wilmington Harbor Blast Effect Mitigation Tests: Results of Sturgeon Monitoring and Fish Caging Experiments. Final Report to CZR, Inc under contract to U.S. Army Corps of Engineers. Wilmington District.

Moyer, R.P., B. Riegl, K. Banks, and R.E. Dodge. 2003. Spatial patterns and ecology of benthic communities on a high-latitude South Florida (Broward County, USA) reef system. *Coral Reefs* 22(4):447-464.

Mumby, P. J., A. J. Edwards, J.E. Arias-Gonzalez, K.C. Lindeman, P.G. Blackwell, A.Gall, M.I. Gorczynska, A.R. Harborne, C.L. Pescod, H. Renken, C.C.C. Wabnitz and G. Llewellyn. 2004. Mangroves enhance the biomass of coral reef fish communities in the Caribbean. *Nature* 427: 533-536.

Nagelkerken, I., G. van der Velde, M.W. Gorissen, G.J. Meijer, T. van't Hof and C. den Hartog. Importance of Mangroves, Seagrass Beds and the Shallow Coral Reef as a Nursery for Important Coral Reef Fishes, Using a Visual Census Technique. 2000. *Estuarine, Coastal and Shelf Science* 51:31-44.

National Marine Fisheries Service (NMFS). 1991. Biological Opinion – Dredge of channels in the southeastern United States from North Carolina through Cape Canaveral, Florida. Signed November 25, 1991.

National Marine Fisheries Service (NMFS). 1994. NMFS Southwest Region Position Paper on Experimental Technology for Managing Downstream Salmonid Passage. Southwest Regional Office. Long Beach, CA.

National Marine Fisheries Service (NMFS). 1995. Endangered Species Act Section 7 Consultation with the U.S. Army Corps of Engineers, South Atlantic Division on Hopper Dredging of Channels and Borrow Areas in the Southeastern U.S. from North Carolina through Florida East Coast. Signed August 25, 1995.

National Marine Fisheries Service (NMFS). 1997. Endangered Species Act Section 7 Consultation with the U.S. Army Corps of Engineers, South Atlantic Division on the Continued Hopper dredging channels and borrow areas in the southeastern United States. Signed September 25, 1997.

National Marine Fisheries Service (NMFS). 2002a. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2002. NOAA Technical Memorandum NMFS-NE-169.

National Marine Fisheries Service (NMFS). 2002b. Miami Harbor Phase II ESA consultation (NMFS Consult #I/SER/2002/00178 dated Sept 23, 2002).

National Marine Fisheries Service (NMFS). 2003a. Miami Harbor GRR ESA consultation. NMFS Consult #F/SER/2002/01094 – Feb 26, 2003.

National Marine Fisheries Service (NMFS). 2003b, as amended (2005 and 2007). Endangered Species Act Section 7 Consultation with the U.S. Army Corps of Engineers for Dredging of Gulf of Mexico Navigation channels and San Mining "borrow" areas using hopper dredges by COE Galveston, New Orleans, Mobile and Jacksonville Districts. Consultation Number F/SER/2000/01287. Signed November 19, 2003 and revised 2005 and 2007.

National Marine Fisheries Service (NMFS). 2005a. Acropora Biological Review Team. Atlantic Acropora status Review Document. Report to the National Marine Fisheries Service, Southeast Regional Office. March 3, 2005.152 pp.

National Marine Fisheries Service (NMFS). 2005b. Recovery Plan for the North Atlantic Right Whale (*Eubalaena glacialis*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service (NMFS). 2005c. Taking Marine Mammals Incidental to Specified Activities: Port of Miami Construction Project (Phase II). FR Notice dated April 25, 2005. 70 FR 21174.

National Marine Fisheries Service (NMFS). 2007a. Endangered Species Act 5-Year Review Johnson's Seagrass. Available on-line: http://www.nmfs.noaa.gov/pr/pdfs/species/johnsonsseagrass_5yearreview.pdf

National Marine Fisheries Service (NMFS). 2007b. Interim Acropora Survey Protocol January 2007. http://sero.nmfs.noaa.gov/pr/pdf/RecommendedSurveyProtocolforAcropora.pdf

National Marine Fisheries Service (NMFS). 2007c. (Revised) Endangered Species Act – Section 7 Consultation Biological Opinion, Dredging of Gulf of Mexico Navigation Channels and Sand Mining ("Borrow") Areas Using Hopper Dredges by COE Galveston, New Orleans, Mobile, and Jacksonville Districts (Consultation Number F/SER/2000/01287). NOAA-NMFS Southeast Regional Office. Protected Resources Division, St. Petersburg, FL. 122 pp.

National Marine Fisheries Service (NMFS). 2008a. Biological Opinion for the Reach 8 beach nourishment located in Palm Beach County, Florida (Consultation Number F/SER/2007108929).

National Marine Fisheries Service (NMFS). 2008b. Database output of stranded dolphins in Broward County Florida – 1992 – 2007. Email from Elizabeth Tuohy-Sheen. NMFS-SEFSC, Miami, FL dated 23 January 2008.

National Marine Fisheries Service (NMFS). 2008c. Endangered and Threatened Species; Critical Habitat for Threatened Elkhorn and Staghorn Corals. Proposed rule. 73 FR 6895. February 6, 2008

National Marine Fisheries Service (NMFS). 2008d. Stock Assessment Reports by Species/Stock Website. Accessed January 15, 2008. http://www.nmfs.noaa.gov/pr/sars/species.htm

National Marine Fisheries Service (NMFS). 2008e. Endangered Fish and Wildlife; Final Rule To Implement Speed Restrictions to Reduce the Threat of Ship Collisions With North Atlantic Right Whales. 73 FR 60173. October 10, 2008.

National Marine Fisheries Service (NMFS). 2009a. Endangered Species Act, Section 7 Consultation Biological Opinion. Dade County Beach Erosion Control Project, Contract "E," located in Dade County, Florida. (Consultation Number *F/SERI2009/00879)*. October 21, 2009.

National Marine Fisheries Service (NMFS). 2009b. Recovery Plan for Smalltooth Sawfish (*Pristis pectinata*). Prepared by the Smalltooth Sawfish Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service (NMFS). 2011. Characterization of Essential Fish Habitats in the Port Everglades Expansion Area. St. Petersburg, FL. 45 pp.

National Marine Fisheries Service (NMFS). 2012. Takes of Marine Mammals During Specified Activities; Confined Blasting Operating by the U.S. Army Corps of Engineers During the Port of Miami Construction Project in Miami, Florida; Notice. 77 FR 49278. August 15, 2012.

National Marine Fisheries Service (NMFS) 2014. Endangered and Threatened Species: Critical Habitat for the Northwest Atlantic Ocean Loggerhead Sea Turtle Distinct Population Segment (DPS) and Determination Regarding Critical Habitat for the North Pacific Ocean Loggerhead DPS; Final Rule. 79 FR 39856.

National Marine Fisheries Service (NMFS) 2014a. DRAFT Recovery Plan Elkhorn Coral *(Acropora palmata)* and Staghorn Coral *(A. cervicornis).*

National Ocean Service (NOS). 2010. *Coast Pilot*. Volume 4.

National Research Council (NRC). 1987. Responding to Changes in Sea Level, Engineering Implications, Committee on Engineering Implications of Changes in Relative Mean Sea Level, Marine Board, Commission on Engineering and Technical Systems, National Research Council. National Academy Press, Washington DC 1987, 148pp.

Nedwell, J.R. and T.S. Thandavamoorthy, 1992. The waterborne pressure wave from buried explosive charges: an experimental investigation. *Journal of Applied Acoustics* 37(1992):1-14.

North Atlantic Right Whale Consortium (NARWC). 2010. North Atlantic Right Whale Report Card. http://www.rightwhaleweb.org/pdf/ 2010_report_card_addendum.pdf

Nova Southeastern University Oceanographic Center and Olsen Associates (NSUOC). 2008a. Broward County Port Everglades Sand By Pass Project: Benthic Habitat Mapping and Assessment. Prepared for Broward County. 54 pp.

Nova Southeastern University Oceanographic Center (NSUOC). 2008b. Broward County Port Everglades Sand By Pass Project: Benthic Resource Impact Summary. Prepared for Olsen Associates, Inc.. 9 pp.

Nova Southeastern University Oceanographic Center (NSUOC). 2011. Benthic Habitat Characterization for the South Florida Ocean Measurement Facility (SFOMF) Protected Stony Coral Species Assessment. Prepared for Seaward Services, Inc. 54pp.

Nova Southeastern University Oceanographic Center and National Coral Reef Institute (NSUOC & NCRI). 2007. Development of GIS Maps for Southeast Florida Coral Reefs. Prepared for the Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission. DEP AGREEMENT NO. G0057; NOAA AWARD NA16OZ2440. 71 pp. Available at http://www.dep.state.fl.us/coastal/programs/coral/reports/LBSP/LBSP-06.pdf

Odum, W.E. and C.C. McIvor. 1990. *Mangroves*. In Ecosystems of Florida, R.L. Myers and J.J. Ewel, eds. University of Central Florida Press. Orlando, FL. 29 pp.

Odum, W.E., C.C. McIvor, and T.J. Smith. 1982. The ecology of the mangroves of south Florida: a community profile. FWS/OBS-81/24. Washington, DC, United States Fish and Wildlife Service, Office of Biological Services.

O'Keeffe, D. J., and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. NSWC TR 83-240. Naval Surface Weapons Center, Dahlgren, VA.

Onuf, Christopher P. 1996. Seagrass responses to long-term light reduction by brown tide in upper Laguna Madre, Texas: distribution and biomass patterns. *Marine Ecology Progress Series* 138: 219-231.

OSPAR Commission, 2009a. Overview of the impacts of anthropogenic underwater sound in the marine environment. Convention for the Protection of the Marine Environment of the North-East Atlantic. 133 pp.

OSPAR Commission, 2009b. Assessment of the environmental impact of underwater noise. Convention for the Protection of the Marine Environment of the North-East Atlantic. 40 pp.

Palma, J., and J.J. Uldall. 1943. Immersion blast injuries. *U.S. Navy Medical Bulletin* 41:3-8.

Parrish, James D. 1989. Fish communities of interacting shallow-water habitats in tropical oceanic regions. *Marine Ecology Progress Series* 58:143-160.

Parsons, M and M. Kotonis. 2007. Hydrodynamic Optimization Testing of Ballast-Free Ship Design. Department of Naval Architecture and Marine Engineering. University of Michigan. Ann Arbor, MI.

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham and J. W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. *Fish. Bull., U.S.* 88: 687-696.

PBS&J. 2008. Best Management Practices for Construction, Dredge and Fill, and Other Activities Adjacent to Coral Reefs (PBS&J 2008). Prepared for Southeast Florida Coral Reef Initiative and the Florida Department of Environmental Protection. 126 pp. Available at http://www.dep.state.fl.us/coastal/programs/coral/reports/MICCI/MICCI_6_BMP_Manual.pdf

Pearson, T.H., and Rosenberg, R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology: An Annual Review 16: 229311.

Pennekamp, J..G.S., R.J.C. Epskamp, W.F.Rosenbrand, A. Mullié, G.L.Wessel, T. Arts, and I.K. Deibel. 1996. Turbidity Caused by Dredging; Viewed in Perspective. *Terra et Aqua*. No. 64. Pg. 10-17.

Peterson, C.H., and Peterson, N.M. 1979. The ecology of intertidal flats of North Carolina: a community profile. US Fish and Wildlife Service Biological Services Program FWS/OBS-79/39. 73 pp.

Peterson, C.H., and Lubchenco, J. 1997. Marine ecosystem services. In G.C. Daily (editor), Nature's Services: Societal Dependence on Natural Ecosystems, pp 177-194. Island Press, Washington, DC.

Planes, S., R. Galzin, J.-P. Bablet, and P.F. Sale. 2005. Stability of coral reef fish assemblages impacted by nuclear tests. Ecology 86:2578–2585.

Port Everglades, 2006. Port Everglades Annual Commerce Report Fiscal Year 2006. http://www.broward.org/port/annualreport.htm Accessed 22 January 2008.

Port Everglades. 2007a. Port Protects Environment And Saves Money By Reducing Energy In Cruise Terminals And Offices (press release). Broward County Department of Port Everglades. Ft. Lauderdale, FL. Available at http://www.sunny.org/media/press-releases/view/Port-Protects-Environment-and-Saves-Money-by-Reducing-Energy-In-Cruise-Terminals-and-Offices/830/0/

Port Everglades. 2007b. The Local and Regional Economic Impacts of Port Everglades. Final Report. http://www.broward.org/port/pdfs/masterplan/economic_impact.pdf. Accessed 22 January 2008.

Porter, J.W., 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Florida) - reef-building corals. U.S. Fish and Wildlife. Service Biological Report, 82(11.73), pp. 1-23.

Potts, J. C. and C. S. Manooch, III. 2001. Differences in the age and growth of white grunt (*Haemulon plumieri*) from North Carolina and South Carolina compared with southeast Florida. *Bulletin of Marine Science* 68(1): 1-12.

PPB Environmental Laboratories. 2005. Port Everglades 2004 Section 103 Sediment Characterization. Final Report. January 2005. Contract #DACW17-03-D-0016. Task Order No 6. 30 pp.

Precht, W. F. and R. B. Aronson. 2004. "Climate Flickers and Range Shifts of Reef Corals." *Front Ecol Environ* 2(6): 307-314.

Precht, W.F., and S.L. Miller. 2007. Ecological shifts along the Florida Reef Tract: the past as the key to the future. In Geological Approaches to Coral Reef Ecology, ed. R.B. Aronson, 237–312. New York: Springer-Verlag.

Reine, K. J., Clarke, D. G., and C. Dickerson. 2012a. Characterization of Underwater Sounds Produced by a Bucket Dredge Excavating Rock and Gravel. *DOER Technical Notes Collection* (ERDC TN-DOER-E36), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Reine, K. J., Clarke, D. G., and C. Dickerson. 2012b. Characterization of Underwater Sounds Produced by a Hydraulic Cutterhead Dredge Fracturing Limestone Rock. *DOER Technical Notes Collection* (ERDC TN-DOER-E34), U. S. Army Engineer Research and Development Center, Vicksburg, MS.

Reynolds J.E. 2001. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2000-2001. Prepared for Florida Power and Light Company.

Reynolds J.E. 2002. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2001-2002. Prepared for Florida Power and Light Company.

Reynolds J.E. 2003. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2002-2003. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 890.

Reynolds, J.E. 2003a. Mysterious Manatees. University of Florida Press. ISBN 0-8130-2637-7.

Reynolds J.E. 2004. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2003--2004. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 967.

Reynolds J.E. 2005. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2004-2005. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 1011.

Reynolds J.E. 2006. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2005-2006. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 1093.

Reynolds J.E. 2007. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2006-2007. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 1168.

Reynolds, J.E. 2009. Distribution and Abundance of Florida manatees (Trichechus manatus latirostris) Around Selected Power Plants Following Winter Cold Fronts: 2008-2009. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 1356.

Reynolds J.E. 2010. Distribution and Abundance of Florida manatees (*Trichechus manatus latirostris*) Around Selected Power Plants Following Winter Cold Fronts: 2009-2010. Prepared for Florida Power and Light Company. Mote Marine Laboratory Technical Report 1464.

Rezak, R., S.R. Gittings, and T.J. Bright. 1990. Biotic assemblages and ecological controls on reefs and banks of the northwest Gulf of Mexico. *American Zoologist* 30, 23-35.

Richardson, L. L. 1998. Coral diseases: what is really known? *Trends Ecol. Evol*. 13:438-443.

Richmond, D. R., J. T. Yelverton, and E. R. Fletcher. 1973. Far-field underwater-blast injuries produced by small charges. Defense Nuclear Agency, Department of Defense, Washington, D. C. Technical Progress Report, DNA 3081 T.

Rogers, C.S. 1983. Sublethal and lethal effects of sediments applied to common Caribbean reef corals in the field. *Marine Pollution Bulletin* 14:378-382.

Rogers, C.S. 1990. Responses of coral reefs and reef organisms to sedimentation. *Marine Ecology Progress Series* 62:185-202.

Rudolph, H. 1986. Broward County BAS Biological Study Results.

Schilling, M. R., I. Seipt, M. T. Weinrich, S. E. Frohock, A. E. Kuhlberg and P. J. Clapham. 1993. Behavior of individually identified sei whales, *Balaenoptera borealis*, during an episodic influx into the southern Gulf of Maine in 1986. *Fish. Bull., U.S.* 90(4): 749-755.

Schmahl, G.P., E.L.Hickerson, W.F. Precht. 2008. Biology and ecology of coral reefs and coral communities in the Flower Garden Banks region, northwestern Gulf of Mexico. *In* Riegl, B., R.E. Dodge (Eds.), Coral Reefs of the United States. Springer-Verlag, New York, pp.221-261.

Schroeder, M. C., H. Klein, and N. Hoy. 1958. Biscayne Aquifer of Dade and Broward Counties, Report of Investigation No. 17. Prepared by USGS in Cooperation With Florida Geological Survey.

Sears, R., F.W. Wenzel, and J.M. Williamson. 1987. The Blue Whale: A catalogue of individuals from the western North Atlantic (Gulf of St. Lawrence). Mingan Island Cetacean Study Inc., St. Lambert, Quebec. 27pp.

Serafy, J.E., M. Valle, C.H. Faunce, and J. Luo. 2007. Species-specific patterns of fish abundance and size along a subtropical mangrove shoreline: an application of the delta approach. *Bulletin of Marine Science* 80(3): 609-624.

Settle, L. 2003. NOAA/NOS National Centers for Coastal Ocean Science. Assessment of potential larval entrainment mortality to hydraulic dredging of Beaufort Inlet. Assessment prepared for USACE-Wilmington District for the Morehead City Harbor Environmental Assessment.

Shay, L. K., T. M. Cook, B.K. Haus, J. Martinez, H. Peters, A. J. Mariano, J. VanLeer, P. E. An, S. Smith, A. Soloviev, R. Weisberg,and M. Luther. 2000. VHF Radar detects Submesoscale Vortex Along Florida Coast. *EOS Transactions*. American Geophysical Union. 81(19).

Shay, L.K., T.M. Cook, H. Peters, A.J. Mariano, R. Weisberg, P.E. An, A. Soloviev, E. Soloviev, and M. Luther. 2002. Very high frequency radar mapping of surface currents. *IEEE J. of Oceanic Eng* 27:155-169

Shefter, A.P. and B.L. Grose. 1996. A Real Time Talking Port Entrance Channel Monitoring System. *Conference Proceedings*. *The Coastal Ocean-Prospects for the 21st Century Conference* 1996. Fort Lauderdale, FL. Sponsoring organizations: Marine Technology Society; OES, and IEEE.

Sheridan, P. F. and R.J. Livingston. 1983. Abundance and Seasonality of Infauna and Epifauna Inhabiting a *Halodule wrightii* Meadow in Apalachicola Bay, Florida. *Estuaries* 6(4):407-419.

Sigurjonsson, J. and T. Gunnlaugsson. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland, with a note on occurrence of other cetacean species. *Rep. int. Whal. Commn.* 40: 537-551.

Simpfendorfer, C.A. 2006. Movement and habitat use of smalltooth sawfish. Final Report. Mote Marine Laboratory Technical Report 1070. NOAA Purchase Order WC133F-04-SE-1543. January 2006.

Sonenshein, R.S. 1995. Delineation of Saltwater Intrusion in the Biscayne Aquifer, Eastern Dade County, Florida. USGS WATER-RESOURCES INVESTIGATIONS REPORT 96-4285.

Soong, K. 1993. Colony size as a species character in massive reef corals. *Coral Reefs* 12:77-83.

South Atlantic Fishery Management Council (SAFMC). 1998a. Final Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region. Charleston, SC. 142 pp.

South Atlantic Fishery Management Council (SAFMC). 1998b. Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. Charleston, SC. 408 pp.

South Atlantic Fishery Management Council (SAFMC). 2009. Fishery Ecosystem Plan of the South Atlantic Region. www.safmc.net/ecosystem/Home/EcosystemHome/tabid/435/Default.aspx

South Florida Regional Planning Council (SERPC), 2012. Resident Population Estimates and Projections, 1920-2040.

South Florida Water Management District (SFWMD). 2004. GIS Database. Florida Land Use, Cover and Forms Classification System (Florida Department of Transportation, Procedure No. 550-010-001-a). West Palm Beach, Florida.

Southwest Florida Regional Planning Council. 2012. Strategic Regional Policy Plan. Vol 1: Demographics. Ft. Myers, FL. Pp 1-28.

Spence, J., R. Fischer, M. Bahtiarian, L. Boroditsky, N. Jones and R. Dempsey. 2007. Review of Existing and Future Potential Treatments for Reducing Underwater Sound from Oil and Gas Industry Activities. Prepared for: Joint Industry Programme on E&P Sound and Marine Life. Prepared by Noise Control Engineering, Inc. NCE Report 07-001.

Stoddart D.R. 1969. Ecology and morphology of recent coral reefs. *Biological Review* 44:433-497.

Stoner, A. W. 1983. Distributional Ecology of Amphipods and Tanaidaceans Associated with Three Sea Grass Species. *Journal of Crustacean Biology* 3(4):505-518.

Szmant, A.M., M.G. Meadows. 2006. Developmental changes in coral larval buoyancy and vertical swimming behavior: implications for dispersal and connectivity. *Proceedings Tenth International Coral Reef Symposium* 1:431-437.

Taylor Engineering. 2008. Seagrass and Vegetation Survey: ICWW. 17th Street Bridge to 4000 feet North of the Las Olas Bridge and Dania Cut-Off Canal. Submitted to Florida Inland Navigation District. October 15, 2008.

Telesnicki, G J. and W.M. Goldberg. 1995. Effects of Turbidity on the Photosynthesis and Respiration of Two South Florida Reef Coral Species. *Bulletin of Marine Science* 57(2):527-539.

Thomsen F, S.R. McCully, D. Wood, P. White, and F. Page. 2009. A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters: PHASE 1 Scoping and review of key issues, Aggregates Levy Sustainability Fund / Marine Environmental Protection Fund (ALSF/MEPF), Lowestoft, UK.

Ueland, J.S. 2005. Ecological Modeling and Human Dimensions of Mangrove Change in Florida. PhD. Dissertation, Florida State University, 2005.

U.S. Army Corps of Engineers (USACE). 1990. Navigation Study for Port Everglades Harbor, Florida, 10207 Feasibility Report and Environmental Assessment. U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, Florida.

U.S. Army Corps of Engineers (USACE) 1996a. Coast of Florida Beach Erosion and Storm Effects Study, Region III, Feasibility Report with Final Environmental Impact Statement. Prepared by Gulf Engineers and Consultants, Inc.

U.S. Army Corps of Engineers (USACE) 1996b. Final Feasibility Report and Environmental Impact Statement on Improvement of Navigation, Cape Fear-Northeast Cape Fear Rivers Comprehensive Study, Wilmington North Carolina, Volumes I,II, and III. when this one is deleted - all the refs to USACE 1996 will be correct in the text.

U.S. Army Corps of Engineers (USACE). 2000b. Analysis of Test Blast Results, Wilmington Harbor, NC. (February 2000). 13 pp.

U.S. Army Corps of Engineers (USACE). 2003. General Reevaluation Report with Final Environmental Impact Statement. Broward County, Florida Shore Protection Project. June 2003.

U.S. Army Corps of Engineers (USACE). 2000. Broward County, Florida Shore Protection Project General Reevaluation Report. Prepared by Coastal Planning and Engineering Inc./Olsen Associates, Inc.

U.S. Army Corps of Engineers (USACE). 2005. Environmental Assessment and Finding of No Significant Impact. Maintenance Dredging of Port Everglades. Broward County, Florida. March 2005.

U.S. Army Corps of Engineers (USACE). 2008. EM 385-1-1, Safety and Health Requirements Manual. http://publications.usace.army.mil/publications/eng-manuals/.

U.S. Army Corps of Engineers (USACE). 2009. IWR Report 09-R-3. *Economics Primer*. Alexandria, VA. 26 pp.

U.S. Army Corps of Engineers (USACE) and National Marine Fisheries Service (NMFS). 2014. Mitigation Requirements Analysis for Hardbottom Resources Associated with Port Everglades Harbor Navigation Improvements (Final). USACE Jacksonville District, Jacksonville, FL.

U.S. Census Bureau. 2011. County Population Estimates. Website: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1&prodType=table (Accessed 8/22/11). Washington, D.C.

U.S. Census Bureau. 2012. State and County Quick Facts. http://quickfacts.census.gov/qfd/states/12/12099.html.

U.S. Climate Change Science Program (USCCSP). 2009. Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. U.S. Environmental Protection Agency, Washington D.C., USA. 320 pp. Available at http://www.climatescience.gov/Library/sap/sap4-1/final-report/sap4-1-final-report-all.pdf.

U.S. Coast Guard (USCG). 2004. Port Security Bulletin, Gulf of Mexico. April 27, 2004. .U.S. Coast Guard Eighth District.

U.S. Environmental Protection Agency (USEPA). 1995. - Compilation of Air Emission Factors, AP-42, 5th Edition, USEPA 1995U.S. Environmental Protection Agency (USEPA). 2004.

U.S. Environmental Protection Agency (USEPA). 2004. Final Environmental Impact Statement (EIS) for Designation of the Palm Beach Harbor Ocean Dredged Material Disposal Site and the Port Everglades Harbor Ocean Dredged Material Disposal Site, July 2004, Palm Beach and Broward Counties, Florida.

U.S. Environmental Protection Agency (USEPA). 2006. Southeast Florida Intrastate Air Quality Control Region. 40 CFR Part 81, Section 81.49.

U.S. Environmental Protection Agency (USEPA). 2008a. National Ambient Air Quality Standards (NAAQS). Retrieved from http://www.epa.gov/air/criteria.html. April 18, 2008 (page last updated July 2012).

U.S. Environmental Protection Agency (USEPA) and U.S. Army Corps of Engineers (USACE. 2013. Draft Environmental Assessment on the Expansion of the Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS), Broward County, Florida. Atlanta, GA. 127 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. South Florida Field Office Multi-Species Recovery Plan. http://ecos.fws.gov/docs/recovery_plan/990518_1.pdf.

U.S. Fish and Wildlife Service (USFWS). 2002. Letter from FWS to James Duck, USACE-SAJ. Concurring with USACE determination of May affect, not likely to adversely affect listed species for the Miami Phase II project. June 19, 2002.

U.S. Fish and Wildlife Service (USFWS). 2006 Draft Guidelines for the Protection of Marine Animals During the Use of Explosives In the Waters of the State of Florida. http://www.fws.gov/verobeach/images/pdflibrary/Florida%20Blasting%20Guidelines_May%202006_draft.pdf

U.S. Geological Service (USGS). 1992. The South Florida Environment: A Region under Stress. USGS Circular 1134. http://sofia.usga.gov/publications/circular/1134/wes/ebcr.html.

Valiela, I., J. Bowen, and J.K. York. 2001. Mangrove Forests: One of the World's Threatened Major Tropical Environments. BioScience 51(10):807-815.

Vargas-Angel B., J. D. Thomas and S. M. Hoke. 2003. High-latitude *Acropora cervicornis* thickets off Fort Lauderdale, Florida, USA. Coral Reefs. 22: 465–473.

Virnstein, R.W and L.M. Hall. 2009. Northern Range extension of the seagrasses *Halophilia johnsonii* and *Halophilia decipiens* along the east coast of Florida, USA. *Aquatic Botany* 90:89-92.

Virnstein, R. W., Hayek, L. A. C., & Morris, L. J. 2009. Pulsating patches: a model for the spatial and temporal dynamics of the threatened seagrass Halophila johnsonii. Marine Ecology, Progress Series, 385, 97-109.

Vollmer, S.V., and D.I. Kline. 2008. Natural disease resistance in threatened staghorn corals. PLoS ONE 3:e3718. doi:10.1371/journal.pone.0003718.

Walker, B.K., D.S. Gilliam, R.E. Dodge, and J. Walczak. 2012. Dredging and shipping impacts on southeast Florida coral reefs. Proceedings of the 12th International Coral Reef Symposium. 9-13 July, 2012. Cairns, Queensland, Australia.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam, and M. Sano. 1993. Sperm whales associated with Gulf Stream features off the northeastern USA shelf. Fish. Oceanogr. 2:101-105.

Waring, G.T., D.L. Palka, P.J. Clapham, S. Swartz, M.C. Rossman, T.V.N. Cole, K.D. Bisack, and L.J. Hansen. 1999. U.S. Atlantic marine mammal stock assessment reports-1998. NOAA Tech. Memo. NMFS-NE- 116, 182 pp.

Wenzel, F., D. K. Mattila and P. J. Clapham. 1988. *Balaenoptera musculus* in the Gulf of Maine.

Winston, G. O. 1992. Atlas of Structural Evolution and Facies Development on the Florida-Bahama Platform, Triassic Through Paleocene. Miami Geological Society.

Wright, D.G. and G.E. Hopky 1998. Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters. Canadian Technical Report of Fisheries and Aquatic Sciences 2107: pp.43.

Wright, S.J. 2011. Survey of and Management Recommendations for *Jacquemontia reclinata* (beach clustervine) at John U. Lloyd State Park. Fairchild Tropical Botanic Garden, Miami, FL. 7 pp.

Yelverton, J. T., D. R. Richmond, E. R. Fletcher, and R. K. Jones. 1973. Safe distance from underwater explosions for mammals and birds. Technical Report DNA 3114 T. Defense Nuclear Agency, Department of Defense, Washington, D. C.

Yochem, P. K. and S. Leatherwood. 1985. Blue whale. Pages 193-240 *in:* S. H. Ridgeway and R. Harrison (eds), *Handbook of Marine Mammals*, Vol. 3: The Sirenians and Baleen Whales. *Academic Press*, New York.

Young, G.A. 1991. Concise Methods for Predicting the Effects of Underwater Explosions on Marine Life. NAVSWC No. 91-220. Naval Surface Warfare Center, Silver Spring, Maryland.

Zimmer, B., Precht, W.F., Hickerson, E.L., Sinclair, J., 2006. Discovery of *Acropora palmata* at the Flower Garden Banks National Marine Sanctuary, northwestern Gulf of Mexico. *Coral Reefs* (25) 192.

APPENDICES

Appendix A Pertinent Correspondence

Appendix B Clean Water Act Section 404(b)(1)

Appendix C Coastal Zone Management Act (CZMA) Determination

Appendix D Natural Resource Reports
- Appendix D-1 Environmental Baseline Assessment
- Appendix D-2 Benthic Community Assessment
- Appendix D-3 Staghorn/Elkhorn Coral Assessment
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Appendix E Mitigation Plan
- Appendix E-1 Uniform Mitigation Assessment Methodology Worksheets for Seagrass and Mangrove Impact Areas
- Appendix E-2 Environmental Permits for Improvements at West Lake Park
- Appendix E-3 Mitigation Requirements Analysis for Impacts to Hardbottom Resources
- Appendix E-4 Draft Compensatory Mitigation Recommendations of the Port Everglades Reef Group for Navigation Improvements at Port Everglades Harbor (2004)
- Appendix E-5 NOAA Fisheries--Developed Mitigation Plan for Impacts to Reefs and Hardbottom Habitats
- Appendix E-6 Mitigation Monitoring and Adaptive Management Plan

Appendix F Endangered Species Act (ESA) Consultation

Appendix G Fish and Wildlife Coordination Act Report (FWCAR)

Appendix H Characterization of Essential Fish Habitats in the Port Everglades Expansion Area

Appendix I State Historic Preservation Office (SHPO) Determination

Appendix J Phase I Assessment

Appendix K List of Recipients

Appendix L Comments on Draft Environmental Impact Statement and Responses to Comments