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PORT EVERGLADES BROWARD COUNTY, FLORIDA ENVIRONMENTAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, DEPARTMENT OF DEFENSE

TRANSMITTING

THE DEPARTMENT'S PORT EVERGLADES FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT DATED MAY 2015

PART 1 OF 3

FEBRUARY 25, 2016.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

JAN 29 2016

Honorable Paul Ryan
Speaker of the House of Representatives
U.S. Capitol Building, Room H-232
Washington, DC 20515-0001

Dear Mr. Speaker:

In response to a resolution by the Committee on Transportation and Infrastructure of the United States House of Representatives adopted May 9, 1996, the Secretary of the Army supports the authorization and construction of the Port Everglades project in Broward County, Florida for the purpose of deep draft navigation improvements. The proposal is described in the report of the Chief of Engineers dated June 25, 2015, which includes other pertinent documents. The Secretary of the Army plans to implement the project at the appropriate time, considering National priorities and the availability of funds.

The project study was conducted to analyze and formulate improvements for increasing the overall economic efficiency of commercial navigation at Port Everglades, Florida by improving loading capacities and reducing delays. The recommended plan includes the following features:

a. Deepen the existing -42-foot mean lower low water (MLLW) channel to -48 feet MLLW from the outer entrance channel through the Southport Access Channel (SAC).

b. The following areas of widening are included as part of the new channel footprint for the recommended plan: the Outer Entrance Channel would be widened from the existing 500-foot channel width to 800 feet and extend 2,200 feet seaward; the southeast corner of the Main Turning Basin, referred to as the widener, would be widened by 300 feet; the SAC would be widened by 250 feet (including reconfiguration of the U.S. Coast Guard (USCG) facility easterly on USCG property); the existing 400-foot wide channel would be shifted 65 feet to the east; the Turning Notch (TN) would be widened by 100 feet parallel to the channel on the eastern edge of the SAC; and the western edge of the SAC that provides access to the TN from the existing Federal channel edge would be widened by 130 feet at the north edge of the TN.

The recommended plan is not the National Economic Development (NED) plan, but is the Locally Preferred Plan (LPP). The non-Federal sponsor is Broward County, (represented by its Board of County Commissioners), which requested an LPP of -48 feet MLLW with associated widening. The LPP has positive net benefits, is economically justified, and is a larger plan than the -47 foot MLLW NED plan. In

accordance with Corps policy, an NED Exception request was submitted for consideration to the Assistant Secretary of the Army for Civil Works and approved as the recommended plan on October 16, 2014.

Based on October 2015 (FY 2016) price levels, the estimated project first cost is $329,000,000 which includes the cost of constructing the General Navigation Features (GNFs) estimated as follows: $150,600,000 for channel modifications; $3,100,000 for mobilization; $39,600,000 for reconfiguration of the USCG basin for purposes of safety; $62,200,000 for construction of an environmentally engineered bulkhead for shoreline stabilization; $5,200,000 for items related to environmental compliance standards (Clean Water Act section 401 water quality certification and Endangered Species Act requirements); $53,800,000 for compensatory environmental mitigation and monitoring; $5,800,000 for pre-construction engineering and design (PED); and $8,700,000 for Construction Management. There are no costs associated with lands, easements, rights of way, and relocations (LERR). In addition to these costs, there are other associated project costs of $52,100,000 for non-Federal local service facilities (LSF), a non-Federal expense and $200,000 for USCG aids to navigation. The associated costs are not included in the total first cost of the project.

By comparison, at October 2015 price levels, the project first cost of the NED plan is $311,300,000, of which all is GNF with no cost associated with LERRs. The GNF is estimated as follows: $135,400,000 for channel modifications; $3,100,000 for mobilization; $62,200,000 for construction of an environmentally engineered bulkhead for shoreline stabilization; $39,600,000 for reconfiguration of the USCG basin for purposes of safety; $4,500,000 for items related to environmental compliance standards (Clean Water Act section 401 water quality certification and Endangered Species Act requirements); $51,900,000 for compensatory environmental mitigation and monitoring; $5,800,000 for PED; and $8,700,000 for Construction Management. Additional associated costs are $50,500,000 for LSF, a non-Federal expense and $200,000 for USCG aids to navigation.

It is estimated that there will be an average annual increase of 5,700 cubic yards of shoal material to be dredged each year from the new project with an added annual operations and maintenance (O&M) cost of $58,800. The increase in annual O&M is primarily due to the increase in channel footprint (widening and channel extension). In accordance with section 2102(b) of the Water Resources Reform and Development Act of 2014, all O&M costs are Federal for depths up to -50 feet MLLW. The dredged material management plan for the proposed project makes use of the Ocean Dredged Material Disposal Site for all disposal and is of sufficient capacity to include material from the 48-foot plan and future O&M, with no impact to long-term disposal capacity.

Broward County, as the non-Federal cost-sharing sponsor for all features, agrees to pay for 100 percent of the project costs exceeding the NED plan. The Federal share of the initial construction is estimated to be $224,500,000 with the non-Federal share estimated at $104,500,000, which equates to 68% Federal and 32% non-Federal, as apportioned in accordance with the cost sharing provisions of section 101 of the Water

Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. § 2211). The cost for the GNF to deepen to -45 feet MLLW (at $278,700,000) will be shared at a rate of 75 percent by the Federal government ($209,000,000) and 25 percent by the non-Federal sponsor ($69,700,000); the cost of the GNF greater than -45 feet and up to -47 feet MLLW (at $32,600,000) will be shared at a rate of 50 percent by the government and 50 percent by the non-federal sponsor ($16,300,000 each); and 100 percent of the cost of the GNF from -47 feet to -48 feet MLLW (at $17,700,000) will be borne entirely by the non-Federal sponsor, because this increment represents the LPP. Section 101 of WRDA 1986 also establishes that the non-Federal sponsor is required to pay back 10% of the GNF costs to the Federal Treasury over a period not to exceed 30 years, which is an additional $31,100,000 with interest. There is no eligible LERR credit to offset the 10 percent repayment.

Based on FY 2016 price levels, a 3.125 percent discount rate, and a 50-year period of analysis, the project total cost of the LPP is $381,300,000 (inclusive of associated costs), with average annual benefits of $48,370,000, average annual costs of $16,440,000, net benefits of $31,930,000, and a benefit-to-cost ratio of 2.9 to 1. In comparison, the project total cost of the NED plan is $362,900,000, with average annual benefits of $46,990,000, average annual costs of $15,540,000, net benefits of $31,450,000, and a benefit-to-cost ratio of 3.0 to 1.

An environmental impact statement was prepared in accordance with the National Environmental Policy Act. The recommended plan has been identified as the environmentally preferred plan. Adverse environmental impacts have been avoided and minimized where practicable.

Compensatory mitigation for unavoidable impacts to 4.21 acres of seagrass habitat, 1.16 acres of mangrove habitat, and 14.62 acres of hardbottom and coral reef habitats is required. To mitigate for these unavoidable impacts, the U.S. Army Corps of Engineers (Corps) will purchase one "functional unit" of mangrove habitat and 2.4 "functional units" of seagrass habitats generated by an ecosystem restoration project within West Lake Park, a Broward-County-operated natural area. Additionally, the Corps will construct approximately five acres of boulder reefs that will be used to support approximately 11,500 corals transplanted from the area of the dredged channel. The exact location of the boulder reefs will be determined during PED. The boulder reefs will be located offshore of Broward County, most likely in the sand trough between reefs 2 and 3 (see attached map 1). In addition, approximately 18 acres of hardbottom and reef habitats will be enhanced by installing over 103,000 coral colonies grown by coral nurseries. The exact location of these enhancement sites will be determined during the project construction phase, but will most likely be in ship grounding areas, inshore of the former anchorage, or in areas where coral densities have dropped due to disease or some other factor, on either reefs 1 or 2 (see attached map 2). The mitigation plan for the hardbottom and reef habitats was developed in coordination with the Department of Commerce (DOC) National Marine Fisheries Service (NMFS). As described in the state and agency review letters between DOC and the Corps, during

the PED phase, the Corps will collaborate with NMFS and will consider all practicable and applicable technology to potentially avoid and minimize environmental effects.

In accordance with the Endangered Species Act of 1973, as amended, NMFS issued a biological opinion on March 7, 2014, determining that the project will not jeopardize the continued existence of federal listed species. All terms and conditions resulting from these consultations shall be implemented in order to minimize take of endangered species.

An Independent External Peer Review was completed by Battelle Memorial Institute. The review comments resulted in expanded narratives throughout the report to support the decision-making process and justify the recommended plan. All comments from the above referenced reviews have been addressed and incorporated into the final documents.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to the Congress and concludes that the report recommendation is consistent with the policy and programs of the President. However, OMB also noted that the project would need to compete with other investments for funding in future budgets. A copy of OMB's letter dated December 21, 2015 is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also providing an identical letter to the President of the Senate.

Very truly yours,

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

14 Enclosures

1. Record of Decision, signed January XX, 2016
2. OMB Clearance letter, dated December 21, 2015
3. Chief's Report, June 25, 2015
4. Letter from Dept of the Interior, dated April 17, 2015
5. Letter from Dept of Homeland Security – U.S. Coast Guard, dated April 22, 2015
6. Letter from Dept of Transportation, dated April 17, 2015
7. Letter from Dept of Commerce, Nat'l Marine Fisheries, dated April 17, 2015
8. Letter from U.S. Environmental Protection Agency, dated April 20, 2015
9. Letter from Florida Dept of Environmental Protection, dated April 21, 2015
10. Letter from Florida Fish and Wildlife Conservation Commission
11. Letter from Seminole Tribe of Florida –Tribal Historic Preservation Office, dated May 12, 2015
12. Letter of Sponsor support, Port Everglades, dated August 14, 2014
13. Project Slides
14. Final Feasibility Report and Environmental Impact Statement, May 2015, Port Everglades Harbor, Broward County, Florida (CD)

2 Map Enclosures

1. Map Enclosure 1
2. Map Enclosure 2

RECORD OF DECISION

PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

The Final Feasibility Report and Environmental Impact Statement (FR/EIS), dated March 2015 (revised May 2015), for the Port Everglades Feasibility Study, addresses the Federal interest in navigational improvements to reducing transportation costs and increasing channel safety and maneuverability for the existing fleet and future vessels at Port Everglades, Florida. Based on the Final FR/EIS, the reviews of other Federal, State, and local agencies, input from the public, and the review by my staff, I find the plan recommended by the Chief of Engineers to be technically feasible, economically justified, in accordance with environmental statutes, and in the public interest.

The Final FR/EIS, incorporated herein by reference, evaluated various structural and non-structural alternatives that would provide deeper and/or wider channels for more efficient transit of large commercial vessels. In addition to a "no action" plan, five alternatives with varying dredge depths with structural and non-structural measures were analyzed. The recommended plan is the Locally Preferred Plan (LPP), and includes:

- Deepening the existing -42 foot Mean Lower Low Water (MLLW) channel to -48 feet MLLW from the Outer Entrance Channel (OEC) through the Southport Access Channel (SAC);
- Widening the OEC from the existing 500-foot channel width to 800 feet and extending it 2,200 feet seaward;
- Widening the southeast corner of the Main Turning Basin, referred to as the widener, by 300 feet;
- Widening the SAC by 250 feet (including reconfiguration of the U.S. Coast Guard (USCG) facility easterly on USCG property);
- Shifting the existing 400-foot-wide channel by 65 feet to the east;
- Widening the Turning Notch (TN) by 100 feet parallel to the channel on the eastern edge of the SAC;
- Widening the western edge of the SAC that provides access to the TN from the existing federal channel edge by 130 feet at the north edge of the TN; and
- Implementing the environmental compensatory mitigation and associated monitoring and adaptive management plan.

All dredged material, approximately 5.5 million cubic yards, would be placed in the Ocean Dredged Material Disposal Site (ODMDS) located offshore of Ft. Lauderdale, Florida and managed by U.S. Environmental Protection Agency (EPA). EPA is scheduled to complete the formal designation process for expansion of the ODMDS boundaries including rulemaking in 2016.

The -47 foot dredge depth alternative was the National Economic Development (NED) plan. The recommended plan would be one foot deeper than the NED plan and was requested by the sponsor. In accordance with U.S. Army Corps of Engineers policy, I approved the LPP for consideration as the recommended plan on September 30, 2014.

The recommended plan is the environmentally preferred plan, the least environmentally damaging practicable alternative that accomplishes all the project objectives. All practicable means to avoid or minimize adverse environmental effects have been incorporated. The recommended plan will result in unavoidable impacts to 4.21 acres of seagrass habitat; 1.16 acres of mangrove habitat; and 14.62 acres of hardbottom and reef habitats. To mitigate for these unavoidable impacts, the Corps will purchase one "functional unit" of mangrove habitat and 2.4 "functional units" of seagrass habitats generated by an ecosystem restoration project within West Lake Park, a Broward-County-operated natural area. The Corps will construct approximately five acres of boulder reefs that will be used to support approximately 11,500 corals transplanted from the area of the dredged channel. The exact location of the boulder-reefs will be determined during PED. The boulder reefs will be located offshore of Broward County, most likely in the sand trough between reefs 2 and 3. The Corps will enhance approximately 18 acres of hardbottom and reef habitats by installing over 103,000 coral colonies grown by coral nurseries. The exact location of these enhancement sites will be determined during the project construction phase, but will most likely be in ship grounding areas, inshore of the former anchorage, or in areas where coral densities have dropped due to disease or some other factor on either reefs 1 or 2. The mitigation plan for the hardbottom and reef habitats was developed in coordination with the National Marine Fisheries Service (NMFS). During the pre-construction engineering and design phase, the Corps will consider all practicable and applicable technology to potentially avoid and minimize environmental effects.

A water quality certification pursuant to Section 401 of the Clean Water Act will be obtained from the State of Florida. The Florida State Clearinghouse stated that the proposed deepening is conditionally consistent with the Florida Coastal Management Program. In accordance with Section 7 of the Endangered Species Act, the NMFS issued a biological opinion determining that the proposed project will not jeopardize the continued existence of federal listed species managed by NMFS. The U.S. Fish and Wildlife Service (USFWS) concurred with the Corps' determination that the project would not adversely affect federal listed species managed by USFWS. All terms and conditions resulting from these consultations shall be implemented in order to minimize take of endangered species.

Public Review of the Draft FR/EIS was completed on August 12, 2013. All comments submitted during the public comment period were responded to in the Final FR/EIS. A 30-day review of the Final FR/EIS was completed on April 15, 2015. Comments from the state and Federal agencies did not result in any changes to the Final FR/EIS.

Technical and economic criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations and local government plans were considered in the evaluation of alternatives. Based on review of these evaluations, I find that the benefits of the recommended plan outweigh the costs and any adverse effects. This Record of Decision completes the National Environmental Policy Act process.

Jan. 29, 2016
Date

Jo-Ellen Darcy
Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

December 21, 2015

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has reviewed a May 2015 Army Corps of Engineers (Corps) feasibility report (report) that proposes that the Corps deepen and widen the principal channels and other features of Port Everglades. Based on the Corps estimate of the benefits and costs, we have concluded that an authorization to construct this project would be consistent with the policy and programs of the President.

The report estimates that the benefit-cost ratio (BCR) for the project is 2.9 to 1 at a discount rate of 3.375%. This is the discount rate for FY 2014 under section 80 of the Water Resources Development Act of 1974. The report estimates that the equivalent BCR is 1.5 to 1 at a 7% discount rate. This is the discount rate that the Administration uses in budgeting to measure the performance of Corps construction projects, like this one, whose primary purpose is to provide an economic return to the Nation.

The report suggests that the collection of additional data, along with the application of the National Oceanographic and Atmospheric Administration's (NOAA) PORTS technology, could potentially reduce the scope of the proposed changes to the outer entrance channel. To minimize adverse impacts to the reefs, we recommend that the Corps work with NOAA and the port to determine if such data would help reduce the footprint of the outer entrance channel, and thereby reduce direct losses to the habitat provided by the reefs, before constructing changes to the outer entrance channel.

The Office of Management and Budget does not object to your submitting the report for this project to the Congress. When you do so, please advise the Congress that this project, like all other Corps projects, will need to compete with other proposed investments in future Budgets.

Sincerely,

John Pasquantino
Deputy Associate Director
Energy, Science, and Water

Encl 2

DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, DC 20310-2600

DAEN

JUN 2 5 2015

SUBJECT: Port Everglades Navigation Improvements Project, Broward County, Florida

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the final feasibility report and environmental impact statement on navigation improvements for Port Everglades, Broward County, Florida. It is accompanied by the reports of the district and division engineers. This report was prepared as an interim response to a resolution by the Committee on Transportation and Infrastructure of the United States House of Representatives, dated 9 May 1996. Preconstruction engineering and design activities for the Port Everglades, Broward County, Florida Navigation Project will continue under the authority provided by the resolution cited above.

2. The reporting officers recommend a project that will contribute to the economic efficiency of commercial navigation. The national economic development (NED) plan includes a channel depth of 47 feet with associated widening. Based on Fiscal Year (FY) 2015 price levels, a 3.375-percent discount rate, and a 50-year period of analysis, the project first cost of the NED plan is $305,300,000, with average annual benefits of $46,900,000; average annual costs of $15,900,000; and a benefit-to-cost ratio of 2.9. The non-federal sponsor, Broward County represented by its Board of County Commissioners, subsequently requested a locally preferred plan (LPP) of 48 feet with associated widening. The LPP has positive net benefits and is economically justified. In accordance with U.S. Army Corps of Engineers (USACE) policy, the LPP was submitted for consideration to the Assistant Secretary of the Army for Civil Works (ASA(CW)) and approved for consideration as the recommended plan on 16 October 2014. The recommended plan is the LPP and consists of the following improvements:

a. The project would deepen from the existing 42-foot mean lower low water (MLLW) channel to 48 feet MLLW from the outer entrance channel through the Southport Access Channel (SAC);

b. The following areas of widening are included as part of the new channel footprint for the recommended plan: Outer Entrance Channel: widen from the existing 500-foot channel width to 800 feet and extend 2,200 feet seaward; Main Turning Basin: widen by 300 feet, referred to as the widener, including reconfiguration of the U.S. Coast Guard (USCG) facility easterly on USCG property; SAC: widen by 250 feet and shift the existing 400-foot wide channel 65 feet to the east; Turning Notch (TN): widen by 100 feet parallel to the channel on the eastern edge of the SAC, and widen the western edge of the SAC to access the TN from the existing federal channel edge to a width of 130 feet at the north edge of the TN;

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Encl 3

c. The land required for the widener is federally owned and operated by the USCG. The USCG owns a total of 7.8 acres. Approximately one acre of uplands will be removed and turned into submerged lands to support the widening of the SAC. Use of the USCG property is necessary to allow deep draft vessels the ability to turn safely. The uplands being submerged will remain federally owned and be used for USCG vessels. The reconfiguration requires several USCG structures, facilities, and utilities to be shifted to the east onto adjacent federally owned property. The cost for this reconfiguration is included in the cost-shared project construction costs as a general navigation feature (GNF). A permit for use of real property by other federal agencies will be executed between the USCG and the Department of the Army for construction purposes;

d. Construction of the recommended plan involves dredging of approximately 5.5 million cubic yards of material. Material will be removed using a cutter head dredge or blasting with cutter head or clam shell removal and placed in ocean disposal. The proposed Ocean Dredged Material Disposal Site (ODMDS) is of sufficient capacity to include material from the 48-foot plan and future operations and maintenance (O&M), with no impact to long-term disposal capacity. All material dredged for construction is assumed to go to the ODMDS; and

e. To compensate for the unavoidable adverse effects of the action on various significant habitat types, USACE has proposed the following: mitigate for (a) the removal of approximately 7.41 acres of vegetated and unvegetated seagrass habitat (including that within the new channel footprint and resulting side slopes) and (b) the loss of approximately 1.16 acres of mangroves in the project footprint through use of ecosystem benefits from a previously permitted restoration project at West Lake Park (Broward County, FL), which is located in a county-operated, state-owned, natural area immediately to the south of the harbor. Mitigation for impacts will involve use of 2.4 seagrass functional units and one (1) mangrove functional unit, respectively, from that project. USACE has also proposed the following: mitigate for (c) the direct removal of approximately 14.62 acres of complex, high-profile, linear and spur/groove reef habitat through the creation of approximately 5 acres of artificial reef with the transplantation of 11,502 corals from the impact site to the artificial reef, as well as the enhancement of additional acreage through the outplanting of approximately 103,000 nursery raised corals to existing reefs. Additional mitigation will be provided for any direct and indirect impacts caused by dredging or increased turbidity/sedimentation. These mitigation components were determined to be economic "Best Buys" from among mitigation alternatives. The coral mitigation plan for reef impacts is included as a requirement in the Biological Opinion (BiOp) issued by the National Marine Fisheries Service (NMFS). Per a letter sent by NMFS to USACE on 1 May 2014, NMFS considers the scope of the coral mitigation plan as laid out in the BiOp, including associated monitoring and adaptive management actions, to be final with the exception of coordination of fine-scale construction level details and implementation of lessons learned from other similar efforts.

DAEN
SUBJECT: Port Everglades Navigation Improvements Project, Broward County, Florida

3. Project Cost Breakdown based on October 2014 Prices.

a. Project First Cost: The estimated project first cost is $322,700,000, which includes the cost of constructing the GNF and the lands, easements, rights-of-way (LER), and relocations. Broward County represented by its Board of County Commissioners is the non-federal cost-sharing sponsor for all features.

b. Estimated Federal and Non-Federal Cost Shares: The estimated federal and non-federal shares of the project first cost are $220,200,000 and $102,500,000 respectively, as apportioned in accordance with the cost sharing provisions of Section 101 of the Water Resources Development Act (WRDA) 1986, as amended (33 U.S.C. 2211), as follows:

(1) The cost for the GNF from greater than 20 feet to 45 feet will be shared at a rate of 75 percent by the government and 25 percent by the non-federal sponsor, plus

(2) The cost for the GNF from greater than 45 feet will be shared at a rate of 50 percent by the government and 50 percent by the non-federal sponsor, plus

(3) 100 percent of the costs attributable to dredging to a depth over the NED plan of 47 feet MLLW.

c. Additional 10 Percent Payment. In addition to the non-federal sponsor's estimated share of the total first cost of constructing the project in the amount of $322,700,000 pursuant to Section 101(a)(2) of WRDA 1986, as amended, the non-federal sponsor must pay an additional 10% of the NED first costs ($305,000,000) of GNF of the project, $30,500,000, in cash over a period not to exceed 30 years, with interest.

d. Operations and Maintenance Costs. It is estimated that there will be an average annual increase of 5,700 cubic yards (CY) of shoal material to be dredged each year from the new project with an added annual O&M cost of $55,500. The increase in annual O&M is primarily due to the increase in channel footprint (widening and channel extension).

e. Associated Costs. Estimated associated costs of $200,000 include navigation aids, (a USCG expense).

f. Local Service Facilities and Non-Federal Berthing Area Costs. The cost for local service facilities and non-federal berthing area costs is approximately $51 million dollars. These costs are 100% non-federal and are not included in the total first cost of the recommended plan.

g. Authorized Project Cost and Section 902 Calculation. The project first cost, for the purposes of authorization and calculating the maximum cost of the project pursuant to Section 902 of WRDA 1986, as amended, includes estimates for GNF construction costs, the value of LER and the value of relocations provided under Section 101(a)(3) of WRDA 1986, as amended. Accordingly, as set forth in paragraph 3.a. above, based on FY 2015 price levels, the

estimated project first cost for these purposes is $322,700,000 with a federal share of $220,200,000 and a non-federal share of $102,500,000.

4. Based on FY 2015 price levels, a 3.375-percent discount rate, and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated to be $16,860,000. The average annual equivalent benefits are estimated to be $48,240,000. The average annual net benefits are $31,380,000. The benefit-to-cost ratio for the recommended plan is 2.9.

5. The federal government would be responsible for O&M of the navigation improvements proposed in this report upon completion of the construction contract. The federal government currently maintains the existing project. The contractor would be responsible for all maintenance during the construction contract.

6. Risk and uncertainty were evaluated for economic benefits, costs and sea level rise. Economic sensitivities examined the effects of commodity forecasts which had lower growth rates or capped the growth earlier in the period of analysis. In accordance with the USACE Engineering Circular (EC) on sea level change, the study analyzed four sea level rise rates; historic, baseline, intermediate, and high. Based on a 50-year period of analysis of historical sea level measurements taken from National Ocean Service (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). Analysis shows that the sea level rise values for the baseline, intermediate, and high levels of future sea level rise at the end of the 50-year period of analysis are projected to be 0.39 feet, 0.84 feet, and 2.25 feet, respectively. In general, regional sea level rise (baseline, intermediate, and high) will not affect the functioning of the project alternatives or the overall safety of the vessels. While there is expected to be a small increase in tide range and storm surge penetration for all three scenarios, the structural aspects of the project will be either unaffected or can be easily adapted to accommodate the change.

7. In accordance with the USACE EC on review of decision documents, all technical, engineering and scientific work underwent an open, dynamic and vigorous review process to ensure technical quality. This included District Quality Control, Agency Technical Review, Policy and Legal Compliance Review, Cost Engineering Mandatory Center of Expertise Review and Certification, Independent External Peer Review (IEPR), and the review and approval of technical models. The IEPR was completed by Battelle Memorial Institute. An initial IEPR was conducted on the draft report in 2013 and a second IEPR was completed on the final report in 2014. The first review resulted in one comment of high significance and the second review resulted in five comments of medium high to high significance. The IEPR comments identified concerns in the areas of engineering assumptions, economic analysis, and environmental considerations. All comments from the above referenced reviews have been incorporated into the final document. Overall, the reviews resulted in improvements to the technical quality of the report.

DAEN
SUBJECT: Port Everglades Navigation Improvements Project, Broward County, Florida

8. Washington level review indicates that the plan recommended by the reporting officers is technically sound, environmentally and socially acceptable, and on the basis of congressional directives, economically justified. The plan complies with all essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies. The recommended plan complies with other Administration and legislative policies and guidelines. The views of interested parties, including federal, state and local agencies have been considered.

9. I concur in the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that navigation improvements for Port Everglades be authorized in accordance with the reporting officer's recommended plan at an estimated first cost of $322,700,000 with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing, financing, and other applicable requirements of federal and state laws and policies, including Section 101 of WRDA 1986, as amended. This recommendation is subject to the non-federal sponsor agreeing to comply with all applicable federal laws and policies including that the non-federal sponsor must agree with the following requirements prior to project implementation.

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

(1) 25 percent of the cost of design and construction of the GNFs attributable to dredging to a depth in excess of -20 feet MLLW but not in excess of -45 feet MLLW, plus

(2) 50 percent of the cost of design and construction of the GNFs attributable to dredging to a depth in excess of -45 feet MLLW but not in excess of -47 feet MLLW, plus

(3) 100 percent of the costs attributable to dredging to a depth over -47 feet MLLW;

b. Provide all LER, including those necessary for the borrowing of material and placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, all as determined by the government to be necessary for the construction or O&M of the GNFs;

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of the NED GNFs less the amount of credit afforded by the government for the value of the LER and relocations, including utility relocations, provided by the non-federal sponsor for the GNFs. If the amount of credit afforded by the government for the value of LER and relocations, including utility relocations, provided by the non-federal sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the non-federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LER and relocations, including utility relocations, in excess of 10 percent of the total costs of construction of the GNFs;

d. Provide, operate, and maintain, at no cost to the government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and any specific directions prescribed by the government;

e. In the case of project features greater than -47 feet MLLW in depth, provide 100 percent of the excess cost of O&M of the project over that cost which the government determines would be incurred for O&M if the project had a depth of 47 feet;

f. Accomplish all removals determined necessary by the federal government other than those removals specifically assigned to the federal government;

g. Give the government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs;

h. Hold and save the United States free from all damages arising from the construction or O&M of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

i. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LER that the government determines to be necessary for the construction or O&M of the GNFs. However, for LER that the government determines to be subject to the navigation servitude, only the government shall perform such investigation unless the government provides the non-federal sponsor with prior specific written direction, in which case the non-federal sponsor shall perform such investigations in accordance with such written direction;

j. Assume complete financial responsibility, as between the government and the non-federal sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LER that the government determines to be necessary for the construction or O&M of the project; and

k. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA.

10. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the state of Florida, Broward County represented by its Board of County

DAEN
SUBJECT: Port Everglades Navigation Improvements Project, Broward County, Florida

Commissioners (the non-federal sponsor), interested federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, DC 20240

APR 17 2015

9043.1
PEP/NRM

ER 13/0465

Jeremy LaDart
Project Review Team Lead
Headquarters US Army Corps of Engineers
CECW/P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

RE: Chief of Engineers and the Report of the District Engineer on the Port Everglades Harbor Navigation Improvement Project, FL

Dear Mr. LaDart:

The U.S. Department of the Interior (Department) has reviewed the U.S. Army Corps of Engineers (Corps), Chief of Engineers Report, and supporting documents on the Port Everglades Harbor Navigation Improvement Project.

Our U.S. Fish and Wildlife Service (FWS) South Florida Ecological Service Office (SFESO) previously provided comments to the Corps St. Paul district office under the Fish and Wildlife Coordination Act (FWCA). SFESO has previously commented on the project (August 20, 2013) via a Wildlife Coordination Act Report (2007-FA-1548) and provided concurrence on the project based on implementation of specific conservation and minimization. The SFESO did not have time to complete a thorough review of the attached Final Environmental Impact Statement (FEIS) for Port Everglades Harbor Navigation Improvement. Based on the review of the FEIS, Appendix L, page 200, concerning the Corps' comments on the FWS letter dated August 20, 2013, the Corps did not provide any further comments on Departmental concurrence with the Corps' determinations in regard to the American crocodile, sea turtles, and the West Indian manatee. No further comment or discussion is necessary at this time. The FWS also provided extensive recommendations to further minimize or avoid possible adverse effects of the proposed project on fish and wildlife resources. The Department advises the Corps to include all the protective measures previously identified.

In the Wildlife Coordination Act Report, the FWS concluded that implementation of the proposed project may impact fish and wildlife resources directly and indirectly as a result of dredging and/or blasting activities. Examples of fish and wildlife resources likely to be affected include seagrass, low relief hardbottom, high relief coral reefs, rock/rubble habitat, and shallow sandy bottom habitats. It would be helpful if the term "functional unit" that is used in the Chief's Report is defined.

Sec 4

In addition to previous comments and recommendations, the Department continues to support the recommendations of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service as it relates to all essential fish habitat issues.

We appreciate the opportunity to provide comments. If you have any questions or need further assistance related to the FWCA, please contact Jeff Howe, U.S. Fish & Wildlife Service, South Florida Ecological Services Office at 772-469-4283 or at Jeffrey_howe@fws.gov.

Sincerely,

Mary Josie Blanchard

for Willie R. Taylor
Director
Office of Environmental Policy
and Compliance

bcc: PEP (File)
REOs/Atlanta
BIA, FWS, NPS, GS

Email to: Jeremy.M.LaDart@usace.army.mil and Terri.Jordan-Sellers@usace.army.mil

U.S. Department of Homeland Security
United States Coast Guard

Commander
United States Coast Guard
Seventh District

909 S.E. 1st Avenue
Miami, FL 33131-3050
Staff Symbol: (DM)
Phone: (305) 415-6701
Fax: (305) 415-6704
Email: John.G.Turner@uscg.mil

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APR 2 2 2015

Headquarters
U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860
ATTN: Jeremy LaDart

Dear Sir:

In response to your March 16, 2015 letter concerning the Port Everglades Feasibility Report and Environmental Impact Statement, the Coast Guard offers the following comments concerning the impact to the affected Port Everglades Aids to Navigation (ATON) and Coast Guard Station Fort Lauderdale. Please note that Coast Guard attention on these issues is the responsibility of two distinct and separate programs. To maintain continued effective communication for both, appropriate points of contact for each are noted below.

Aids to Navigation: POC Mr. Gene Stratton, Seventh District Waterway Branch
Phone: (305) 415-6750 Email: allen.e.stratton@uscg.mil

Existing ATON will have to be relocated throughout the project in order to facilitate dredging as well as other project activities. The ATON relocation, whether permanent or temporary will require environmental analysis to comply with NEPA. Due to Coast Guard asset and resource limitations, it is our expectation that temporary movements of ATON will be carried out by contractors employed for the Port Everglades dredging project. The Army Corps of Engineers' (USACOE) environmental analysis should account for contractor ATON movements within the 150 meter impact area that may include dragging of ATON as well as lifting by crane. To further facilitate the project the contract proposal should clearly state the contractor's responsibility for temporary relocation of the ATON with Coast Guard approval.

The Coast Guard will provide and maintain the proper number of navigational aids for the day and night as indicated on page 88 of the EIS and will employ the most cost effective ATON to facilitate safe navigation at minimal expense to taxpayers. In certain circumstances buoy tender support for ATON relocation may be available. Early communication between our agencies is imperative to providing sufficient lead time to facilitate competing demands for buoy tender assistance in multiple ports. Contractor relocations of ATON will facilitate the project and will be verified by more readily available Coast Guard assets.

USCG Station Fort Lauderdale: POC LCDR Jeffrey Coon, Civil Engineering Unit Miami
Phone: (305) 278-6764 Email: Jeffrey.K.Coon@uscg.mil

The Port Everglades Project will have significant impacts to Coast Guard Station Fort Lauderdale and its tenant commands. The preferred alternative is described in the Coast Guard

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Civil Engineering Unit (CEU) Miami's Facilities and Infrastructure Requirements for Station Fort Lauderdale Multi-Mission Facility dated August 2009. Coast Guard Station Fort Lauderdale and tenant units must maintain full operational capabilities throughout the construction period. I request the USACOE provide a proposal with options to meet the Coast Guard continuous operational requirement, phasing if applicable and estimated timeline. I would like to reiterate that the Coast Guard has no funding available or budgeted to construct the new facilities or address temporary facilities during the construction period. Any real property agreements, cost, environmental compliance, NEPA and permitting requirements for both temporary and permanent facilities will need to be borne by the USACOE.

The existing Coast Guard boat basin does not require maintenance or periodic dredging. It's unknown whether or not the USACOE's proposed new boat basin will require maintenance or periodic dredging due either to the new configuration, or changes made to the shoreline and channel by this project. I request the USACOE include follow on dredging if required.

Sincerely,

John. G. Turner
Captain, U.S. Coast Guard
Chief, Resource Management Division

Copy: Jacksonville District Army Corp of Engineers
CGD Seven (DPW)
CEU Miami

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Associate Administrator
for Airports

800 Independence Ave., SW.
Washington, DC 20591

APR 17 2015

Mr. Theodore A. Brown, P.E.
Chief, Planning and Policy Division
U.S. Army Corps of Engineers
7701 Telegraph Road
Alexandria, VA 22315

Dear Mr. Brown:

Thank you for your March 16 letter providing the Federal Aviation Administration (FAA) the opportunity to review and comment on the project reports and Final Environmental Impact Statement for the Port Everglades Harbor Navigation Study.

As you noted in your letter, the FAA's Southern Region has received the project reports for review. They will be responding directly to you with the FAA's review comments as requested.

I trust this information is helpful.

Sincerely,

Bernt Pelz

for Eduardo A. Angeles
Associate Administrator
for Airports

Page 6

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

F/SER47:JK/pw

Colonel Alan Dodd, Commander
U.S. Army Corps of Engineers, Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232

APR 17 2015

Dear Colonel Dodd:

NOAA's National Marine Fisheries Service (NMFS) reviewed the *Final Environmental Impact Statement, Port Everglades Harbor Navigation Study, Broward County, Florida* (EIS) dated March 6, 2015. The Final EIS recommends deepening the outer entrance channel (OEC) to -57 feet mean lower low water (MLLW), widening the OEC to 800 feet, and extending the OEC seaward 2,200 feet; deepening the main turning basin to -50 feet MLLW and extending the southeastern boundary of the turning basin 300 feet; widening and deepening the south access channel; and deepening the turning notch to -50 feet MLLW after the local sponsor dredges the same area to -42 feet MLLW.[1] Blasting may be required to remove rock substrate. Dredged material disposal would occur at an expanded Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS).[2]

During the past two years, the Jacksonville District and NMFS worked diligently to complete consultations for this project under the Endangered Species Act (ESA) and Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), including face-to-face meetings with senior leadership from both agencies on September 5 and 6, 2013; November 18, 2013; and April 17 and 18, 2014. These consultations were completed during 2014, and their primary focus was offsetting impacts to coral reef and hardbottom, which are designated critical habitat for corals under the ESA and a Habitat Area of Particular Concern for the snapper-grouper fishery under the Magnuson-Stevens Act. Appendix E-3 of the Final EIS describes this mitigation plan.

Comments on the Final EIS

By letter dated August 13, 2013, NMFS provided the Jacksonville District with 14 essential fish habitat (EFH) recommendations after reviewing the Draft EIS. The Jacksonville District provided its response to those EFH conservation recommendations in Appendix H of the Final EIS, dated August 14, 2014. NMFS will use the EFH conservation recommendations and the District's response as a framework for commenting on the Final EIS. The responses provided for EFH conservation recommendations No. 5 (monitoring of blasting), No. 9 (evaluation of the OEC as a sink for larval corals), No. 13 (updates to cumulative impact assessment), and No. 14

[1] By letter dated April 2, 2014, NMFS responded to public notice SAJ-1984-04146 for the dredging by the local sponsor.
[2] The U.S. Environmental Protection Agency is the lead federal agency for expanding the Port Everglades Harbor ODMDS and developed an Environmental Assessment for the expansion separate from this Final EIS for the Port Everglades Harbor Navigation Study.

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(best management practices to avoid and minimize impacts) require no further comment from NMFS.

Biological Monitoring
EFH conservation recommendations No. 1 (mitigation for indirect impacts to coral reef below the dredging depth) and No. 3 (environmental monitoring plan) and Terms and Conditions Nos. 5, 6, and 7 of the Biological Opinion issued by NMFS on March 7, 2014, address monitoring for impacts beyond those anticipated in the Final EIS. Two of the potential causes of those impacts are rubble rolling down slope from the dredge cut colliding with coral colonies and sediments suspended by the dredge or spilled from transfer barges smothering coral colonies. As the project moves forward, the Jacksonville District will work with NMFS, the U.S. Environmental Protection Agency, and State of Florida natural resource agencies to finalize an environmental monitoring plan. Section 2.7.2 of the Final EIS indicates continued development and refinement of the plan will occur during the Preconstruction Engineering and Design (PED) phase after the U.S. Congress authorizes the Port Everglades expansion project.

Given the high importance of the monitoring and adaptive management to successful implementation of the agreements NMFS and the Jacksonville District reached during the ESA and Magnuson-Stevens Act consultations, NMFS offers to lead the interagency coordination needed to finalize the environmental monitoring plan. Both NMFS and the Jacksonville District have committed to having the Port Everglades monitoring reflect lessons learned from recent monitoring of the Port of Miami expansion project. The environmental monitoring plan in Appendix E-6[3] of the Final EIS largely reflects experiences prior to the Port of Miami expansion. During January 2014, NMFS provided the Jacksonville District with an alternate plan developed in close coordination with the Florida Department of Environmental Protection. On February 13, 2015, NMFS provided the Jacksonville District with a report entitled, *Port of Miami* Acropora cervicornis *Relocation Report*, which included summaries of observations by NOAA divers examining the severity and spatial extent of impacts to coral colonies from the Port of Miami dredging. These observations include methods for detecting and relocating stressed corals in the field before the colonies succumb to chronic, severe sedimentation. Together, this alternate monitoring plan and relocation report serve as a viable base for incorporating lessons learned regarding the severity and spatial extent of sedimentation from dredging operations in coral reef environments.

Compensatory Mitigation for Coral Reef Impacts
As already noted, the Jacksonville District and NMFS worked diligently to develop a coral reef compensatory mitigation plan. The expected impacts to coral habitat are 17.51 acres, including 10.58 acres of high quality outer reef not impacted from past dredging and 2.90 acres of coral outside the dredging footprint impacted indirectly by sedimentation. To offset these impacts, the Jacksonville District will: (1) create five acres of hardbottom habitat by placing boulders on the seafloor, (2) transplant approximately 11,500 corals rescued from the dredge footprint onto 2.03 acres of those boulders, and (3) enhance approximately 18.93 acres of coral reef with approximately 103,200 nursery raised corals. A majority of the outplanted coral will be ESA-

[3] While Appendix E-6 of the Final EIS lists NMFS as a co-author of the monitoring plan, NMFS only contributed to Section 4.7 (pages 20 to 23) and the Biological Opinion requires further development and refinement of the environmental monitoring plan. Accordingly, NMFS requests it not be listed as co-author of the current version of the monitoring plan.

protected staghorn corals (*Acropora cervicornis*) because this species performs well in nursery settings and its fast growth and three-dimensional structure promote settlement and growth by other coral reef organisms. This mitigation effort addresses EFH conservation recommendations No. 1 (mitigation for direct impacts to coral reef), No. 2 (mitigation for impacts to coral reef resulting from anchoring), No. 4 (mitigation for indirect impacts to coral reef from sedimentation and turbidity), No. 6 (mitigation amounts are determined using Habitat Equivalency Analysis), and No. 7 (compensatory mitigation for coral, coral reef, and hardbottom impacts). Regarding the Habitat Equivalency Analysis, NMFS appreciates the Jacksonville District noting in Section 4.6.1.4 of Appendix E-3 of the Final EIS that NOAA and U.S. Army Corps of Engineer policies differ on use of discount rates in Habitat Equivalency Analysis and these differences did not require resolution to complete the Port Everglades mitigation plan.

Coral Relocation

EFH conservation recommendation No. 8 addresses relocation of corals from the dredging footprint. While the Final EIS commits the Jacksonville District to relocating approximately 11,500 corals, many times that amount will not be relocated because the District views the relocation to be impracticable. In Section 2.7.2 of the Final EIS, the Jacksonville District indicates development of a final coral relocation plan will occur during the PED phase and that plan will reflect the best information available at that time. NMFS appreciates the District's commitment to consider new information to guide relocation of corals, particularly the numerous smaller colonies in the project area whose relocation would increase the likelihood of the boulder portion of the mitigation succeeding. NMFS also recommends planning during the PED phase closely evaluate potential efficiencies from integrating the coral relocation with operation of the coral nurseries because these project components have similar equipment and personnel needs. NMFS is prepared to work closely with the Jacksonville District on this integration and on development of performance standards, monitoring protocols, and schedules for the coral relocation.

Seagrass Impacts and Mitigation

The Jacksonville District notes in the Final EIS it is unable to address fully at this time the EFH conservation recommendations pertaining to the assessment and mitigation for seagrass impacts; i.e., EFH conservation recommendation No. 10 (direct impacts to seagrass habitat), No. 11 (indirect impacts to seagrass habitat), and No. 12 (compensatory mitigation for seagrass habitat impacts). Appendix E-1 of the Final EIS indicates the project would directly impact 4.21 acres of seagrass and an additional 3.20 acres of seagrass habitat[4] would be mapped prior to construction to determine if mitigation for up to 7.41 acres of seagrass habitat is needed. Section 4.1 of Appendix E-1 describes the District's planned approach for addressing seagrass impacts. While NMFS continues to recommend the Jacksonville District include all previously mapped seagrass habitat in the impact assessment and mitigation planning, NMFS appreciates the District's commitment to consider during PED phase planning additional information on the ecological services of seagrass beds that naturally contract and expand. An important part of the evaluation will be post-construction surveys showing exact locations of past dredging events.

[4] The seagrass species present (i.e., *Halophila decipiens* and *Halodule wrightii*) exhibit seasonal growth tied to a moveable seed bank. This 3.20-acre area has had seagrass present during some surveys but not during all surveys.

Closing

Thank you for the opportunity to provide these comments. The NMFS looks forward to further cooperation with the Jacksonville District on the Port Everglades project to ensure the conservation of the nation's marine resources. Please direct related questions or comments regarding the ESA consultation to the attention of Ms. Kelly Logan at 727-460-9258 or Kel.Logan@noaa.gov. Please direct related questions or comments regarding the EFH consultation to the attention of Ms. Jocelyn Karazsia at 561-249-1925 or Jocelyn.Karazsia@noaa.gov.

Sincerely,

Roy E. Crabtree, Ph.D.
Regional Administrator

cc: USACE - Jason Spinning
USFWS - Jeffrey Howe
FWCC - Lisa Gregg
FDEP - Lainie Edwards
EPA - Ron Miedema, Beth Walls
SAFMC - Roger Pugliese
PPI-NEPA (ppi.nepa@noaa.gov)
F - Leathery
F/SER3 - Logan
F/SER47 - Karazsia

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

By Electronic Mail

April 20, 2015

Theodore A. Brown, Chief,
Planning and Policy Division
Directorate of Civil Works,
Headquarters, U.S.C.E., CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

SUBJECT: Port Everglades Harbor Navigation Study Final Environmental Impact Study and Feasibility Study, Broward County, Florida, CEQ No. 20150064, ERP No. COE-E00000-FL

Dear Mr. Brown:

To fulfill U.S. Environmental Protection Agency's (USEPA's) Clean Air Act (CAA) §309 and National Environmental Policy Act (NEPA) §102(2)(C) responsibilities, the USEPA reviewed the above final EIS (FEIS). Under §309, USEPA is directed to review and comment publicly on the environmental impacts of Federal activities. In its review of the draft EIS (DEIS), the USEPA expressed environmental concerns over potentially significant impacts to public water supplies, water quality, aquatic ecosystems including corals and hardbottoms, mangrove wetlands, seagrasses, and the associated mitigation identified to offset these impacts.

The USEPA continues to have some environmental concerns for the project as proposed, including concerns that were raised following the review of the DEIS and that remain unaddressed in the FEIS. A summary of these unresolved environmental concerns are further discussed in an attachment to this letter (please see Attachment A). In addition, numerous environmental issues associated with the Port of Miami project and its associated dredging impacts have further highlighted the need for Best Management Practices (BMPs) for the proposed dredging operations to avoid and minimize direct and indirect (secondary) impacts; an improved assessment methodology and monitoring plan; appropriate mitigation commitments for proposed dredging activities; and adequate budgeting for monitoring (including disposal site) and mitigation. The EPA Region 4 Water Protection Division can provide more detailed technical comments to the U.S. Army Corps of Engineers (USACE) to help address some of the identified issues regarding BMPs for dredging operations, and to clarify some issues surrounding the ocean disposal of dredged material from the proposed project. In addition, for the purposes of addressing potential technical issues regarding the ocean disposal of dredged material from the proposed project prior to the USACE's Marine Protection Research and Sanctuaries Act (MPRSA) Section 103 determination, the EPA Region 4 Water Protection Division can also provide additional technical comments regarding this matter under separate cover.

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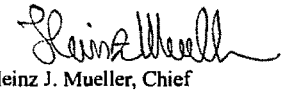
In summary, the USEPA continues to have environmental concerns regarding the proposed mitigation from direct impacts to Aquatic Resources of National Importance, water quality impacts and associated indirect project impacts. The USEPA recommends that the unresolved issues identified in Attachment A be further addressed by the USACE and documented in the Chief's Report and/or Record of Decision (ROD). Additionally, we understand that USACE plans to host an interagency team to refine the monitoring plan and evaluate its effectiveness during implementation for this project. We strongly recommend the USACE convene meetings with this team within the next three or four months and also utilize this team to work through the other issues highlighted in this correspondence.

If you wish to discuss these comments provided further, please contact Beth Walls, (404-562-8309 or Walls.beth@epa.gov), or Christopher Militscher, (404-562-9512 or Militscher.chris@epa.gov), of my staff.

Sincerely,



Heinz J. Mueller, Chief
NEPA Program Office
Resource, Conservation, & Restoration Division

Attachment A

CC: Eric Suma, Chief, Environmental Branch, Planning Division, Jacksonville District Corps of Engineers w/Attachment A

Attachment A
Summary of Comments on Final EIS and Feasibility Study for Port Everglades Harbor Navigation Improvements, Broward County, Florida
CEQ No. 20150064
April 20, 2015

The USEPA has identified a number of yet unresolved issues from the DEIS. The primary issues are the implementation of Best Management Practices (BMPs) and dredging technology; the quantification of direct impacts and quantification and mitigation of indirect impacts to coral reef and hard bottom communities; the quantification and mitigation for direct impacts to mangrove wetlands; the monitoring plan; and adequate budgeting for monitoring (including the disposal site) and mitigation. The issues are more fully described below.

Environmental Concerns Identified from the Draft Chief's Report (Report)

The USEPA is concerned that the proposed funding for the compliance with the Marine Pollution, Research and Sanctuaries Act (MPRSA), including appropriate amount of sediment testing, disposal site monitoring, compliance and site selection (if needed), appears to be inadequate. Based on our review of Paragraph 2d of the Report, the USEPA understands that the use of the Ocean Dredge Material Disposal Site (ODMDS) is expected to be contingent upon a hardbottom habitat assessment. Due to the deep and high current environment at the ODMDS, the EPA Region 4 Water Protection Division staff have estimated the cost of this assessment to be on the order of $500,000. This cost is not reflected in the budget presented in the draft Chief's Report or FEIS/Feasibility Study.

Paragraph 2e of the Report states, "*Additional mitigation will be provided for any direct and indirect impacts caused by dredging or increased turbidity/sedimentation.*" However, the Report does not quantify or provide an estimate regarding the amount of mitigation that might be required or clearly describe how this will be determined. Moreover, the FEIS/Feasibility Study does not identify which BMPs for the dredging operations will be implemented nor were site specific impact assessments conducted with respect to whether/how such BMPs are utilized. The USEPA recommends that the USACE clarify this issue and clearly document it in the Report. The level of impacts from the dredging operation (and amount of mitigation required to offset such impacts) will be dependent on the BMPs selected to be implemented. Accordingly, the USACE should require specific BMPs as part of the dredging operation that ensure the avoidance and minimization of increased turbidity/sedimentation. The USEPA will be pleased to offer technical assistance to the USACE to ensure the implementation of appropriate BMPs during the dredging operation.

Per Paragraph 3 of the Report, the projected cost breakdown does not include the cost of monitoring or additional mitigation costs. Considering the significant amount of monitoring and mitigation expected for the proposed project, the USEPA believes that these costs should be addressed and disclosed.

Per Paragraph 6 of the Report, the unknown cost of an unknown amount of mitigation (to be determined through construction monitoring) appears to the USEPA to be a significant risk and the potential uncertainty is not reasonably accounted for in this discussion.

The Affected Environment to be Impacted

The USEPA considers mangrove, seagrass, coral reefs and hardbottom communities to be Aquatic Resources of National Importance (ARNI) and every effort should be made to avoid these impacts. Moreover, the Clean Water Act's implementing regulations establish environmental standards for the USEPA and the USACE's use in evaluating USACE feasibility studies for those activities impacting special aquatic sites,[1] (e.g., the Port Everglades harbor mangrove wetlands and submerged aquatic vegetation habitats).[2] The Florida Department of Environmental Protection designated the waters within the Port as Class III, acceptable for recreation, fish, and wildlife, and the waters adjacent to State Park, the Atlantic Ocean, as Outstanding Waters of the State.[3]

Environmental Impacts, Proposed Mitigation, Status of the Issue and Recommendations

Corals/hardbottom: One of the most significant impacts associated with dredging the outer entrance channel is the permanent removal of coral and hardbottom habitat. Within the outer reef system, the proposed action will widen the outer entrance channel an additional 3 feet, deepen the outer entrance channel from 45 to 57 feet, and extend the channel 2,200 feet further into the middle and outer reef tracts. The DEIS indicated the permanent removal of approximately 5.58 acres of the middle reef and approximately 11.09 acres of the outer reef (a total of 16.57 acres) to create the entrance channel flare for vessel safety purposes. However, the FEIS indicates the permanent removal of 14.62 acres of the middle and outer reefs, instead of 16.57 acres, to create the entrance channel flare. Clarification of this change is needed for the determination of the total direct impacts acreage amount.

The FEIS identifies the potential for up to an additional 17.13 acres of reef and nearshore hardbottom impacts with respect to the option for anchoring of cutterhead dredge equipment (See Section 4.5.10.2.2.). In order to ensure the implementation of the project avoids and minimizes the impacts to coral reefs and hardbottom communities in accordance with the Clean Water Act Section 404(b)(1) Guidelines, the USEPA recommends that the project plans include the BMPs for prohibiting the anchoring of cutterhead dredge equipment on reef and hardbottom communities.

The USEPA is concerned that the amount of mitigation required to compensate for indirect impacts to coral and hardbottom resources has been underestimated as the projected impacts do not account for the following:

- The FEIS indicates the proposed action will remove 0.07% of the middle reef (shallow colonized pavement and linear reef middle tract) and 0.52% of the outer reef (deep

[1] 40 CFR Part 230, Subpart E - Potential Impacts on Special Aquatic Sites, §§ 230.41 Wetlands and 230.43 Vegetated shallows.
[2] CWA, Section 404(b)(1) Guidelines.
[3] FEIS (2015), Section 3.9.1, p. 152.

colonized pavement; linear reef outer tract; spur & groove reef) foraging habitat within Broward County by expansion of the outer entrance channel. However, these estimates do not include secondary impacts to the coral reef complex associated with the actual construction activity (e.g., dredging, and any blasting effects, including associated turbidity and sedimentation).

- The USEPA notes that uncertainty may continue to exist between the USACE's and the National Oceanic and Atmospheric Agency (NOAA) Fisheries' defined indirect impacts as it is unknown whether impacts will extend beyond 150 meters as assumed by the USACE. The USEPA recommends further coordination with NOAA to help narrow the uncertainties associated with indirect impacts considering the importance of the resources that may be effected by this proposed project.

The USACE proposes a hybrid mitigation plan that includes mitigation for the direct removal of approximately 14.62 acres of complex, high-profile, linear and spur/groove reef habitat through the creation of approximately 5 acres of artificial reef, along with the transplantation of 11,502 corals from the impact site to the artificial reef. A third component of the USACE hybrid mitigation plan includes the enhancement of approximately 18 acres of reef via the installation of approximately 103,000 coral colonies out-planted from coral nurseries. However, the amount of mitigation required to compensate for indirect impacts to coral and hardbottom resources may not be sufficient as the impacts are not fully defined due to the potential uncertainties with the USACE criteria.

Seagrasses: The DEIS indicates dredging will permanently remove up to 3.57 acres of mixed or monoculture Johnson's seagrass where it occurs along the south access channel and widener and impede post-dredging recolonization as the seagrasses require shallow, 13-14 foot habitats. The USEPA notes a discrepancy in defined impacts exists between the USACE and the NOAA Fisheries. The proposed project may include the removal of approximately 7.41 acres of vegetated and un-vegetated seagrass habitat (including that within the new channel footprint and resulting side slopes).

The USACE proposes mitigation for seagrass impacts to involve the use of approximately 2.4 seagrass 'functional units' at a previously permitted restoration project at West Lake Park, which is currently under design. The difference in the quantification of the direct impacts should be clearly identified in the Final Chief's Report ('Final Report') and/or Record of Decision (ROD). The USEPA recommends that the mitigation for seagrass and associated habitat for direct impacts be adequate compensation for the direct losses to these aquatic resources. Given the current status of mitigation credits needed to offset losses, the USEPA requests that the USACE fully address compensatory mitigation issues in the Report and/or ROD.

Mangrove wetlands: The USACE indicates the proposed action will impact 1.16 acres of jurisdictional mangrove wetlands located along the east side of the south access channel along J. Lloyd State Park's western shore. However, the USEPA finds there is a larger wetlands impact (8.59 acres) associated with the close linkage between the turning notch component of the proposed action to be done by the USACE and that being directly performed by the local project sponsor. Instead of the USACE removing these black and red mangrove wetlands, the project

sponsor will be removing them to allow the USACE to completely implement the proposed action.

The USACE proposes to directly mitigate only for the loss of approximately 1.16 acres of mangroves in the project footprint by providing one mangrove 'functional unit' at a previously permitted restoration project at West Lake Park, which is currently under design.

Given the cumulative impacts of all proposed components of this harbor deepening project, both by the USACE and the local sponsor, the USEPA considers the proposed mangrove wetlands mitigation to be insufficient. The USEPA recommends that the USACE include complete information with the total mitigation needed for all direct losses of mangrove wetlands planned, and provide this information in the Final Report and/or the ROD.

Water Quality and BMPs: The USACE has deferred specific BMPs for dredging operations to the proposed contractor and the State of Florida. Water quality and offshore habitat impacts from this 6-7 year project are expected to be very significant and have the potential to degrade water quality and result in secondary sedimentation impacts to ARNI. The FEIS/Feasibility Study does not provide a comprehensive analysis or specific BMP requirements that addresses avoidance and minimization of secondary sedimentation impacts and minimization of water quality impacts during the multi-year project in accordance with CWA Section 404(b)(1) Guidelines .

The USACE has proposed to follow a similar monitoring criteria and BMP implementation process that was utilized for the Port of Miami project which has proved problematic, resulting in a citizen lawsuit and a warning letter from the State of Florida. Because the USACE's proposed monitoring plan is written in the context of adaptive management, the USEPA recommends that the impacts to water quality and aquatic resources be addressed in a timely manner. The USEPA can provide the USACE with technical assistance that would help to meet the avoidance of potentially critical impacts before they become a re-occurring problem.

The USEPA does not believe that the proposed identification, monitoring and enforcement of future, project-specific BMPs to protect water quality under the Clean Water Act and ARNI is adequately detailed in the FEIS. Because required BMPs are to be determined based on the USACE dredging contractor's discretion, it is unknown what minimization efforts will be instituted for the proposed project. In addition, the USEPA strongly recommends consideration of BMPs from the Permanent International Association of Navigation Congresses' (PIANC) document "*Dredging and Port Construction around Coral Reefs*," as well as those BMPs discussed in the FEIS.

The USEPA believes a site specific assessment could have been completed and is still recommended to be completed utilizing existing USACE models (e.g., SSFATE, ERDC TN-DOER-E10) for evaluating the potential extent of sedimentation effects of the dredging operations and evaluating the relative benefits of different BMPs. This modelling with site-specific data would aid in identifying BMPs to avoid and minimize impacts, and as well, to identify the geographic extent of indirect impacts, important for designing the monitoring zone evaluation area, and for ultimately determining the appropriate amount of compensatory mitigation.

The USEPA requests that the BMPs or appropriate equipment selection be implemented through Federal contracting practices in accordance with the USACE's *Dredging and Dredged Material Disposal Engineer Manual 1110-2-5025*. The USEPA recommends that the most effective and practical BMPs should be utilized by established USACE methods. The costs associated with these BMPs should be incorporated into the project budget and be required and implemented as part of the USACE's dredging contract.

Because the estimated funding to perform adequate ODMDS criteria testing of dredged materials is not provided in the FEIS, the USEPA questions if adequate funding for the testing of materials is going to be provided based upon past experience with the District's deepening projects. The FEIS did not provide an assessment of the risks of the project's full implementation if portions of the project do not meet the ocean disposal criteria. The USEPA also questions if the USACE has underestimated the costs associated with conducting their own ODMDS site selection pursuant to MPRSA Section 103, as the draft Chief's Report and FEIS/Feasibility Study do not appear to include all costs associated with the monitoring of the proposed expanded ODMDS.

The USEPA requests that further coordination and communication with the USACE prior to the commencement of the proposed project. Based on the review of the FEIS/Feasibility Study, the USEPA would be pleased to share extensive and detailed technical comments on the proposed dredging contracting and operations. The USEPA believes these detailed technical comments can identify potential solutions to reasonably foreseeable problems with water quality and associated indirect impacts to ARNI and can be provided to the USACE under separate cover. In addition, the USEPA would also be pleased to discuss these issues with the interagency team that we understand the USACE will be leading with respect to this project.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

JUN 2 2015

Planning and Policy Division

Mr. Heinz J. Mueller
U.S. Environmental Protection Agency, Region IV
Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303

Dear Mr. Mueller:

This letter is in response to your comments on the Port Everglades Final Feasibility Report and Environmental Impact Statement provided in a letter dated April 20, 2015. Responses to the concerns raised in your letter are below.

EPA raises a funding concern on multiple occasions in the letter. The concern pertains to compliance with the Marine Pollution, Research and Sanctuaries Act (MPRSA) and the potential necessity to mitigate for additional indirect impacts not presently part of the impact analysis. Compliance with MPRSA will be accomplished during the Pre-Engineering and Design (PED) Phase of the study. Appropriate funding for MPRSA compliance will be requested during PED. The Corps may also utilize the project's contingency to address the ODMDS concerns along with any additional mitigation if necessary. The current project contingency is 26% of the overall cost.

With regards to the use of best management practices (BMPs), future BMPs will be derived from lessons learned from the Miami Harbor Deepening Project and the National Marine Fisheries Service's (NMFS) biological opinion requirement for the creation of an interagency team to assist in future project development. The BMPs evaluation during PED will consider the type of equipment, anchoring in or out of the channel, other measures or methods to avoid or reduce impacts, and monitoring protocol. In addition, the Corps is adding the BMP document referenced in the USEPA final EIS comment letter (*"Dredging and Port Construction around Coral Reefs"*) to Sections 5.4 and 4.4.2.2 of the Final EIS.

Your letter also documents a concern for multiple resources under NMFS purview including corals, other reef species, seagrasses and mangroves. The Corps has worked collaboratively with NMFS to address impacts to these resources. The collaborative efforts guided the project's impact assessment, mitigation needs, and an appropriate mitigation plan with monitoring to ensure success. NMFS and the Corps also evaluated both direct and indirect effects of the project. The Corps has proposed to mitigate 2% upfront of the offshore project area to provide assurances that indirect effects will be addressed. The Corps also proposes to monitor this project area for any

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additional impacts greater than 2%. If additional impacts are identified then they will be assessed utilizing the same protocol, agreed to by NMFS, to generate a mitigation need. If the need arises, the Corps proposes to address it by transplanting additional nursery grown specimens. This information is discussed in section 4.4.2.2 and 4.5.10.2.3 of the Final EIS.

Your letter also highlights a discrepancy between the Draft and Final EIS for the offshore reef impacts (14.62 vs. 16.57). This change occurred through comments received on the Draft EIS from both NMFS and the Florida Department of Environmental Projection. These agencies requested that the Corps utilize the most recent LADS data for offshore impact acreage assessment. The reduction in acreage resulted from a recalculation utilizing the 2013 LADS, provided by Broward County, in lieu of the previously used 2008 LADS.

Your letter expressed concern in regards to the anchoring of cutterhead dredges. As detailed in the responses to comments (Appendix M of the Final EIS), specific methods or equipment cannot be required in USACE contracts. However the Corps will request the selected contractor implement an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat.

The Final EIS also discusses the impact assessment and proposed mitigation plan fo unavoidable impacts to seagrasses and mangroves. The Corps has agreed with NMFS to further evaluate during the PED phase scientific literature to consider if mitigation is necessary for impacts to unvegetated seagrass habitat. Currently, the Corps would only plan to mitigate for vegetated seagrass impacts.

Mangrove impacts have been vastly reduced by modifying the proposed channel side bulkheads to allow water to allow flushing to areas landward. The minimal remaining mangrove impacts along with the seagrass impacts will be mitigated at West Lake Park. West Lake Park was authorized by a Corps' Department of Army Permit and a permit from the South Florida Water Management District with the full understanding that the mitigation area would service Port Everglades.

The cumulative effects section of the Final EIS also evaluated and discussed the reasonable foreseeable effects of the removal of mangroves within the Turning Notch. The Port has worked with FDEP to develop a separate mitigation plan to compensate for the mangrove impact. The Turning Notch expansion is currently in the design and permitting phase, with anticipated construction commencement in mid to late 2016. Therefore, the lost functions for the Turning Notch mangroves will most likely be realized and mitigated prior to the end of PED of the Port Everglades Deepening project.

We trust that the information provided here sufficiently addresses any of your unresolved concerns, and will continue to coordinate with the EPA as the project moves forward. If you would like to discuss these issues further, please contact Mr. Jason Spinning, at (904) 232-1231.

Sincerely,

Theodore A. Brown

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

Enclosure

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
BOB MARTINEZ CENTER
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32399-2400

RICK SCOTT
GOVERNOR

CARLOS LOPEZ-CANTERA
LT. GOVERNOR

JONATHAN P. STEVERSON
SECRETARY

April 21, 2015

Mr. Theodore A. Brown, P.E., Chief
Planning & Policy Division, CECW-P (SA)
U.S. Army Corps of Engineers, Headquarters
7701 Telegraph Road
Alexandria, VA 22315-3860

RE: Department of the Army, Jacksonville District Corps of Engineers
Final Feasibility Report and Environmental Impact Statement, Navigation Study
for Port Everglades Harbor – Fort Lauderdale, Broward County, Florida.
SAI # FL201503117224 (Reference Prior SAI # FL201306266640C)

Dear Mr. Brown:

The Florida Department of Environmental Protection (Department) appreciates the opportunity to comment on the Final Feasibility Report and Environmental Impact Statement, Navigation Study for Port Everglades Harbor – Fort Lauderdale, Broward County, Florida (FEIS). In light of the cooperative spirit of the interagency agreement between the Department and the United States Army Corps of Engineers (Corps), the Department would like to use this opportunity to provide a few comments to the FEIS and touch on a couple topics that the Department and the Corps will address during the permitting of this project, thereby simplifying the permitting process for the Corps.

Initially, the Department appreciates the inclusion in the FEIS of a discussion of potential impacts associated with project-generated sedimentation. Indeed, the Department appreciates that the Corps included information on sedimentation resulting from the recent expansion of the Port of Miami and the effects on hardbottom habitats. The Department will work with the Corps to apply lessons learned from the Port of Miami expansion project to the Port Everglades project, in order to minimize impacts to the greatest extent practicable and to ensure that mitigation offsets unavoidable impacts to resources resulting from dredging activities and associated sedimentation.

As you are aware, the Florida State Clearinghouse coordinated the state's review of the Corps' Draft Feasibility Report and Environmental Impact Statement (DEIS), in June of 2013, and the review of supplemental mitigation information supplied in March of 2014, and subsequent communications and presentations both by the Corps and the National Marine Fisheries Service (NMFS). The Department determined that the proposed federal action, identified in the DEIS, was conditionally consistent with the enforceable policies of the Florida Coastal Management Program, provided certain conditions would be satisfied before or during the permitting phase.

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These conditions requested additional or revised information on the flooding and flushing model, hardbottom impacts, mangrove and seagrass impacts, monitoring and mitigation plans, and John U. Lloyd Beach State Park[1] impacts.

The FEIS for the Port Everglades Project was published in the Federal Register on March 20, 2015. The FEIS included written responses to address the conditions in the Department's June, 2013 conditional consistency letter. The Department acknowledges that the Corps has provided more information addressing the Department's comments relating to the seagrasses located within the project area. Furthermore, the Department has recently re-reviewed its comments and determined that the Department is now satisfied that there shouldn't be any flooding issues associated with this project. Notwithstanding the Corps' additional efforts, it appears that there are still a few matters that will need to be addressed as part of the permitting process. They are as follows:

The Flushing Model
Prior to permitting this project, the Department would request that the flushing model be validated and calibrated in order to adequately analyze the potential hydraulic impacts from the widening and deepening of the channels and turning basins within the Port.

Monitoring & Mitigation
The Department would request that a comprehensive baseline survey of areas surrounding the channel be conducted, as this is crucial for adequate comparison to during- and post-construction data. Monitoring plans should be provided for seagrasses and hardbottom. Minimization measures for corals, sponges and octocorals should also be addressed.

The Department would like the opportunity to discuss hardbottom mitigation proposals prior to the submission of a permit application. The Department is in agreement with the blended mitigation approach proposed by the Corps; however, using the Uniform Mitigation Assessment Method (UMAM), Department-generated mitigation amounts for transplantation requirements exceed those of the Corps. This is an issue that the Department and Corps have discussed in the past, and the Department looks forward to continued discussions in that regard.

The Department is committed to work with the Corps to assist with the resolution of all of the above items.

Sincerely,

Frederick L. Aschauer, Jr., Director
Division of Water Resource Management

[1] This letter is not intended to address the FEIS' discussion of the State Park.

cc: Dr. Jeffrey Payne, NOAA OFCM Acting Director
Mr. Eric Summa, USACE-SAJ
Ms. Terri Jordan-Sellers, USACE-SAJ
Mr. Steven Cernak, Broward County Port Everglades Department
Ms. Danielle Irwin, DEP Division of Water Resource Management
Dr. Lainie Edwards, DEP Beaches, Mining and ERP Support Program
Mr. Martin Seeling, DEP Beaches, Inlets and Ports Program
Ms. Kristina May, DEP Beaches, Inlets and Ports Program
Mr. Kevin Claridge, DEP Florida Coastal Office
Mr. Parks Small, DEP Bureau of Natural and Cultural Resources
Mr. Lewis Scruggs, DEP Office of Park Planning
Ms. Lauren Milligan, DEP Office of Intergovernmental Programs
Mr. Scott Sanders, FWC Conservation Planning Services

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Immokalee

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Charles W. Roberts III
Tallahassee

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Nick Wiley
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Eric Sutton
Assistant Executive Director

Jennifer Fitzwater
Chief of Staff

Office of the
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Executive Director

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(800) 955-8771 (T)
(800) 955-8770 (V)

MyFWC.com

April 17, 2015

Ms. Lauren Milligan
Office of Intergovernmental Programs
Florida Department of Environmental Protection
3900 Commonwealth Boulevard, Mail Station 47
Tallahassee, FL 32399-3000
Lauren.Milligan@dep.state.fl.us

RE: SAI #FL201503117224 - Department of the Army, Jacksonville District Corps of Engineers - Final Feasibility Report and Environmental Impact Statement, Navigation Study for Port Everglades Harbor - Fort Lauderdale, Broward County, Florida

Dear Ms. Milligan:

The Florida Fish and Wildlife Conservation Commission (FWC) has reviewed the Final Feasibility Study (FFS) and Environmental Impact Statement (FEIS) for Navigation Improvements in Port Everglades Harbor.

FWC is pleased to see that USACE has incorporated a number of our recommendations on the Draft Environmental Impact Statement and provided additional information as part of the Final EIS. We stand ready to assist the Florida Department of Environmental Protection and the USACE in resolving any remaining issues during the Water Quality Certification/permitting phase of this project.

The FWC appreciates the opportunity to review the Final Feasibility Study and Environmental Impact Statement for Navigation Improvements in Port Everglades Harbor. If you need further assistance, please do not hesitate to contact Jane Chabre either by phone at (850) 410-5367 or by email at FWCConservationPlanningServices@MyFWC.com.

Sincerely,

Scott Sanders, Director
Office of Conservation Planning Services

ss/jdg
ENV 1-3-2
Port Everglades Harbor Navigation Study Final EIS_20813_041715

cc: Eric Summa, USACE, Eric.P.Summa@usace.army.mil
Fred Aschauer, FDEP, Fred.Aschauer@dep.state.fl.us

Encl 10

SEMINOLE TRIBE OF FLORIDA
TRIBAL HISTORIC PRESERVATION OFFICE
AH-TAH-THI-KI MUSEUM

TRIBAL HISTORIC
PRESERVATION OFFICE

SEMINOLE TRIBE OF FLORIDA
AH-TAH-THI-KI MUSEUM

30290 JOSIE BILLIE HWY
PMB 1004
CLEWISTON, FL 33440

PHONE: (863) 983-6549
FAX: (863) 902-1117

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LAVONNE KIPPENBERGER

TREASURER
PETER HAHN

May 12, 2015

Terri Jordan-Sellers, Biologist
Department of the Army
U.S. Army Corps of Engineers – Jacksonville District
Phone: 904-232-1817

Dear Ms. Jordan-Sellers,

Subject: Port Everglades Harbor Navigation Study
THPO#: 0028544

The Seminole Tribe of Florida's Tribal Historic Preservation Office (STOF-THPO) thanks you for contacting the Tribe regarding the Final Environmental Impact Statement, the proposed report of the Chief of Engineers, and the report of the district Engineer for the Port Everglades Harbor Navigation Study, Broward County, Florida project. The THPO has reviewed the documents you provided and has no objections to the project at this time. However, because the project lies within an area that is of historical importance to the Tribe, the THPO would like to be informed in the event that any archaeological, historical, or burial resources are inadvertently discovered during execution of the project. We also respectfully request that the U.S. Army Corps of Engineers (USACE) continue to consult with the THPO as per Section 106 of the National Historic Preservation Act and in keeping with the USACE's trust responsibilities. For any issues related to this matter please reference THPO# 0028544. We look forward to working with you in the future.

Respectfully,

Bradley M. Mueller

Bradley M. Mueller, M.A., Supervisor
STOF-THPO-Compliance Review Section
30290 Josie Billie Hwy, PMB 1004
Clewiston, FL 33440
Office: 863-983-6549 x12245
Email: bradleymueller@semtribe.com

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BROWARD COUNTY FLORIDA

PORT EVERGLADES DEPARTMENT - Chief Executive/Port Director's Office
1850 Eller Drive, Fort Lauderdale, Florida 33316
954-468-0140 FAX 954-523-8713

August 14, 2014

Colonel Alan M. Dodd
US Army District Commander
U.S. Army Corps of Engineers, Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Dodd:

I am in receipt of your letter dated July 25, 2014 and have been briefed by members of your staff concerning the selection of 47-feet as the National Economic Development (NED) Plan for Port Everglades. The analysis of channel improvements at Port Everglades conducted by the U.S. Army Corps of Engineers (USACE) Jacksonville District and the Deep Draft Navigation Center has identified 48-feet as the channel depth that maximizes net benefits. However, the USACE has determined that the net benefits for the 48-foot channel are "not significantly different" from the benefits of the 47-foot channel, and thereby identified the 47-foot channel as the NED plan.

Broward County recognizes the value of a 48-foot channel to the nation as well as to the state, regional and local economy. After careful consideration by our executive team and the Broward County Board of County Commissioners, Broward County, as the non-federal sponsor, supports the 48-foot channel and requests that the 48-foot channel be implemented as the Locally Preferred Plan (LPP). The 48-foot channel is instrumental to the Port Everglades Master/Vision Plan and will contribute greatly to the future economic growth of the region.

By selecting 48-feet as the LPP, Broward County understands and is prepared to meet all of the commitments as the local sponsor that this depth represents in terms of deepening expenses.

Broward County Board of County Commissioners
Sue Gunzburger • Dale V.C. Holness • Kristin Jacobs • Martin David Kiar • Chip LaMarca • Stacy Ritter • Tim Ryan • Barbara Sharief • Lois Wexler
www.broward.org

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As Broward County's primary liaison with the USACE on this project, I am very appreciative of you and your team's efforts to move this very important project forward in a timely manner given its lengthy history.

If additional information is needed, please do not hesitate to contact me at (954) 468-3516.

Sincerely,

Steven M. Cernak, P.E., PPM
Chief Executive/Port Director
Port Everglades

SMC:DA:kwr

Attachment

CC: Bertha Henry, Broward County Administrator
Glenn Wiltshire, Deputy Director, Port Everglades
David Anderton, II, AICP, PPM, Assistant Director, Port Everglades
Edward Labrador, Director, B.C. Intergovernmental Affairs and Professional Standards

NON-FEDERAL SPONSOR'S
SELF-CERTIFICATION OF FINANCIAL CAPABILITY
FOR DECISION DOCUMENTS

I, Leah Brasso, do hereby certify that I am the Acting Director of Finance for the Port Everglades Department of Broward County, Florida (the "Non-Federal Sponsor"); that I am aware of the financial obligations of the Non-Federal Sponsor for the Port Everglades Harbor Feasibility Report and Environmental Impact Statement; and that the Non-Federal Sponsor will have the financial capability to satisfy the Non-Federal Sponsor's obligations for that project. I understand that the Government's acceptance of this self-certification shall not be construed as obligating either the Government or the Non-Federal Sponsor to implement a project.

IN WITNESS WHEREOF, I have made and executed this certification this 14th day of August, 2014.

BY: Leah Brasso

TITLE: Acting Director of Finance

DATE: August 14, 2014

Sworn to and subscribed before me this 14th day of August, 2014, by Leah Brasso, who is personally known to me.

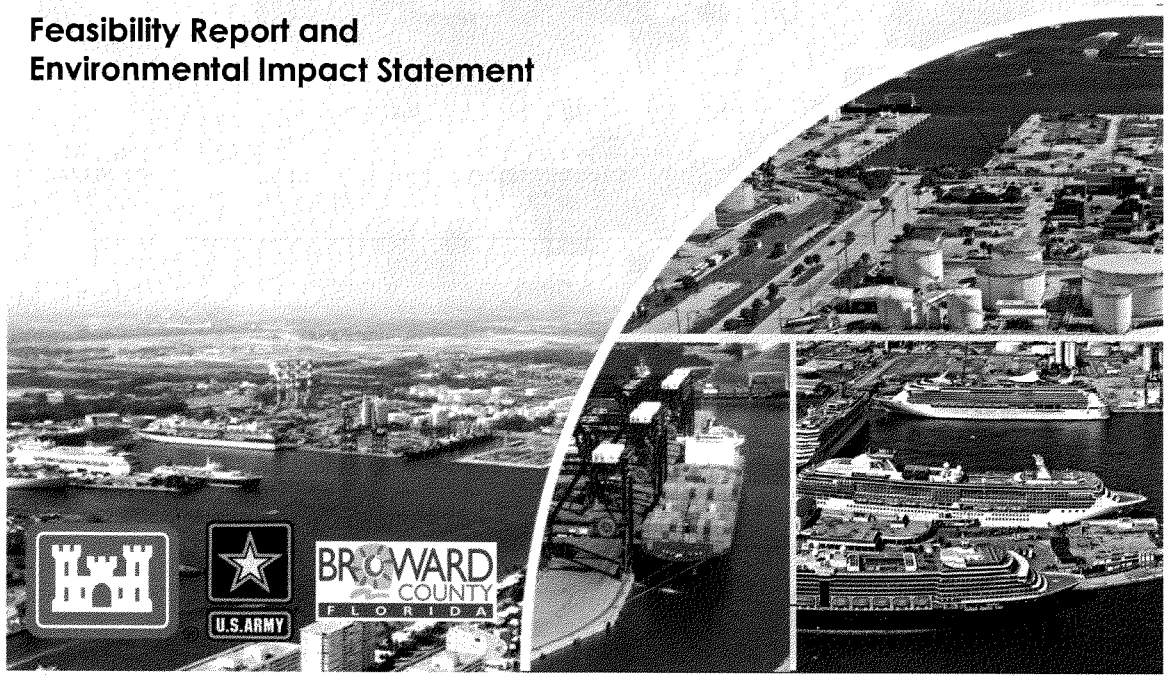
Julie L. Ciucevich

JULIE L CIUCEVICH
Notary Public - State of Florida
My Comm. Expires Mar 24, 2018
Commission # FF 105443

PORT EVERGLADES HARBOR

Broward County, Florida

Feasibility Report and
Environmental Impact Statement



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XLVI

PORT EVERGLADES LEGISLATIVE AUTHORITY

Authorization: House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, and by a resolution of the House Committee on Transportation dated May 9, 1996:

> "...to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of navigation and related purposes, with particular reference to navigation into and within the port of the project known as the Southport Channel."

Non-federal Sponsor: Broward County, Florida

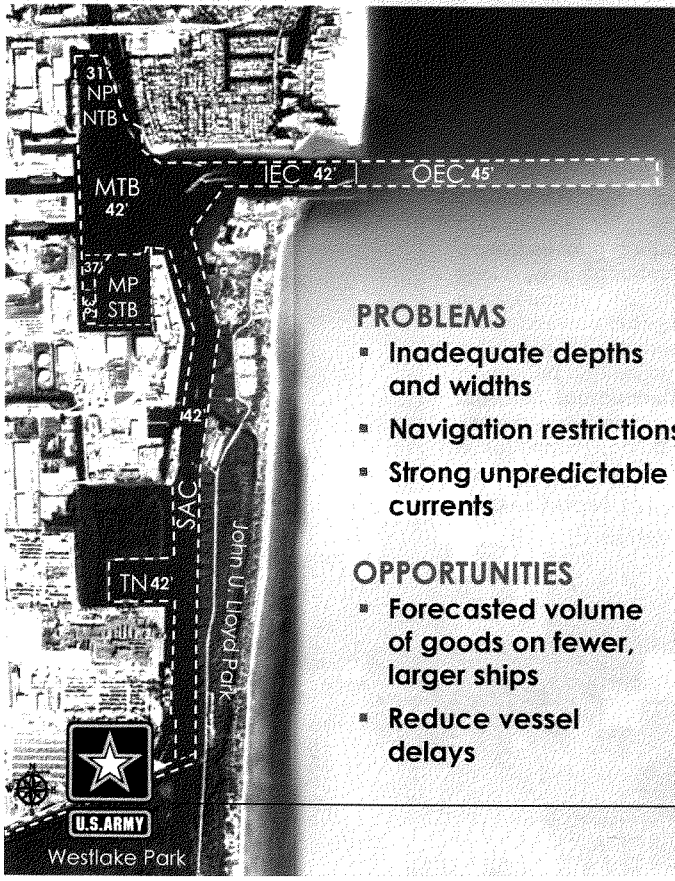
DEEPENING HISTORY

RECOMMENDED PLAN

1930's	1960's	1980's	1990's	2015
35ft Entrance Channel and Main Turning Basin	37 ft Outer Entrance Channel through Main Turning Basin	42 ft Outer Entrance Channel through Main Turning Basin	42 ft Southport Access Channel and Turning Notch	48 ft Outer Entrance Channel through South Access Channel

Bay Mabel Harbor was dedicated on February 22, 1968

PORT EVERGLADES: PROJECT PURPOSE



NP	Northport
MTB	Main Turning Basin
MP	Midport
SAC	Southport Access Channel
TN	Turning Notch
IEC	Inner Entrance Channel (500-foot width)
OEC	Outer Entrance Channel (500-foot width)

PROBLEMS

- Inadequate depths and widths
- Navigation restrictions
- Strong unpredictable currents

→

- Vessel light-loading
- More frequent trips
- Vessel delays

OPPORTUNITIES

- Forecasted volume of goods on fewer, larger ships
- Reduce vessel delays

→

- Reduce transportation costs

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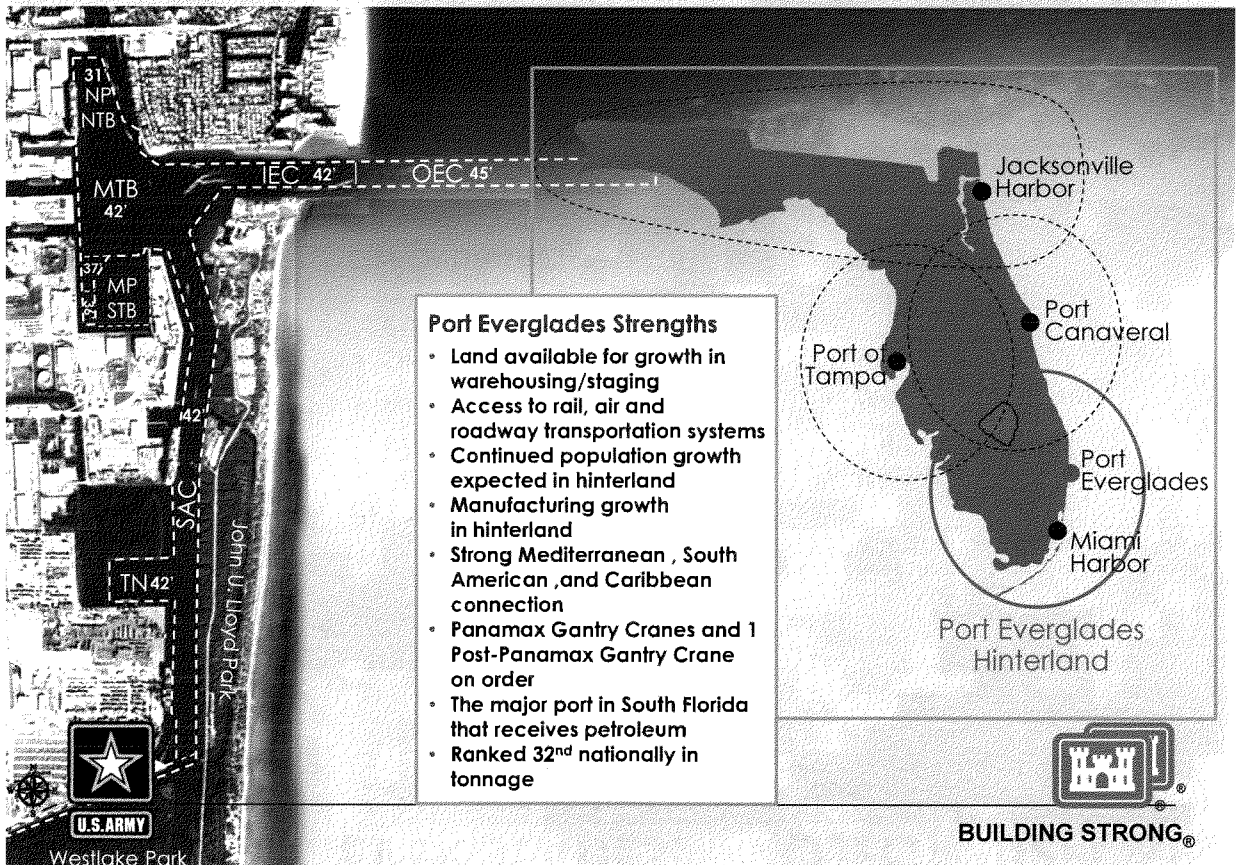
PORT EVERGLADES: LOCATION



Port Everglades Strengths

- Land available for growth in warehousing/staging
- Access to rail, air and roadway transportation systems
- Continued population growth expected in hinterland
- Manufacturing growth in hinterland
- Strong Mediterranean , South American ,and Caribbean connection
- Panamax Gantry Cranes and 1 Post-Panamax Gantry Crane on order
- The major port in South Florida that receives petroleum
- Ranked 32nd nationally in tonnage

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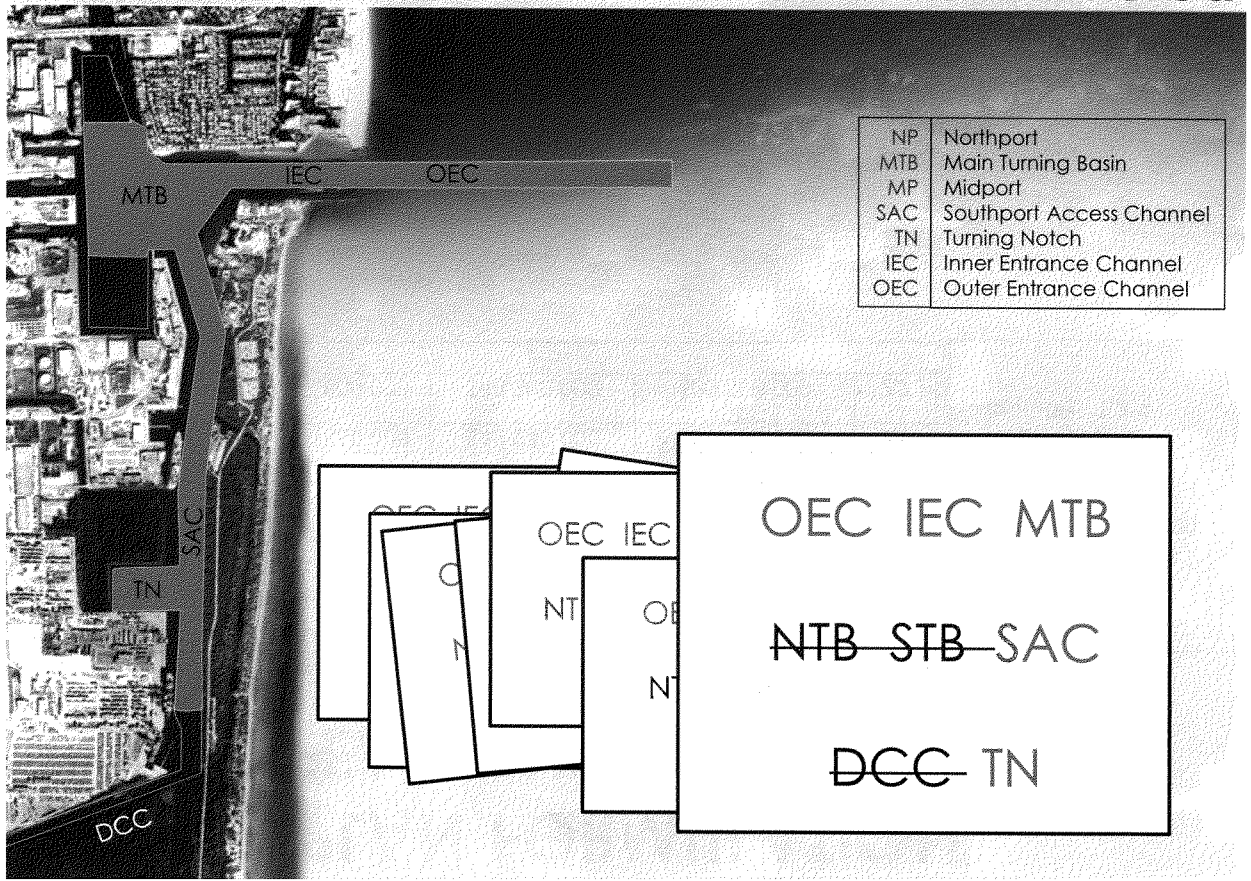
PORT EVERGLADES: Alternatives Considered



PLAN FORMULATION
FEASIBILITY ANALYSIS

(FY15 Discount Rate 3.375% and October 2014 Price Level)

Depth	Average Annual Costs*	Average Annual Benefits	Average Annual Net Benefits	BCR
46ft	$15,000,000	$45,100,000	$30,100,000	3.0
NED Plan 47ft	**$15,900,000**	**$46,900,000**	**$31,000,000**	**2.9**
LPP/Recommended Plan 48ft	**$16,860,000**	**$48,240,000**	**$31,400,000**	**2.9**
49ft	$17,800,000	$48,300,000	$30,500,000	2.7

**Costs include IDC and O&M.*

Net Incremental Average Annual Benefits: $400,000

Increase in Average Annual Benefits: 1.3%

LPP [illegible]lly Preferred Plan

U.S.ARMY

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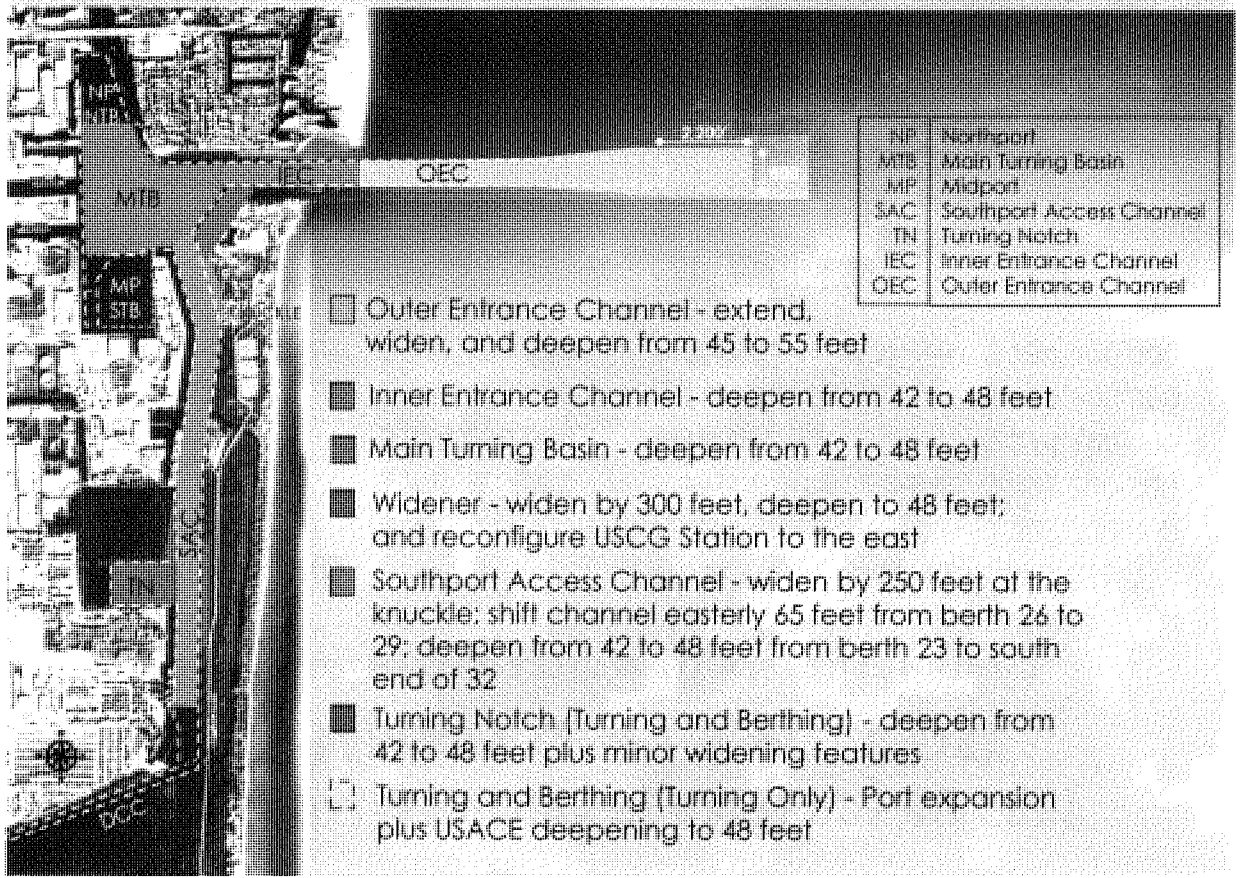
PORT EVERGLADES: RECOMMENDED PLAN



- Outer Entrance Channel - extend, widen, and deepen from 45 to 55 feet
- Inner Entrance Channel - deepen from 42 to 48 feet
- Main Turning Basin - deepen from 42 to 48 feet
- Widener - widen by 300 feet, deepen to 48 feet; and reconfigure USCG Station to the east
- Southport Access Channel - widen by 250 feet at the knuckle; shift channel easterly 65 feet from berth 26 to 29; deepen from 42 to 48 feet from berth 23 to south end of 32
- Turning Notch (Turning and Berthing) - deepen from 42 to 48 feet plus minor widening features
- Turning and Berthing (Turning Only) - Port expansion plus USACE deepening to 48 feet

RECOMMENDED PLAN (LPP) 48 FEET SUMMARY OF PROJECT COST

(FY 15 Discount Rate 3.375% and October 2014 Price Level)

NED Plan (47 feet)

- GNF Cost: $ 305,300,000
- First Cost *(902 Basis)*: $ 305,300,000
- **Total Cost: $ 356,000,000**
- **Federal Share: $ 189,900,000**
- **Non-federal Share: $ 166,100,000**
- **BCR: 2.9**

Recommended Plan (48 feet)

- GNF Cost: $ 322,700,000
- First Cost *(902 Basis)*: $ 322,700,000
- **Total Cost: $ 374,100,000**
- **Federal Share: $ 189,900,000**
- **Non-federal Share: $ 184,200,000**
- **BCR: 2.9**

Average Annual O&M: $55,500

(No discernible difference in future O&M for the NED vs. Recommended Plan)

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DEVIATION FROM THE NED PLAN

- NED (47 feet) vs. Recommended Plan (LPP 48 feet) Incremental Analysis:
  - Incremental AAEQ Costs: $960,000
  - Incremental AAEQ Benefits: $1,340,000
  - Net AAEQ Incremental Benefits: $400,000
  - Incremental BCR: 1.40

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ENVIRONMENTAL COMPLIANCE

- ☑ DEIS prepared and coordinated
- ☑ Endangered Species Act Coordination (USFWS)
- ☑ Endangered Species Act Coordination (NMFS)
- ☑ Essential Fish Habitat Coordination (NMFS)
- ☑ Cultural Resources Coordination
- ☑ Coastal Zone Consistency

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LV

PUBLIC/AGENCY INVOLVEMENT

FROM 1999 TO 2014: OVER 30 MEETINGS

Scoping

- Scoping letters issued, 2001
- Notice of Intent (NOI) to prepare a Draft Environmental Impact Statement (DEIS) published in Federal Register, 2001

Agency Coordination

- Cooperating Agency Letters:
- Meetings and Site Visits:
- Endangered Species Act (ESA) coordination with USFWS (August 20, 2013) and NMFS (May 1, 2014)
- Magnuson-Stevens Fishery Conservation and Management Act (EFH) coordination with NMFS (April 17, 2014)

PROJECT IMPLEMENTATION
(Key Dates)

Feasibility Phase:

- Chief of Engineers Report: May 2015

Preconstruction Engineering and Design (PED) Phase:

- April 2015 – September 2017

Construction Phase:

- Subject to Authorization and Appropriations: 2017-2022

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Civil Works Review Board

- Date and Time: February 19, 2015 at 1300
- Summary of Decision: Release Draft Chief's Report for State and Agency Review
- OMB Attendees: Gary Waxman

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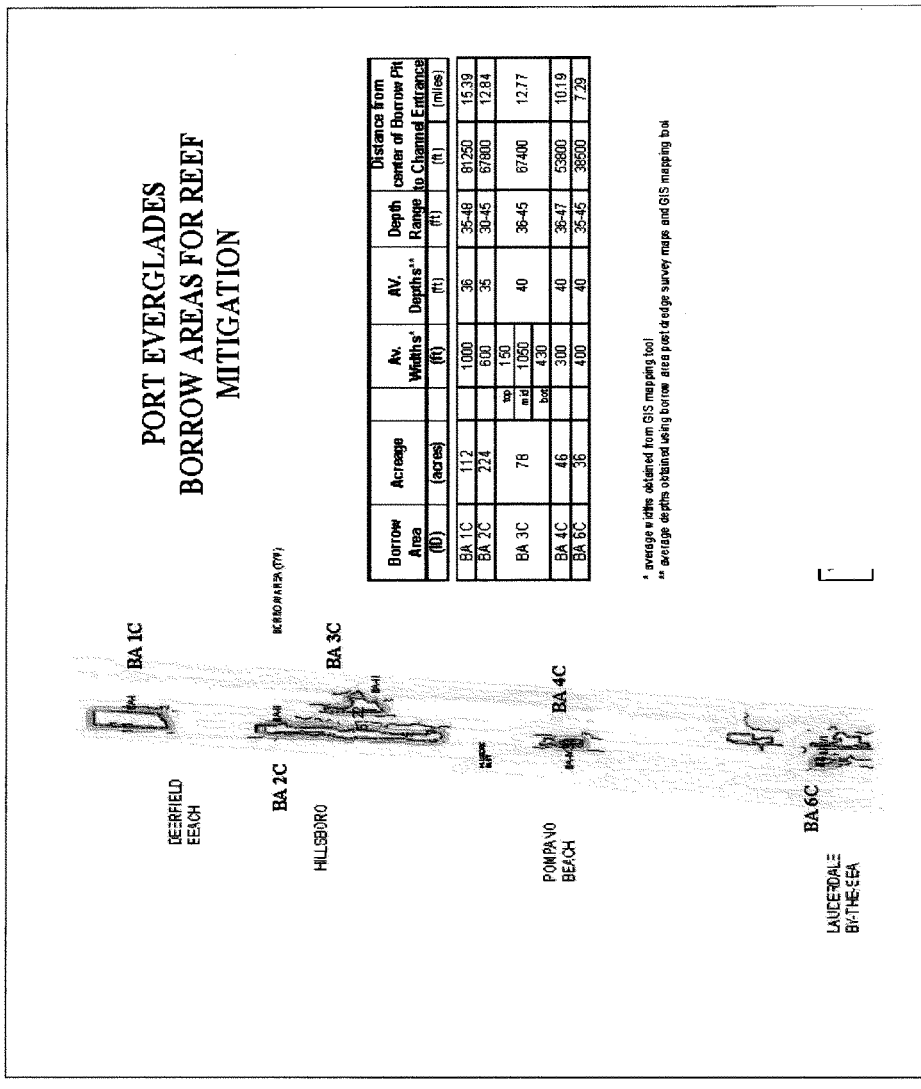


Borrow Area	Acreage	Av. Widths*	AV. Depths**	Depth Range	Distance from center of Borrow Pit to Channel Entrance
(ID)	(acres)	(ft)	(ft)	(ft)	(ft)	(miles)
BA 1C	112	1000	36	35-48	81250	15.39
BA 2C	224	600	35	30-45	67800	12.84
BA 3C	78	top 150 mid 1050 bot 430	40	36-45	67400	12.77
BA 4C	46	300	40	36-47	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

Figure 8 Proposed Artificial Reef Installation Sites, Broward County

Map Encl 1

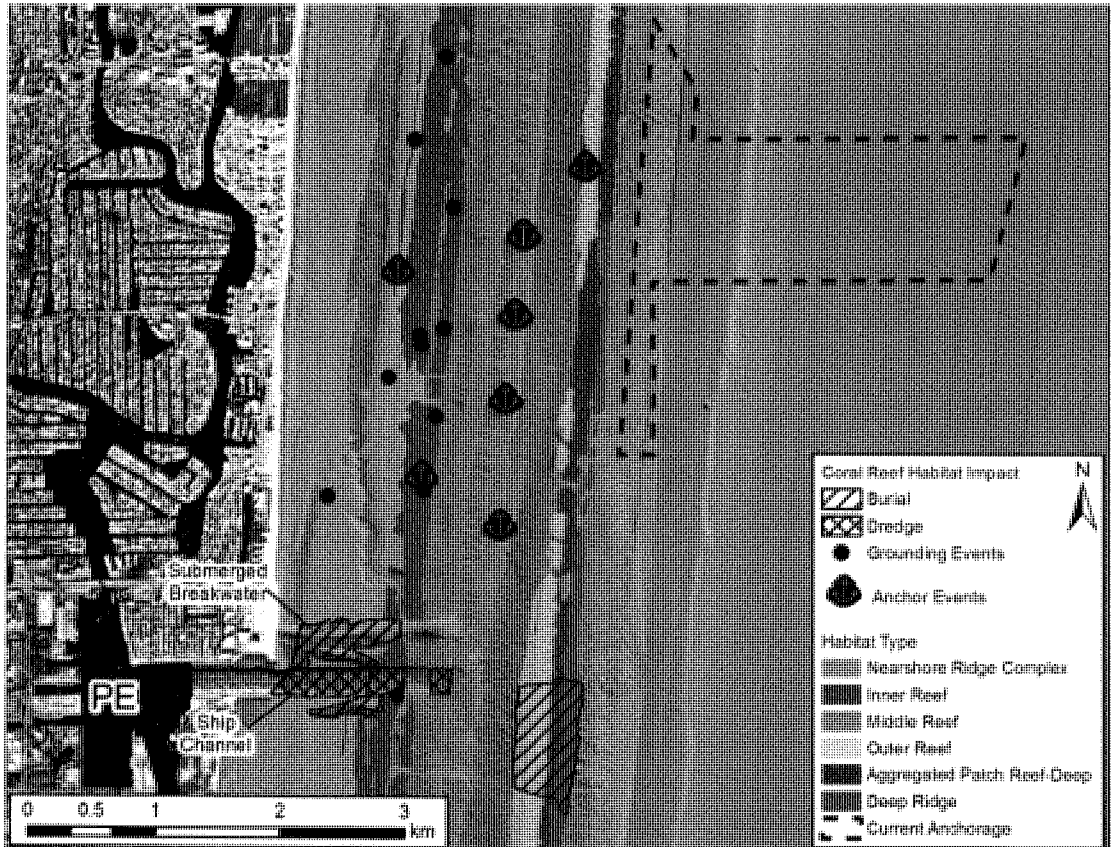
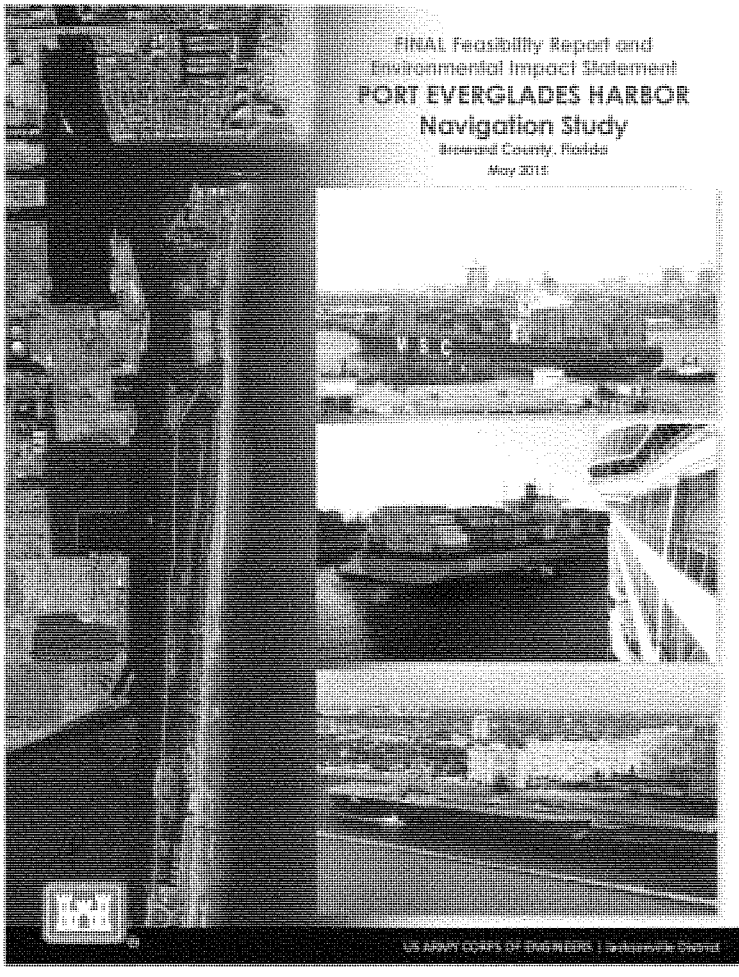


Figure 2: Map of Port Everglades dredging and shipping-related direct impacts to coral reef habitats. Grounding and anchoring points show the locations of known events present in the Florida Department of Environmental Protection's Coral Reef Conservation Program (FDEP CRCP) database.

Page Exec 2


FINAL Feasibility Report and
Environmental Impact Statement
PORT EVERGLADES HARBOR
Navigation Study
Broward County, Florida
May 2016
US ARMY CORPS OF ENGINEERS | Jacksonville District

Executive Summary

Description of Report: This report presents an evaluation of alternative plans considered for navigation improvements at Port Everglades (Broward County), Florida, the Recommended Plan, cost-sharing and cost allocation, and implementation requirements. An Environmental Impact Statement (EIS) follows the main text of this document and evaluates impacts on the quality of the human environment, effects of the Recommended Plan, and proposed mitigation.

Purpose and Need: The purpose of the Port Everglades Harbor feasibility study is to assess Federal interest in navigation improvements resulting in transportation cost savings to the nation. The navigation project at Port Everglades is authorized by the River and Harbors Act of 1930, as amended. This feasibility study was initially authorized in House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 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. The non-federal sponsor is Broward County represented by its Board of County Commissioners.

Port Everglades is the largest Florida Atlantic coast port in terms of total tonnage, one of three ports in Florida receiving petroleum, is ranked 32nd nationally in tonnage, and is the 2nd busiest cruise port in the world based on multi-day passengers. Port Everglades has land available for growth in warehousing and staging, and has access to rail, air and roadway transportation systems for efficient movement of goods. The continued long-term population growth in south Florida in combination with an active Mediterranean, South American, and Caribbean trade connection creates an opportunity for future growth at Port Everglades, especially for the transport, docking and loading/unloading of container ships.

As a result of increased traffic and overall growth in vessel size, improvements including deepening and widening were considered to help alleviate vessel congestion and improve transit efficiency and maneuverability. In addition, there are strong unpredictable crosscurrents in the Entrance Channel due to the proximity of the Gulf Stream and strong opposing nearshore currents.

The scope of the feasibility study includes;

- widening and deepening the major channels and basins within the Port,
- expanding into the Dania Cutoff Canal, and
- deepening the turning basin (Turning Notch) at the end of the Southport Access Channel.

Alternative Plans: Widening and deepening measures were evaluated throughout the Port. The Port is comprised of three main areas: Northport, Midport, and Southport. The Northport terminal area serves multiple cargoes and vessel types, including cruise operations, liquid bulk unloading (and occasionally loading), small container vessels, general cargo, roll-on/roll-off ("RO/RO") cargo, float-on/ float-off cargo (yachts and other vessels), military berthing, and lay-berth areas. The Midport terminal area serves cruise ships, containerships up to Panamax size, bulk vessels, lift-on/lift-off ("LO/LO") cargo, RO/RO cargo, naval ships, harbor tugboats, and

smaller lay-in vessels. Southport services predominantly container ships and has the largest area for growth.

The structural measures evaluated were grouped into six different plans based on structural characteristics, environmental impacts, and economic benefits. *Plan 1* focused on solutions for petroleum vessel constraints. *Plan 2* focused on container ship constraints (which incidentally solves the petroleum vessel constraints). *Plan 3* focused on increasing the number of berths and improving port operations by relocating fleets without impacting environmentally sensitive areas. *Plan 4* focused on improving operational efficiency in the Main Turning Basin while minimizing environmental impacts. *Plan 5* focused on solutions for all of the port constraints and creating opportunities for efficiencies. *Plan 6* focused on accommodating light-loaded Post-Panamax container vessels and reduced impacts on environmentally sensitive areas. Different versions and different channel depths were considered for each plan. Channel width was optimized to improve maneuverability and minimize environmental impacts, while depth was optimized to maximize economic benefits.

Recommended Plan: The Recommended Plan is the locally preferred plan (LPP) recommending deepening to 48 feet. After evaluation and comparison, the NED plan was identified as 47 feet. Included in the 47-foot alternative is deepening, widening, and extending the Outer Entrance Channel, deepening the Inner Entrance Channel, and deepening and widening the Main Turning Basin, Southport Access Channel, and Turning Notch. The NED plan is the plan that reasonably maximizes net benefits. USACE ER 1105-2-100 Exhibit G-1 3.c directs that "where two cost-effective plans produce no significantly different levels of net benefits, the less costly plan is to be the NED plan." The 48-foot alternative did result in higher net benefits by approximately $400,000 but was only 1.3% greater benefits than at 47 feet; as such the 47-foot plan was determined to be the NED plan. The non-federal sponsor, Broward County, requested an LPP of 48-feet on August 14, 2014. The ASA (CW) approved the LPP on October 16, 2014. The Recommended Plan includes deepening the Federal channel to 48 feet from the Outer Entrance Channel to the Main Turning Basin, Southport Access Channel, and Turning Notch with associated widening and including an extension of the Outer Entrance Channel. Through Authorization of the recommended plan, the existing limits of the Federal channel will be expanded (see **Figure A**). The LPP includes the same recommended navigation features (i.e. areas of widening) as the NED plan with the exception of the one foot of additional depth.

To compensate for the unavoidable adverse effects of the action on various significant habitat types, USACE has proposed the following: mitigate for (a) the removal of approximately 7.41 acres of vegetated and unvegetated seagrass habitat (including that within the new channel footprint and resulting side slopes) and (b) the loss of approximately 1.16 acres of mangroves in the project footprint through use of ecosystem benefits from a previously permitted restoration project at West Lake Park (Broward County, FL), which is currently under design. Mitigation for impacts will involve use of approximately 2.4 seagrass functional units and approximately one (1) mangrove functional unit, respectively, from that project, located in a county-operated, state-owned, natural area immediately to the south of the project area. USACE has also proposed the following: mitigate for (c) the direct removal of approximately 14.62 acres of complex, high-profile, linear and spur/groove reef habitat through the creation of approximately 5 acres of artificial reef with the transplantation of 11,502 corals from the impact site to the artificial reef

and the outplanting of approximately 103,000 nursery raised corals. Additional mitigation will be provided due to any detectable, incidental, direct impacts of dredging equipment and indirect impacts on hardbottom habitats due to turbidity/sedimentation. These mitigation components were determined to be economic "Best Buys" from among mitigation alternatives.

Construction of the Recommended Plan involves dredging of approximately 5.5 million cubic yards of material. The widening/extension of the project will increase the channel by approximately 2,033,000 square feet, increasing the estimated annual shoaling rate for the increased project footprint by 5,740 cy/yr to total rate of 27,440 cy/yr. All dredged material will be placed in the ocean dredged material disposal site (ODMDS). Expansion of the site is underway. The U.S. Environmental Protection Agency (EPA) has drafted an Environmental Assessment (EA) and the public comment period has concluded on the document. EPA is working to finalize the EA and is scheduled to complete the formal designation process including rule making and publication in the Federal Register in 2015.

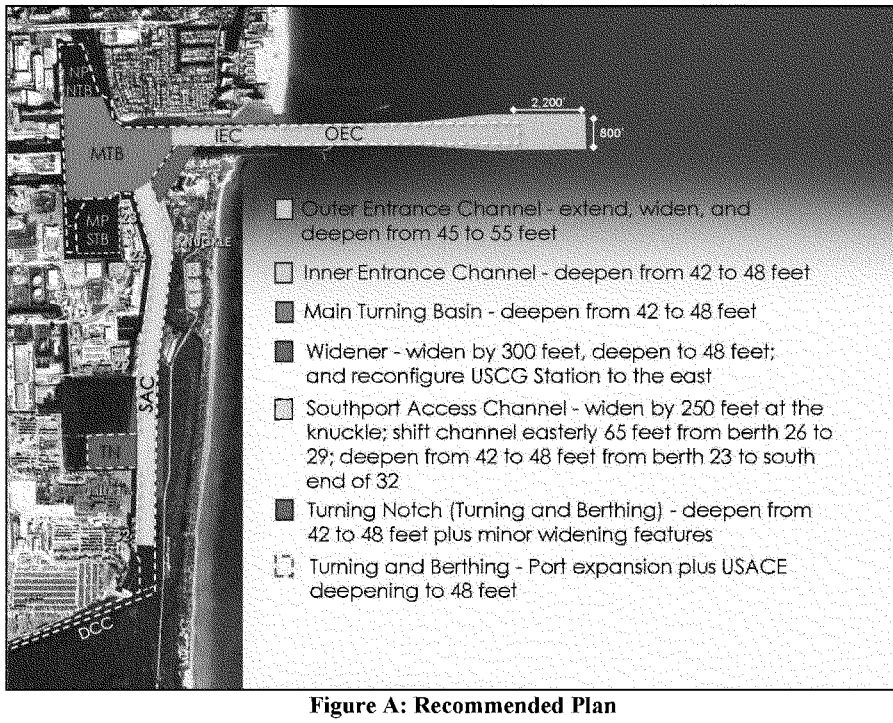


Figure A: Recommended Plan

Table A: Recommended Plan Costs and Benefits

Depth	Plan	AAEQ Costs	*AAEQ IDC*	AAEQ Benefits	AAEQ Net Benefits	BCR 3.375%	BCR 7%
47ft	NED	$ 15,900,000	*$ 1,200,000*	$46,900,000	$ 31,000,000	2.9	1.5
48ft	LPP	$ 16,860,000	*$ 1,400,000*	$48,240,000	$ 31,400,000	2.9	1.5

**AAEQ IDC costs are included in the AAEQ Costs.*

Benefits, Costs, and Implementation of the Recommended Plan: Project benefits are based on transportation cost savings. These benefits, or transportation cost savings, are attributable to enabling vessels to use their capacity more efficiently and/or reduced susceptibility to tidal delays and congestion. The project first cost of the Recommended Plan is estimated at $323 million at October 1, 2014 price levels with the Federal share of the Recommended Plan $220 million and the non-federal share $103 million. The additional deepening costs of dredging one additional foot from 47 feet to 48 feet are 100% non-federal, Table B. After authorization, it is estimated that the project could be constructed in approximately 5 years, assuming sufficient Federal and non-federal appropriations to support award of construction contracts.

Table B: 48-Foot Recommended Plan Cost Sharing Table

(October 1, 2014 Price Levels and FY15 discount rate)
Cost Summary
Recommended Plan/Locally Preferred Plan (Deepen to 48 feet)

General Navigation Features	Total Cost	Federal Share	Non-federal Share
	20-45 ft.	75%	25%
	46-47 ft.	50%	50%
	48 ft.	0%	100%
Mobilization	$3,100,000	$2,100,000	$1,000,000
Dredging and Disposal	$147,800,000	$93,000,000	$54,800,000
Environmentally Friendly Bulkhead[6]	$61,000,000	$45,800,000	$15,200,000
Associated General Items[1]	$5,100,000	$3,200,000	$1,900,000
Environmental Mitigation	$52,800,000	$37,100,000	$15,700,000
Mitigation (Mangrove, Seagrass, Art Reef w/Corals)	*$35,600,000*	*$25,400,000*	*$10,200,000*
Monitoring	*$900,000*	*$700,000*	*$200,000*
Coral Propagation	*$16,300,000*	*$11,000,000*	*$5,300,000*
Pre-Construction, Engineering, and Design	$5,600,000	$3,900,000	$1,700,000
Construction Management (S&I)	$8,400,000	$5,900,000	$2,500,000
USCG Reconfiguration	$38,900,000	$29,200,000	$9,700,000
Subtotal Construction of GNF	$322,700,000	$220,200,000	$102,500,000
Lands and Damages[2]	-	-	-
Total Project First Costs	$322,700,000	$220,200,000	$102,500,000
Non-federal Construction Costs (Local Service Facilities)	$37,800,000	$0	$37,800,000
Non-federal Berthing Area Costs	$13,400,000	$0	$13,400,000
Aids to Navigation[3]	$200,000	$200,000	$0
10% GNF Non-Federal[4]	$0	($30,500,000)	$30,500,000
Total Cost Allocation[5]	$374,100,000	$189,900,000	$184,200,000

1. Includes Turbidity Monitoring and Dedicated Marine Animal Observer

2. Real Estate Costs: There are no LERR for this project, there is $12,000 under PED for minimal administrative costs.

3. Navigation Aids - 100% Federal

4. The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment. The value of lands provided for mitigation including the sponsor's incidental cost of acquisition are not creditable against this 10% since that value is cost shared as a GNF.

5. In addition to these costs the AAEQ increases in O&M costs are approximately $55,500. Future O&M costs are due to the channel widening and are 100% Federal. There is no increase in O&M costs from 47 to 48 feet.

6. These bulkheads are required to stabilize the shoreline as the channel is deepened and widened the natural side slopes will fall. To prevent damage to John U Lloyd and the Conservation Easement from slide slopes, these bulkheads will be placed along portions of the SAC to maintain the existing shoreline.

Coordination with Agencies and the Public: To ensure that the public and Federal, tribal, state, and local agencies were kept informed about progress on technical analyses and policy issues, public meetings were held throughout the study period, EIS Section 1.6.

Areas of Controversy and Unresolved Issues: The Jacksonville District continues to coordinate with resource agencies and other stakeholders concerning fish and wildlife habitat, threatened or endangered species, and designated critical habitat. Discussions include assessed impact acreages, functional assessment output, and potential compensation derived from the proposed mitigation alternatives. The Jacksonville District has coordinated multiple surveys, conducted a review through the USACE environmental center of expertise of functional assessment methods and outputs, and applied experience from other recent deepening projects. USACE worked closely with the agencies to finalize the mitigation plan included in the Final EIS package.

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
ON
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

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1.0 STUDY INFORMATION

1.1 STUDY LOCATION

The Port Everglades Harbor is a major seaport located on the southeast coast of Florida in Broward County, (**Figure 1**). It is located in 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, 31 nautical miles south of the Port of Palm Beach, and 301 nautical miles south of Jacksonville Harbor, Florida.

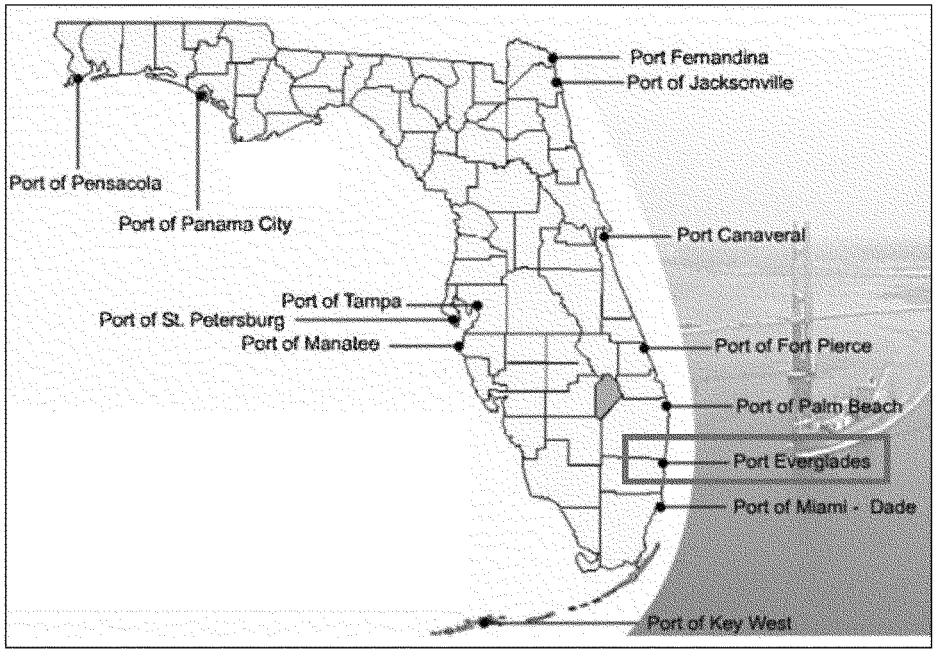

Figure 1: Florida Deep Draft Ports

Graphic was modified from Florida Ports Council (http://www.flaports.org/index.htm).

Figure 2: Port Everglades Vicinity Map

1.2 STUDY AUTHORITY

This Feasibility Study was authorized by a May 9, 1996 resolution of the House Committee on Transportation. The resolution reads, in part, as follows:

> Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the reports of the Chief of Engineers on Port Everglades Harbor, Florida, published as House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 1st Session, and other pertinent reports to determine whether any

modifications of the recommendations contained therein are advisable at the present time in the interest of navigation and related purposes, with particular reference to navigation into and within the part of the project known as the Southport Channel.

1.3 Study Purpose and Scope (Goals and Objectives)

The existing Federal channel project depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and containerships currently transiting the harbor. The largest ships must light-load or transit at high tide in order to assure the proper safety clearances. Furthermore, the next (larger) generation of containerships and petroleum tankers require significantly more channel depth and width to maintain safe and routine navigation transit.

The primary objectives of this feasibility study are the following;

- decrease costs associated with vessel delays from congestion, and channel passing restrictions at Port Everglades through the 50-year period of analysis;
- decrease transportation costs through increasing economies of scale for container and petroleum vessels at Port Everglades through the 50-year period of analysis;
- increase channel maneuverability and efficiency at Port Everglades for existing vessel use as well as for larger vessels through the 50-year period of analysis;

This study follows the U.S. Army Corps of Engineers (USACE) six-step planning process as defined in the Principles and Guidelines (P&G) and incorporates the USACE seven Environmental Operating Principles (EOP).

The main report summarizes feasibility study assumptions, analyses and findings. Following the main report is the Environmental Impact Statement (EIS) and its supporting appendices.

All channel depths indicated in this report are "project depths" unless otherwise specified. Project depth is the authorized depth to which the Federal government maintains channels and basins. The Outer Entrance Channel (OEC) has additional depth requirements for squat and underkeel clearance, currently three feet beyond the required and allowable overdepth. These depths and USACE engineering requirements can be found in further detail in the **Engineering Appendix A**.

1.4 Regional Background

The following text provides a general description of Federal and non-federal navigation and beach nourishment projects located within the general study area.

1.4.1 Port Everglades Federal Navigation Project

Table 1 shows Federal Authorizations for the Port Everglades Harbor project.

Table 1: Federal Authorizations

Act	Document, Congress/Session	Work Authorized
R&H Act 1930	HD 357, 71/2	Federal maintenance of entrance channel, turning basin, and jetties constructed by local interests.
R&H Act 1935	HR Committee of R&H Doc. 25, 74/1	Construction and maintenance of an enlarged entrance channel, and a 1,200 foot square turning basin to a depth of 35 feet.
R&H Act 1938	HD 545, 75/3	Construction and maintenance of a 350 foot wide trapezoidal area on the north side of the main turning basin.
R&H Act 1946	HD 768, 78/2	Construction and maintenance of a 200 foot northerly and 500 foot southerly extensions to the main turning basin.
R&H Act 1958	HD 346, 85/2	Construction and maintenance of outer entrance channel deepening to 40 feet, inner entrance channel deepening to 37 feet, expanding the main turning basin to the north and south.
PL 89-298 Section 201, 1965	HD 93-144	Deepen outer entrance channel to 45 feet at a width of 500 feet, inner entrance channel to 42 feet at a width of 450 feet, main turning basin to 42 feet, channel opposite Pier 7 to 36 feet, maintain channel opposite Berth 18 to 36 feet.
WRDA 1992	HD 103-126, 103/1	Federal maintenance of locally constructed Southport Access Channel dredging to 42 feet, and locally constructed turning notch to a depth of 42 feet.

**Rivers and Harbors (R&H), House Report (HR), House Document (HD), Public Law (PL)*

The current Federal Navigation Project Dimensions (**Table 2**) incorporate the most recent Federal and non-federal improvements. The Federal improvements of the 1970s include modifications to the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB), and South Turning Basin (STB). The non-federal improvements of the 1980s and 1990s include modifications to the Southport Access Channel (SAC) and the Turning Notch (TN). Water Resources Development Act (WRDA) 1992 (PL 102-580) Title I, Section 101(9) authorized Federal maintenance of the locally constructed SAC and TN. WRDA 2000 (PL 106-541) Section 515 authorized Federal reimbursement of $15,003,000 to Broward County for the local construction of the SAC and the TN (**Figure 3**).

Table 2: Existing Federal and Non-federal Navigation Project Dimensions

Existing Federal and Non-federal Navigation Project Features		
Existing Port Components	**Authorized and Maintained Nominal Depth in feet MLLW[1]**	**Authorized and Maintained Nominal Width in feet**
Outer Entrance Channel (OEC)	45	500
Inner Entrance Channel (IEC)	42	450
Main Turning Basin (MTB)	42	Varies[2]
North Turning Basin (NTB)	31	Varies[3]
South Turning Basin (STB)	31, 36, 37[4]	1,000 X 1,100
Southport Access Channel (SAC)	42	400
Turning Notch (TN)	42	750 X 1,000
Non-federal Project Features	**Constructed and Maintained Nominal Depth in feet MLLW**	**Constructed and Maintained Nominal Width in feet**
Dania Cut-off Canal (DCC) from SAC to Port Dania	15	Varies (about 100 feet)

[1]*MLLW: Mean Lower Low Water: A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. (NOAA).*
[2]*Basin is irregular shaped that varies in width 800 to 1,100 feet.*
[3]*Basin is irregular shaped. North to South length is 1,200 feet, north side is 500 feet and extends 800 feet on south side.*
[4] *Variable depths by location..*

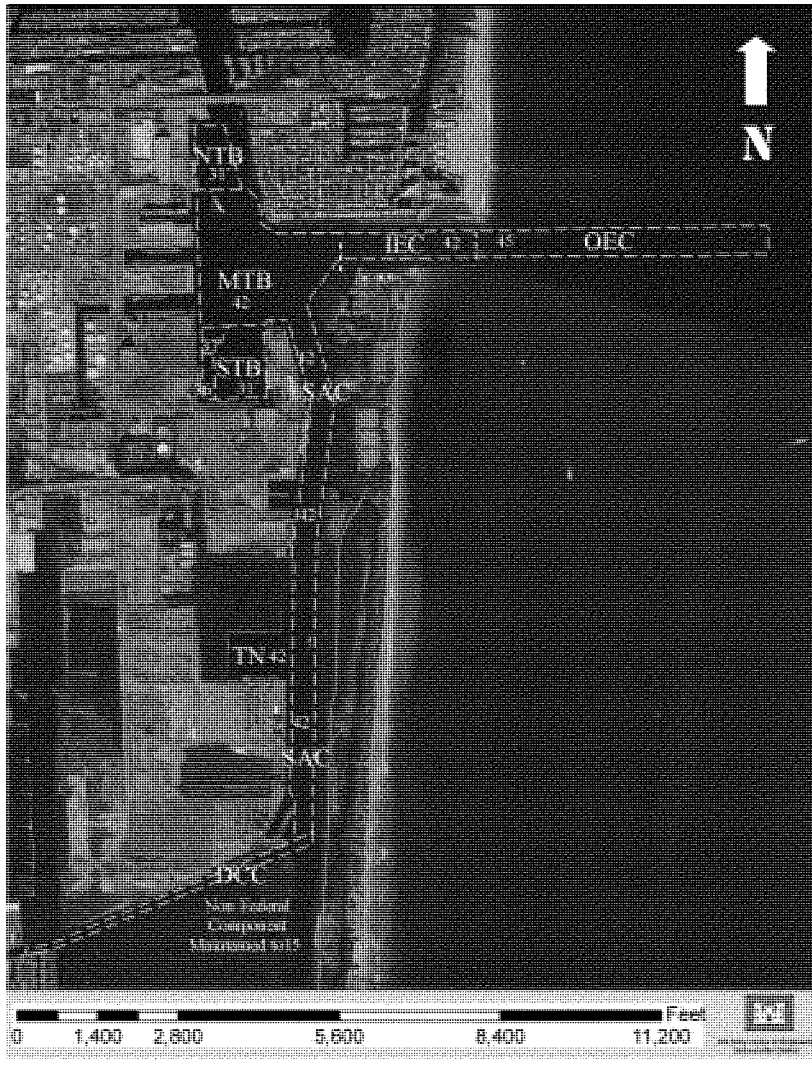

Figure 3: Existing Channel Components

*See Table 2 for definitions of project segment nomenclature.

1.4.2 Adjacent Facilities

Major transportation infrastructure is located west of the Port. This includes: the Fort Lauderdale/ Hollywood International Airport, two interstate highways, and the Florida Turnpike. The Port has access to the Florida East Coast Railway links, with construction of an intermodal container transfer facility underway, **Figure 4**.

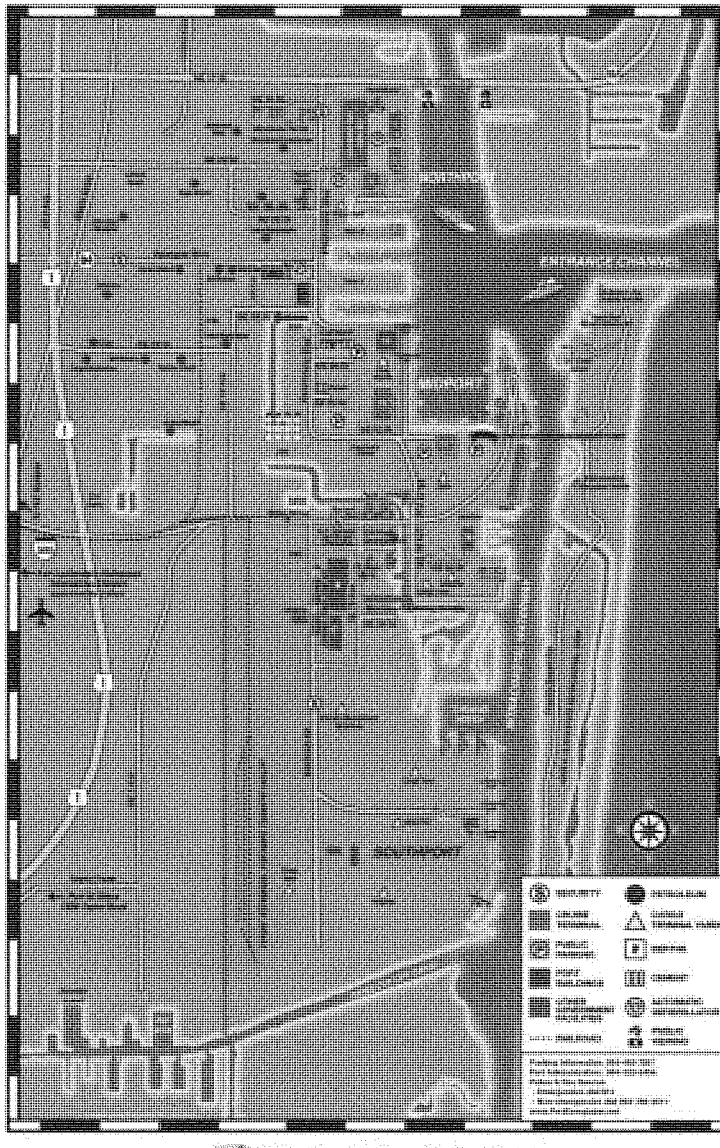

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Figure 4: Port Everglades Map

Located north of the Port are residential and commercial developments including an extensive array of private vessel marinas and docks. The Federal Intracoastal Waterway (IWW) project transits through the Port from north to south, along the Southport Access Channel.

East of the Port is a barrier island that contains the John U. Lloyd Beach State Park (John U. Lloyd SRA), a U.S. Navy facility (Navy), NOVA Southeastern University (NSU) Oceanographic Center, and a U.S. Coast Guard Facility (USCG). On the east side of the barrier island is a sandy beach/offshore reef system (**Figure 4**).

West Lake Park is a 1,500-acre nature preserve, considered one of the largest and last remaining mangrove ecosystems in the 85-mile coastal zone from Miamia Beach to West Palm Beach, and is located south of the Port, **Figure 5**.

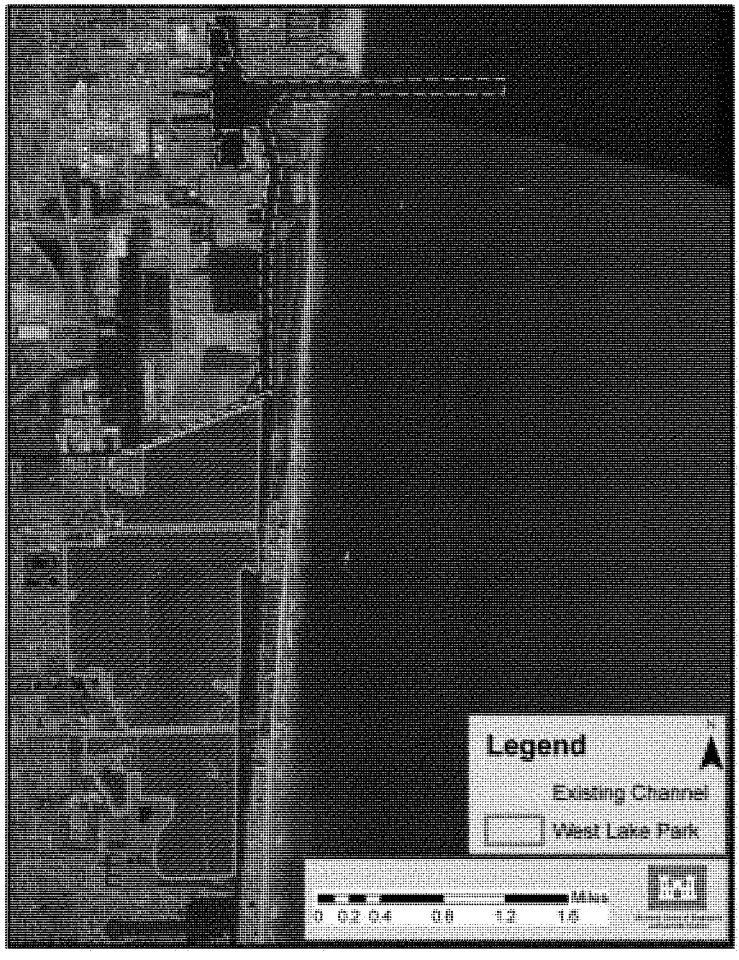

Figure 5: West Lake Park Area Map

1.4.3 Port Berthing Areas

The Port's commercial berths are designated as Berths 1 through 33C as shown in **Figure 4**. There are three main Port berthing areas; Northport, Midport, and Southport. The majority of bulk traffic includes cement and petroleum with the other major commodity being containerized cargo. More information is provided in **Section 2.4.1**: Existing Port Infrastructure.

1.4.4 Federal Intracoastal Waterway (IWW) Project

The Federal IWW project from Jacksonville to Miami, Florida is a major segment of the

Federal inland waterway system. It serves both commercial barges and recreational vessels. The portion of the IWW project that runs through Port Everglades is shown in **Table 3**.

Table 3: Intracoastal Waterway (IWW) Project

Reach or Segment	Nominal Depth (feet MLLW)		Nominal Channel Width (ft)	
	As Auth.	As Maint.[1]	As Auth.	As Maint.
IWW through Port Everglades	10	10' to >10'	125	125
Sponsor Information; Florida Inland Waterway District (FIND)				

[1] Portions of the IWW through Port Everglades are maintained at depths deeper than 10' as they lie within the Federal deep draft navigation project.

1.4.5 Federal Broward County Beach Erosion Control Project

Three segments totaling 24 miles are included in the Federal hurricane and storm damage reduction project for Broward County. The project was authorized by the River and Harbor Act of 1965 for non-federal construction with subsequent Federal reimbursement. **Table 4** provides additional information.

Table 4: Broward County Federal Beach Project

Reach or Segment	Reach Extent		Berm Width (ft)
	R Mon.	Length (mi)	
Segment I	**R-1 - R-24**	4.37	varies
Segment II	**R-25 - R-85**	11.5	varies
Segment III	**R-86 –R-128**	8.1	varies
Sponsor Information			
Broward County			
City of Deerfield Beach			

Broward County has been working on a sand bypass study. The project is located along the north side of the entrance channel. The basic project purpose is to create new, and modify the existing, inlet infrastructure at Port Everglades to facilitate the economical collection of littoral materials that will be available for future mechanical bypassing to the beaches south of the inlet. The project would support the Broward County Comprehensive plan by protecting beaches and restoring altered beaches to the extent possible. The widening and deepening project considers beach and nearshore placement options if viable sand exists within the dredging template. The sand bypass project was noticed to the public and remains in the planning phase.

1.4.6 Dania Cutoff Canal

The Dania Cutoff Canal (DCC) is considered a non-federal project component that extends east-west along the southern extremity of the Port (**Figure 3**). The DCC acts as fresh water drainage for the neighboring watershed and regularly supports navigation of modest size vessels and pleasure crafts. About one mile west of the DCC/SAC confluence are small commercial ports. These ports handle small (200 feet in length) commercial freighters that move cargo in the offshore island trade. Approximately 4,200 linear feet of the easterly extent of the DCC was improved by the Port in 1987 (**Table 5**). Maintenance dredging of this portion of the DCC has not been necessary since the 1987 improvements were completed.

Table 5: DCC Project

Reach or Segment	Nominal Depth (feet MLLW)		Nominal Channel Width (feet)	
	Constructed	Maintained	Constructed	Maintained
DCC from SAC to Port LaDania	15	15	Varies (about 100 feet)	Varies (about 100 feet)
Sponsor Information				
Broward County represented by its Board of County Commissioners				

1.5 Prior Studies and Reports

1.5.1 Federal Reports

Initial construction of Port Everglades began in 1925 and continued through 1928. Construction was accomplished through the excavation of Lake Mabel, a shallow water body separated from the Atlantic Ocean by a low sand ridge. Originally called Bay Mabel Harbor and later Hollywood Harbor, the port was the result of a cooperative effort between the cities of Hollywood, Fort Lauderdale, and a private investor. The Federal government became involved with the port after the passage of the Rivers and Harbors Act of 1930 which provided the locally constructed project with Federal maintenance (**Table 6**). The early harbor design was simple, consisting of a 7,300 foot long entrance channel; a single 1,200 foot long, 300 foot wide slip (Slip 1); two bulkheads; two jetties; two submerged breakwaters; and a single turning basin. Initial project depth was 35 feet. Since 1931, 11 Federal maintenance dredging projects at Port Everglades have been completed.

The USACE has completed several studies and reports focused on the Port Everglades Federal Navigation Project. **Table 6** contains a listing of these reports. **Table 1** provides a description of the authorized project features by Congressional Act.

Table 6: Port Everglades Federal Navigation Reports

Study Type[1]	Report Date	Congressional Documents				Authorizing Act	Summary
		Type	No.	Cong.	Session		
PA	1928	-	-	-	-	-	-
PA	1929	-	-	-	-	-	-
SR	1930	H	357	71	2	R&H 1930	Federal maintenance of entrance channel, turning basin, and jetties constructed by local interests.
PA	1932	-	-	-	-	-	-
SR	1933	-	-	-	-	-	-
SR	1935	H	25	74	1	30-Aug-35	Construction and maintenance of an enlarged entrance channel, and a 1,200 foot square turning basin to a depth of 35 feet.
SR	1937	H	545	75	3	20-Jun-38	Construction and maintenance of a 350 foot wide trapezoidal area on the north side of the main turning basin.
SR	1944	H	768	78	2	24-Jul-46	Construction and maintenance of a 200 foot northerly and 500 foot southerly extensions to the main turning basin.
SR	1946	-	-	-	-	-	-
SR	1958	H	346	85	2	3-Jul-58	Construction and maintenance of outer entrance channel deepening to 40 feet, inner entrance channel deepening to 37 feet, expanding the main turning basin to the north and south.
SR	1971	H	144	93	1	9 and 31 May 1974	Deepen outer entrance channel to 45 feet at a width of 500 feet, inner entrance channel to 42 feet at a width of 450 feet, main turning basin to 42 feet, channel opposite Pier 7 to 36 feet, maintain channel opposite Berth 18 to 36 feet.
FR	1991	H	126	103	1	WRDA 1992, Title I Sec 101(9)	Federal maintenance of locally constructed Southport Access Channel dredging to 42 feet, and locally constructed turning notch to a depth of 42 feet.
LRR[2]	1998	-	-	-	-	WRDA 2000 Sec 515	Reimbursment for Federal portion of WRDA 1992 authorized Southport Access Channel dredging to 42 feet, and Turning Notch construction to 42 feet.

[1] PA = Preliminary Assessment, SR = Survey Report, FR = Feasibility Report, LRR = Limited Re-Evaluation Report
[2] Reimbursement of $15,003,000 was authorized by Congress
Refer to Table 2 for a description of the Federal Components authorized.

1.5.2 Non-federal Reports

Table 7 provides a listing of recent non-federal studies and reports related to Port Everglades.

Table 7: Non-Federal Reports

Study Title and Date	Prepared By	Summary
Port Everglades Master Plan 1988-2000 -3/88	Broward Co. Dpt of Port Everglades and Consultants	Development of Southport Container Terminal, the purchase of a third gantry crane at Midport, and other improvements
ICTF[1] Feasibility Study Phase I-3/94	Broward Co. Dpt of Port Everglades and Consultants	Recommends an Intermodal Container Transfer Facility (ICTF) as both necessary and feasible
ICTF Feasibility Study Phase II-3/95	Broward Co. Dpt of Port Everglades and Consultants	Evaluation of 6 plan sites for ICTF construction.
Port Everglades Master Plan Update November 1995	Broward Co. Dpt of Port Everglades and Consultants	Southport purchase #4-#7 cranes, develop Berths 30&30a as containership. Midport purchase #3 cranes and relocates container operations at Berths 5, 6, 19, 20 to DCC. Deepen and widen DCC. Add slip between Berths 9 and 13. Target mid-week multi-day cruises. Traffic and airport issues. Acquire 172 acres.
Port Everglades Master Plan Update December 2007	Broward Co. Dpt of Port Everglades and Consultants	Recommendations were considered in preparation of the Draft Feasibility Report.
Port Everglades Master/Vision Plan Update March 2011	Broward Co. Dpt of Port Everglades and Consultants	Planning through 2029, with 5, 10 and 20-year plans. Infrastructure improvements to berth fully laden Post-Panamax vessels of 7,000 TEUs, rail to Southport and the proposed ICTF, new berth for crushed rock /aggregate, longer cruise berths, more and longer cargo berths, reconfiguration of Northport slips, and upland improvements to terminals and intermodal access.

[1] Intermodal Container Transfer Facility (ICTF)

1.6 Study Participation and Coordination

This feasibility study is performed as a 50-50 percent cost shared partnership between the USACE and the non-federal sponsor, Broward County represented by its Board of County Commissioners. The feasibility study was performed under the FCSA most recently updated in March 2013. The FCSA is dated April 17, 1997 and has been amended. The work was all done under the 1997 agreement, as amended.

The following agencies and stakeholders participated in the study and provided input at various levels throughout the history of the project. Federal agencies involved include the Unites States Coast Guard (USCG), the United States Navy (USN), the U.S. Environmental Protection Agency (EPA), 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 Environmental Protection and Growth Management Department, Broward County Aviation Department (Fort Lauderdale/ Hollywood Airport), and the Broward County Department of Safety and Emergency Services. Non-government organizations/institutions (NGOs) include Nova Southeastern University (NSU), and the Port Everglades Pilots Association (Pilots). Private interests include Hvide Marine, Maersk-Sealand, Coastal Fuels Marketing, and the Simulation Training and Research Center (STAR), (**Table 8**).

The Florida Department of Environmental Protection (FDEP) continues to participate in the study process and has an existing Interagency Cooperation Agreement (ICA) with the USACE. The FWC, NMFS, EPA, 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. Copies of correspondence regarding being a cooperating agency under NEPA can be found in the **EIS** Appendix A.

Table 8: Agency and Stakeholder Coordination

Federal Agencies	
U.S. Army Corps of Engineers (Corps)	U.S. Coast Guard (USCG)
U.S. Navy (Navy)	Environmental Protection Agency (EPA)
Fish and Wildlife Service (USFWS)	National Marine Fisheries Service (NMFS)
State of Florida Agencies	
Department of Environmental Protection (FDEP)	Fish and Wildlife Conservation Commission (FWC)
Florida Department of State Lands	State Historic Preservation Office (SHPO)
Broward County Agencies	
Department of Port Everglades (Port)	Department of Airports (Airport)
Environmental Protection Department (EPD)	Department of Parks and Recreation (County Parks)
Stakeholders; Non-Government Organizations/Institutions	
Nova Southeastern University (NSU)	Port Everglades Pilots Association (Pilots)
Hvide Marine Corporation	Maersk-Sealand Corporation
Simulation Training and Research Center (STAR)	

1.6.1 NEPA Scoping

The District has engaged the public and the resource agencies through the NEPA scoping and cooperating agency processes, and the non-federal sponsor has worked extensively to educate and engage the public through public workshops and meetings held in response to the Port's master plan (which incorporates the proposed Federal project). More than 50

meetings and workshops have been held with stakeholders since the project began scoping in 2000 (**Table 1 of the EIS**). Modifications to the proposed project have been made directly and indirectly in response to comments received from stakeholders and the public. Comments raised have included concerns about impacts on offshore reef resources and to mangrove and seagrass communities inside the Port inlet. The Department of Environmental Protection - State Parks Division raised concern with some of the original proposals that would have removed more than 50% of John U. Lloyd Beach State Park. Due to the comments (and other project factors including economic and engineering considerations), the project scope has been modified to greatly reduce adverse impacts to the State Park; remove all impacts to a local university's oceanographic research center; and minimize impacts to seagrasses by removal of the Dania cut-off canal component. Impacts to offshore reef resources have been minimized to the maximum extent practicable through ship simulation and coordination with the pilots from the originally proposed 1,000 ft wide cut in the offshore reef to an 800 ft wide cut.

The project would have no effect and would not influence any foreseeable future actions that could adversely affect minority and low-income populations as is stated in **Section 4.28.5 of the EIS** under Environmental Justice. The purpose of the proposed action is to provide increased maneuverability, efficiency, and lower costs for navigation while protecting the environment. 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." The proposed project would benefit shipping and the general economy; refer to the **EIS** for more information.

2.0 EXISTING CONDITIONS

2.1 GENERAL

Port Everglades is the third busiest multi-day cruise port in the world, with approximately 42 different cruise ships visiting in 2012, representing 15 cruise lines. Port Everglades is ranked 12th nationally for international container cargo trade. Port Everglades is ranked 32nd nationally in terms of tonnage. Port Everglades is the top distribution site for South Florida's gasoline, jet fuel, and other petroleum products.

This section summarizes existing physical, environmental, and economic conditions. Additional information regarding historic and existing physical conditions can be found in the Engineering Appendix (**Appendix A**). Additional detail regarding existing environmental conditions can be found in the Environmental Impact Statement (EIS). Additional information regarding historic and existing economic conditions can be found in the Economic Appendix (**Appendix B**).

The existing channel components and depths are presented in **Figure 3** and **Table 2**. There are existing navigation concerns for vesselmanueverability and routine operation of the Port. The Pilots' navigation concerns for Port Everglades include dangerously strong cross currents in the entrance channel that vary in strength and are unpredictable in direction. The currents generally run at right angles to the direction of the narrow entrance channel making transit hazardous. These strong and unpredictable currents have been reported to be as high as 5 knots. Ships approaching from the east should be cautious of strong easterly wind and wave energy in the entrance channel.

2.2 PHYSICAL CONDITIONS

2.2.1 General

General meteorological and oceanographic conditions are summarized in this section. These data are used to establish "existing" and "future with project" boundary and initial conditions as input parameters for the ship simulation model and cumulative impact analyses. The ship simulation model is essential in guiding future engineering design function for channel improvements.

2.2.2 Climate

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

2.2.3 Winds

During the summer months Port Everglades experiences predominantly east and southeast trade winds. This information is based on data collected as part of the National Data Buoy Center (NDBC) Coastal-Marine Automated Network (C-MAN) program. The nearest C-MAN station to Port Everglades is located at Fowey Rocks, Florida, approximately 13 miles southeast of Miami. Meteorological observations at Fowey Rocks cover a period from January 1991 to December 2009. 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.

In addition to measured wind data, hindcast wind data are available from the USACE Wave Information Study (WIS) Program. WIS hindcast data are generated using the numerical hindcast model WISWAVE (Hubertz, 1993). WISWAVE is driven by wind fields overlaying a bathymetric grid. Model output includes significant wave height, peak and mean wave period, peak and mean wave direction, wind speed, and wind direction.

There are 523 WIS stations along the Atlantic Coast. WIS station 467 is considered to be the most representative of offshore deepwater wave conditions for Port Everglades. Station 467 is located at Latitude 26.08N and Longitude 79.92W, approximately 11 miles due east of the Port Everglades Harbor jetties. The WIS hindcast is provided at 1 hour intervals and covers a period from 1980 to 1999.

Appendix A provides a summary of average wind speeds and percentages of occurrence (based on direction) for both hindcast (WIS) and measured (C-MAN) data. Review of both measured and hindcast data reveal similar overall trends in direction and magnitude, relevant information as it pertains to ship navigation and maneuverability.

2.2.4 Hurricanes and Storm Surge

The Atlantic hurricane season runs from June 1 to November 30. During these months, hurricanes develop in the tropical and subtropical latitudes of the Atlantic Ocean and Caribbean Sea north of the equator. Hurricanes are characterized by low barometric pressure, high winds in excess of 75 miles per hour, large waves, heavy rainfall, and storm surges. Such events have historically had significant impacts on Port Everglades and the adjoining shorelines. Between 1889 and 2009, over 100 hurricanes have made landfall on the coastline of Florida, most noteably Hurricane Andrew in 1992 which hit as a category 4. See **Appendix A** for more information on hurricanes and storm surge.

2.2.5 Sea Level

The geologic record of historical sea level variations indicates that both increases and

decreases in global sea level have occurred. Both global cooling and warming contribute to sea level change. The National Ocean Service (NOS) has compiled long term records of measured water surface elevations along the Atlantic coast. This data is the basis for projecting future relative sea level rise at the Port Everglades Harbor. Information on sea level rise analysis can be found in Section 7.2.

2.2.6 Tides

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 less than 2 feet. The usable tide for navigation purposes is approximately 1.5 feet. Storm tides can range from 7 feet to 11 feet above mean sea level during severe hurricanes. **Table 9** presents tide statistics at three locations within the Port.

Table 9: Tidal Information

Tidal Statistics Relative to Mean Lower Low Water (MLLW)			
	N. Turning Basin	Southport Access 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
North 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

2.2.7 Currents

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 Florida Current, a component of the Atlantic Gulf Stream. The presence of the Florida Current creates a strong northerly current that acts perpendicular to vessels approaching and transiting the Port entrance channel. Port Everglades Pilots have historically noted strong and unpredictable currents in the harbor system as noted in the U.S. Coast Pilot 4. See **Appendix A** for more information on the Florida Current and the continental shelf that is documented as a cause for these hydrodynamic forces.

2.2.8 Waves

Wave conditions representative of Port Everglades were obtained using hindcast data available from the WIS station 467. Hindcast wave conditions cover the twenty-year period between 1980 and 1999. Similar to wind conditions, wave conditions in South Florida experience seasonal variability. Winter months show a marked increase in wave height due to northeaster activity. The intensity and direction of these winter wave conditions are reflected in the dominant southward sediment transport and seasonal erosion patterns. Summer months experience milder conditions with more normal shoreline propagation. For more information, refer to **Appendix A**.

2.2.9 Salinity

The Broward County Environmental Protection and Growth Management Department (BCEPD) maintains multiple monitoring stations throughout the waterways of Broward County. Three of these stations fall within Port Everglades, which is a salt saturated area. Salinity values at each station were measured 2 to 4 times annually between 1997 and 2007 and vary from 22.6 parts per thousand (ppt) to 37.2 ppt. Changes in salinity levels may be attributed to fluctuations in local rainfall levels as well as variations in freshwater discharge levels from New River and the Dania Cutoff Canal. For station locations see Section 2.3.8 of the **Engineering Appendix A**.

2.2.10 Littoral Processes

Littoral processes at Port Everglades are influenced heavily by the presence of man-made structures in the vicinity of the Port entrance channel. The natural shoreline sediment transport is from north to south. A shoal consisting of debris from a previous (1962) dredging event lies to the north of the inlet. This rubble shoal along with the inlet's jetties and the navigation channel itself lead to the occurrence of accretion and erosion at the adjacent shorelines. The rubble shoal and North Jetty act to impound sediment while the navigation channel and South Jetty act as a sediment sink for sediment that reaches the inlet. In June 2004, Olsen Associates Inc., under contract with Broward County, completed the Port Everglades Inlet Sand Management Phase I: Sand Bypassing Feasibility Study (Olsen Associates Inc., 2004). This study proposed that the shoreline north of the jetty be fully impounded to capture sand, as well as several bypassing alternatives to prevent annual sand transport moving past the jetty, which results in increasing shoaling within the Federal navigation channel. Phase II: Sand Bypassing Feasibility –Addendum (Olsen Associates Inc., 2007) proposed the most feasible and acceptable plan based upon logistical and environmental criteria. The project was noticed to the public in 2008, but the permit application for the proposed sand trap plan has been deactivated, as relayed by the USACE regulatory office on February 25, 2011. To date, Broward County has continued to move forward with the sand bypass project as a local effort. As of the time of this report, no project features have yet been implemented.

2.2.11 Historic Conditions

Construction in the project area began in 1927 with the creation of Port Everglades (originally known as Port Mabel) as a military facility. During the 1930s, the Port experienced steady growth in use from a growing trade business. In the 1940s the Port was heavily used by the military as steady growth in the south Florida region continued with expansion of the Port and creation of additional land based infrastructure. American settlement in south Florida began in earnest in the late 19th century. In the late nineteenth and early twentieth centuries, the Florida East Coast railway brought new settlers and tourists to Broward County's beaches. Land and agriculture were the economic backbone of south Florida. Today Broward County's industry includes cattle, agriculture, commercial and sport fishing, and tourism.

Since Port Everglades was adopted as a Federal navigation project in 1930, there have been infrequent Federally sponsored dredging events. Due to the location of Port Everglades and low shoaling rate, dredging of the harbor occurs on average every 8 years. More information can be found in the **DMMP (Appendix E)**.

2.2.12 Geology and Sediments

Hundreds of historic core borings have been obtained in and around Port Everglades Harbor. The historic core borings are of varying quality, depth, and usefulness. The Port contracted 36 new borings to USACE specifications as part of this study effort. The USACE also obtained 120 rock probes for use with this study, and results can be found in Section 3.7 of the **Engineering Appendix A**.

Based on historical data, materials generally encountered at Port Everglades are variable between core boring locations and elevations. A majority of subsurface materials encountered at the Port can be characterized as interbedded layers of sandstones, limestones, and sand. Also encountered are interbedded layers of peat, organic silts, sands, silty sands, gravelly sands, weakly cemented sands, moderately cemented sands, weakly cemented sandstones and limestones, occasional competent beds of sandstones and limestones, and deposits of hard massive sandstone and limestone. These deposits of hard massive rock at Port Everglades have been mapped. The majority exists within the Main Turning Basin (MTB) and South Turning Basin (STB). Additional formations of hard massive rock may be found in the Inner Entrance Channel (IEC) and Outer Entrance Channel (OEC), Dania Cutoff Canal (DCC), and in limited isolated deposits, throughout the Port.

Historical cross sections and core borings were analyzed to determine angle of repose for soils at various locations. Along the SAC, TN, and DCC the estimated angle of repose for loose material is 2H (horizontal) to 1V (vertical). All other areas have an estimated angle of repose of 3H:1V. Regardless of location, areas of rock are expected to hold a slope of 0.5H:1V. Knowing the side slopes of a channel is important for the following reasons:

(1) side slopes are critical in generating an accurate quantity estimate of spoil material that will be generated,
(2) side slopes allow an accurate estimate of potential upland impacts (structural and/or environmental), and
(3) side slopes play a vital role in determining potential ship response scenarios, including ship squat requirements, due to their effect on the cross-sectional area of project channels, particularly entrance channels.

2.3 ENVIRONMENTAL RESOURCES

Many of the natural resources in the project area are considered significant under USACE planning guidance ER 1105-2-100. The mangroves, seagrasses and coral/hardbottom communities in the project area have institutional recognition as Essential Fish Habitat-Habitat Areas of Particular Concern under the Magnuson-Stevens Fisheries Management Act's Essential Fish Habitat Provisions. Additionally, Acroporid corals and their designated critical habitat, Johnson's seagrass, Florida manatee, smalltooth sawfish and sea turtles in the project area are all listed as either endangered or threatened species under the Endangered Species Act of 1973, as well as the Florida Endangered Species Act (F.A.C. Chapter 379.2291). Coral and hardbottom habitats are also protected under Florida's Coral Reef Protection Act of 2009. A detailed analysis associated with the Institutional Significance of these resources is included in the Environmental Impact Statement (EIS).

Public recognition of resources in the project area include the recognition of the value of coral and hardbottom habitats offshore of Broward County through the efforts of non-government organizations (NGOs) like the Sierra Club, Reef Rescue, and Cry of the Water. Additionally, West Lake Park, where the mitigation for mangrove and seagrass impacts are proposed, is historically a focus area for local environmental NGOs, including local chapters of the Audubon Society, Sierra Club, and Friends of West Lake. John U. Lloyd State Park is very important to the public as an access location to many of the natural resources and is one of the top ten state parks (based on annual attendance) in Florida. Details concerning coordination efforts with the public for the project are detailed in the EIS.

Mangrove and seagrass habitats are significant in Broward County as they have been limited throughout history as the county has developed. They have become scarce, and connectivity between mangrove and seagrass areas has declined, historically. These habitats are not designated critical habitat for any listed species in the area; however, they do serve as important habitat for endangered smalltooth sawfish and manatee, as well as foraging and nursery habitat for a variety of commercially managed fish species. The hardbottom communities offshore of Broward County are technically significant as they are designated critical habitat for threatened Elkhorn and Staghorn corals. More detail concerning these habitats and their significance is included in the EIS.

The **EIS** has ten accompanying appendices providing data, analysis, consultations, and

evaluations on environmental resources within the project area and surrounding habitats.

These appendices include;

Appendix A: Scoping Pertinent Correspondence
Appendix B: Clean Water Act Section 404(b)(1)
Appendix C: CZMA Determination
Appendix D: Natural Resource Reports
Appendix E: Mitigation Plan Incremental Analysis
Appendix F: Endangered Species Consultations
Appendix G: Fish and Wildlife Coordination Act Report
Appendix H: Essential Fish Habitat Planning Report
Appendix I: State Historic Preservation Officer Determination
Appendix J: HTRW Tier 1 Analysis
Appendix K: Recipient List

The following sections provide a general overview of the information contained in the above. For more detailed analysis of environmental resources, please refer to the EIS and accompanying appendices.

2.3.1 Land Use and Biotic Community Cover Types

Broward County is the second most populous county in the State of Florida, with over 1.8 million citizens (U.S. Census Bureau 2013). Adjacent Miami-Dade County, to the south, is the most populous (well over 2 million). Port Everglades lies within the urban, eastern section of Broward County. As was perviously discussed, to the east of the Port is a barrier island that contains the U.S. Navy facility, the Nova Southeastern University (NSU) Oceanographic Center, U.S. Coast Guard (USCG) Station Ft. Lauderdale, and John U. Lloyd Beach State Park and adjacent beaches. South of the Dania Cutoff Canal (DCC) is an undeveloped coastal system encompassed by West Lake Park. West of the Port is a Federal Highway, 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.

2.3.2 Wetland Areas

Jurisdictional wetlands within the boundaries of the project occur as either fringing mangrove habitat, mixed wetland hardwoods, or cattail marsh. As part of the Essential Fish Habitat (EFH) analysis, NMFS characterized seven mangrove assessment areas that were defined based on similarities in water depth, water quality and clarity, and landscape position, **Figure 6**. The **EIS**, **Section 3.5.2** provides a detailed discussion of these assessment areas analyses.

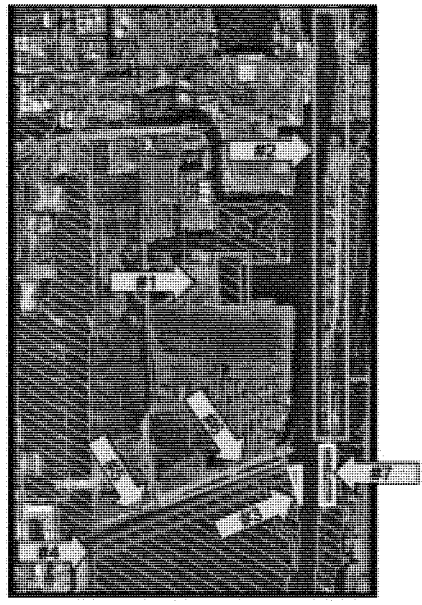

Figure 6: NMFS Mangrove Assessment Characterization Areas

2.3.3 Local Areas of Particular Concern

A number of areas currently exist within the project boundaries that require special consideration with regard to natural resources. Areas of environmental impact within the study area are shown in **Figure 7**. Also shown are potential areas for mitigation including West Lake Park (mostly owned by the state but managed by the county), and Broward County borrow holes offshore and north of the project area. These areas are discussed in more detail in **Section 7.2**. The nearshore bottom and offshore reef habitats of southeastern Florida have been designated as Essential Fish Habitat Areas of Particular Concern.

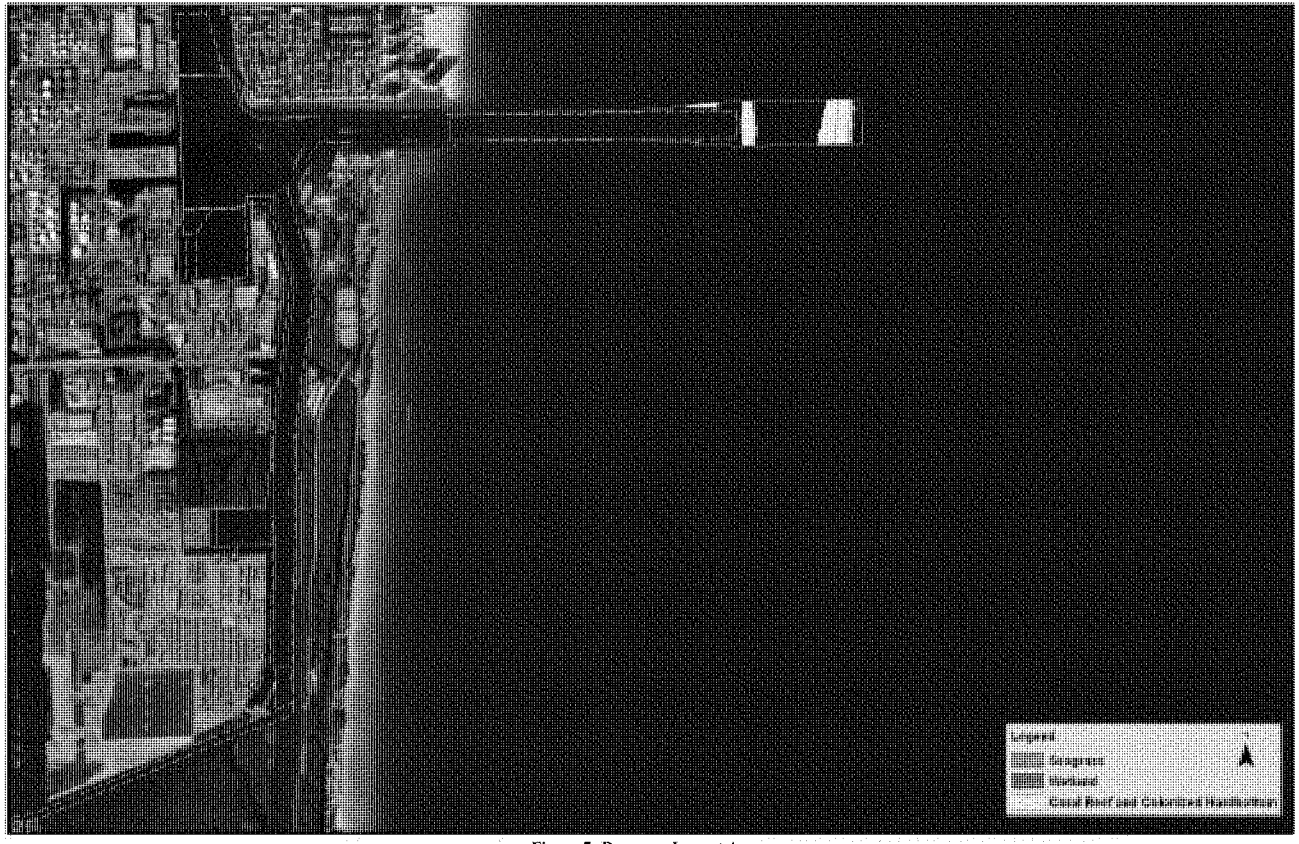

Figure 7: Resource Impact Areas

2.3.4 Seagrass Communities

Seagrass communities within the Port Everglades study area have been investigated on numerous occasions (see discussion of seagrasses in **Section 3.0 of the EIS**). 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 south of the DCC which is outside the study area as well as both north and south of the USCG basin. Since the 1999-2000 seagrass survey noted in **Section 3.6 of the EIS**, seagrass coverage has increased from 8.71 acres in the project area to 11.98 acres, **Figures 8-10**.

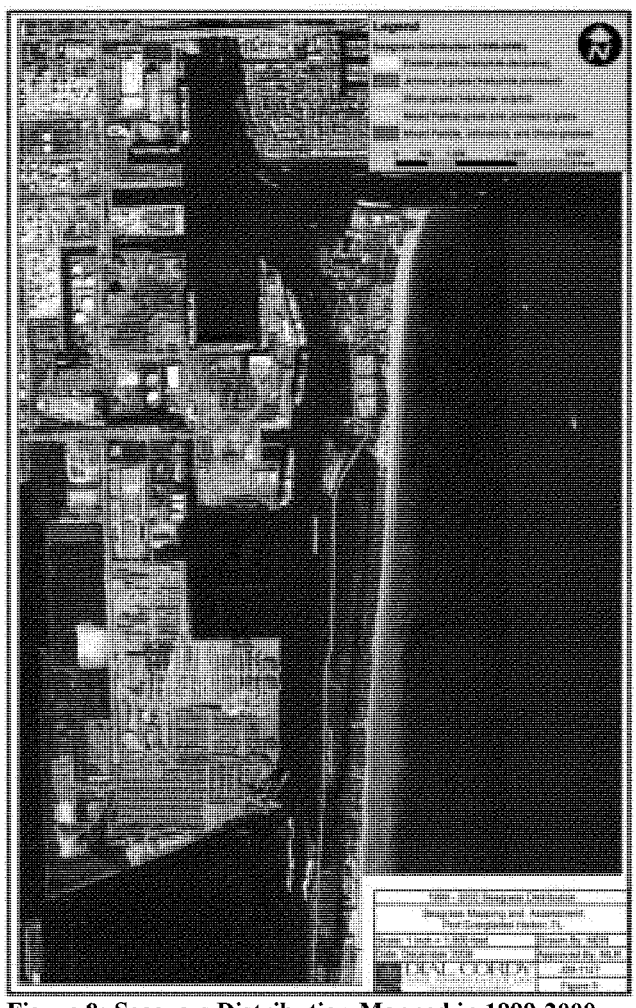

Figure 8: Seagrass Distribution Mapped in 1999-2000

Figure 9: Seagrass Distribution Mapped in 2006

Figure 10: Seagrass Distribution Mapped in 2009

2.3.5 Nearshore Hardbottom and Reef Distribution

The Outer Entrance Channel (OEC) has an inner, middle, and outer reef system. Site mapping and analysis has been conducted.

The nearshore ridge complex runs parallel to the shore and is made up of carbonate/quartz sandstone and coquina rock. 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.

The nearshore hardbottom communities typically exist in a physically stressed environment. Nearshore hardbottom areas offshore of the downdrift beaches from the channel inlet have been characterized using multi-spectral image analysis classification, towed video and in-situ diver verification. The EIS provides a detailed discussion of the hardbottom and reef communities and the associated fish species found there.

Seaward of the nearshore hardbottom area are three separate parallel reef tracts. The inner reef occurs from approximately 100 to 2,000 feet from shore; the middle reef is located 3,000 to 6,000 feet offshore; and the outer reef is approximately 8,000 feet or more offshore. **Figure 11** depicts the locations of habitat in the study area.

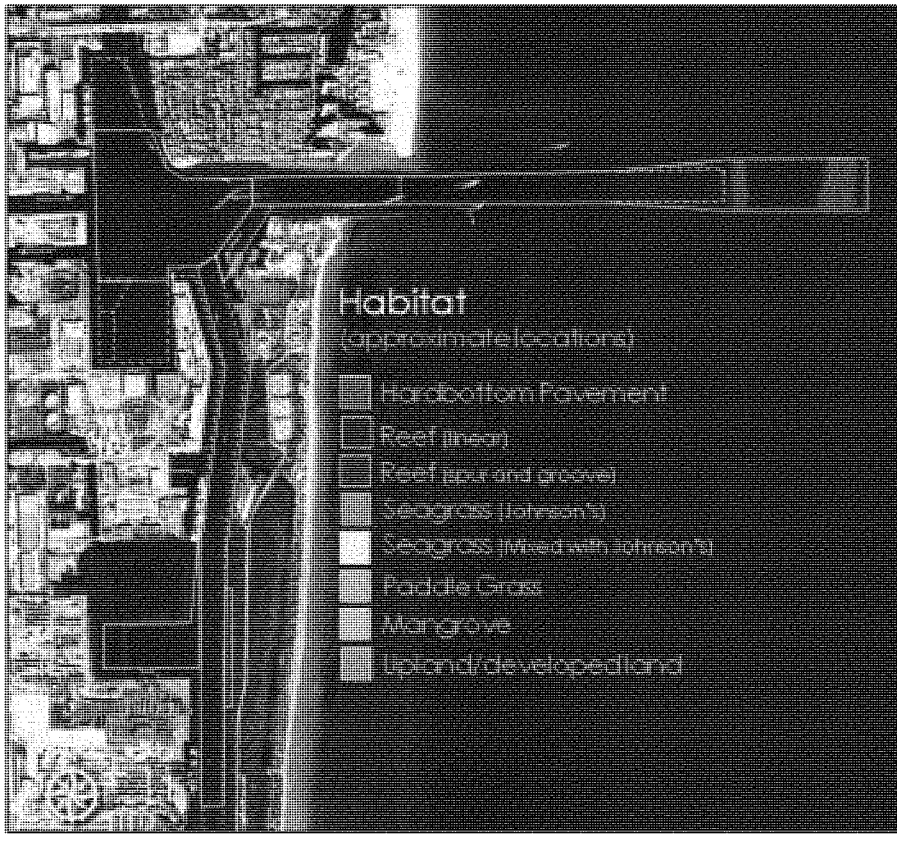

Figure 11: Offshore Reef Tracts

Based on the integrated video mapping survey conducted, marine resources in the project area were classified and a resource mosaic prepared. Resources within the OEC included sand, low-relief reef, high relief reef, scattered rock/rubble, and patchy sparse *H. decipiens*. During investigations of the outer two parallel reef tracts, a total of 41 sampling stations were assessed. Benthic organisms were assessed using in situ visual evaluations of the organisms and the reef fish in addition to underwater video. There is significant variability in the benthic communities between the second and third reefs. The third reef has been found by numerous studies to be more biologically developed than the second reef. This difference can be attributed to recurrent tidal inlet discharge dynamics, groundwater seepage, freshwater inputs, sedimentation rates, and high variability in species complexity and composition. The resource coverage, complexity, and species found throughout the various sampling events have been consistent over time, however. Refer to **Figures 12** and **13**.

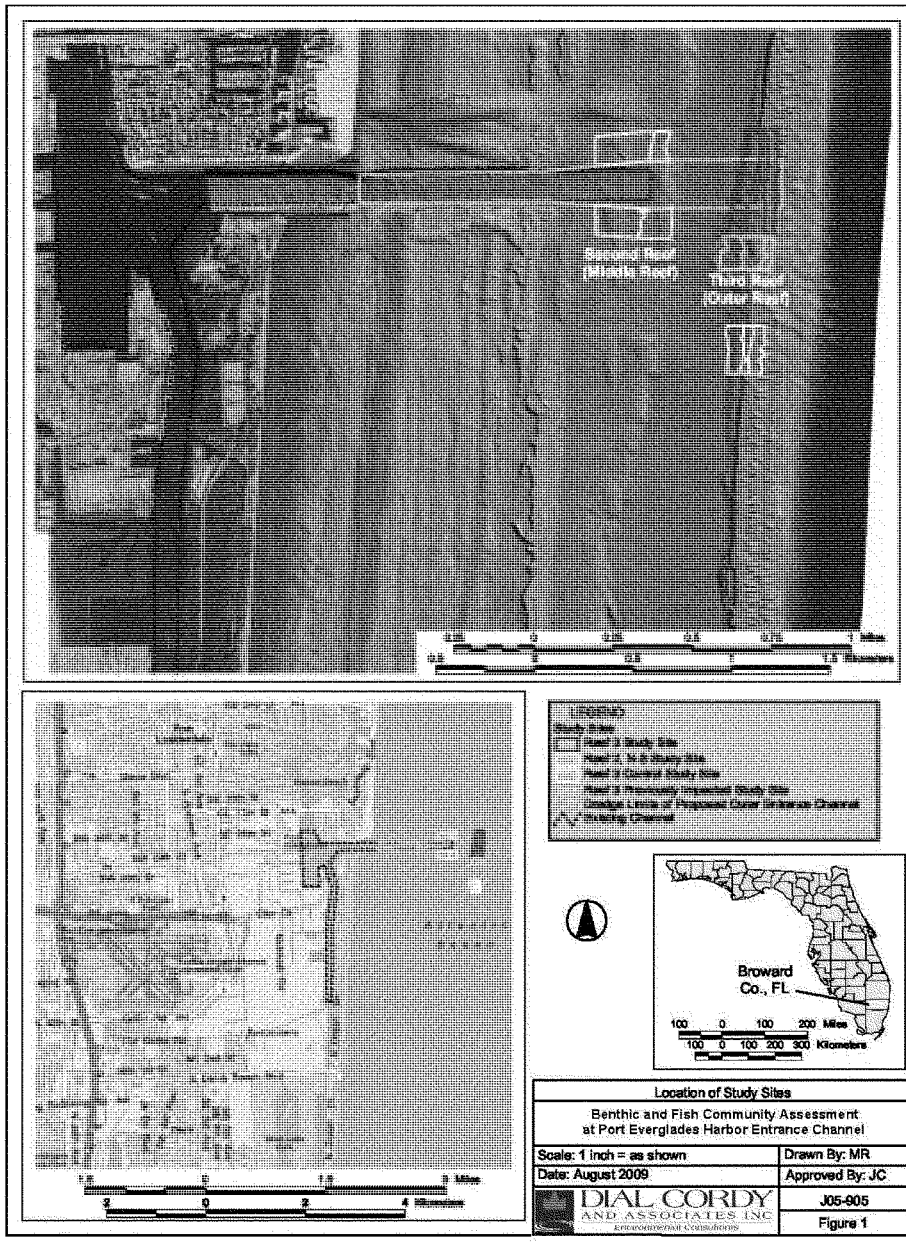

Figure 12: Benthic and Fish Community Assessment

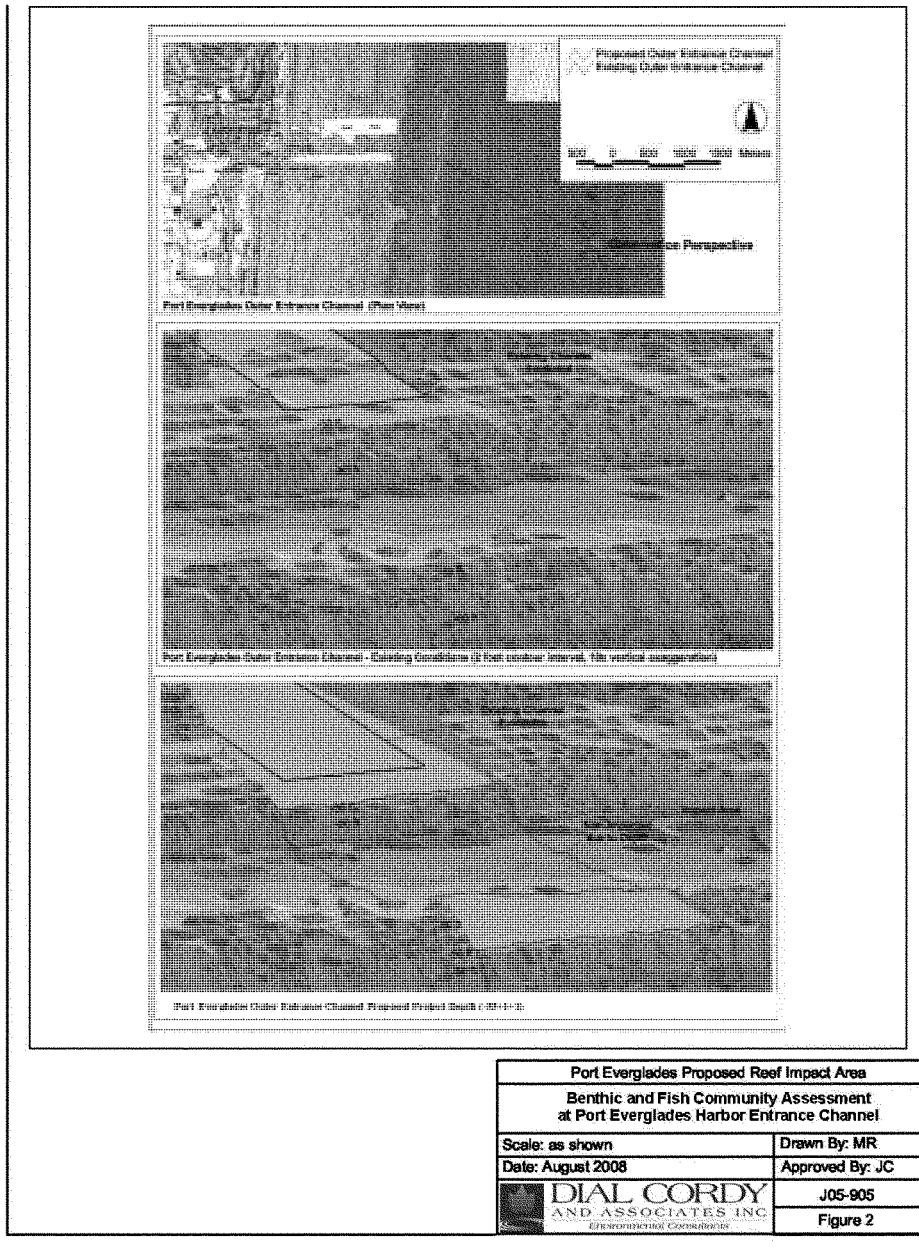

Figure 13: Middle and Outer Reef Bathymetry

2.3.6 Un-vegetated Bottom Communities

Within the harbor, the Southport Access Channel has shallow unvegetated communities. These communities have been extensively surveyed in relation to monitoring of past maintenance dredging within the Port area. This area consists of softbottom benthic communities interspersed with rubble left from previous dredging activities.

2.3.7 Essential Fish Habitat

The South Atlantic Fishery Management Council (SAFMC) has designated mangrove, seagrass, nearshore hardbottom, offshore reef areas, and any areas within the water column as Essential Fish Habitat (EFH). The nearshore hardbottom and offshore reef habitats of southeastern Florida have also been designated as Essential Fish Habitat Habitat Areas of Particular Concern (SAFMC 1998).

2.3.8 Threatened and Endangered Species

Threatened and endangered species that frequent the project area include threatened *H. johnsonii* seagrass; the West Indian manatee; loggerhead, green, leatherback, hawksbill, and Kemp's Ridley sea turtles; smalltooth sawfish; acroporid corals; and American crocodile. **Appendix E of the EIS** includes the Biological Assessments and concurrence to both NMFS and USFWS for consultation under the Endangered Species Act (ESA) and NMFS' Biological Opinion.

2.4 ECONOMIC CONDITIONS

2.4.1 Existing Port Infrastructure

Port Everglades infrastructure is divided into three Port terminal areas, each with individual characteristics and use: Northport, Midport, and Southport (**Figure 4**). The Port's 33 berths are divided amongst the three terminal areas. Total berthing space measures 25,222 linear feet. Berth services available include:

- Portable brows, including six 30 and 32-foot straight brows (cruise terminals offer hydraulic passenger loading bridges)
- Pipeline hose connections for bunker fuels at berths 1 through 27, with all berths accessible by tank truck and barge
- Linehandler services for docking, undocking and/or shifting of vessels, with a shift counting as two movements
- Dockside lighting/high-mast lights for night operations at all berths (external suppliers offer portable diesel power generators)
- Shoreside metered hose connections for fresh water at berths

- Complete chandler and provision services from external suppliers
- Public telephones at all cruise terminals and most berths

The Northport region covers Berths 1-13. **Table 10** provides the breakdown of dimensions and usage for berths in Northport. Northport has 9 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.

Table 10: Specifications for Northport Berths

Berth No.	Length (feet)	Depth (feet)	Width (feet)[1]	Use(s)
1A	180	12	125	Lay-in
1B	220	23	125	Lay-in
1-2-3	1,601	31	125	Cruise, Cargo, RO/RO, Navy
4	900	43	156	Cargo, RO/RO, Cruise
5	900	43	156	Tanker, Cargo, RO/RO
6	380	38	125	Container, Cargo, Lay-in
7-8	1,200	38	156	Tanker
8A-9A	300	38	156	Miscellaneous
9-10	1,200	38	156	Tanker
11	763	38	125	Barge
12A-13A	300	38	156	Miscellaneous
12-13	1,226	38	156	Tanker

Source: Port Everglades Guide, 2010 Guide and Directory, Broward County, Florida.
[1]Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.

The Midport region, like Northport, is a multi-use facility (**Figure 4**). Midport berthing serves cruise industries, lift-on/lift-off ("lo/lo") cargo, ro/ro cargo, naval ships, harbor tugboats, and smaller lay-in vessels (a lay-in vessel is one in an idle status, neither loading or unloading cargo). Primary cargos handled in this area of the Port include containers, bulk cement, lumber, and steel. Midport has 51 acres of open yard container storage. The Midport region covers Berths 14-29. **Table 11** provides the breakdown of dimensions and usage for berths in Midport.

Along with berthing, Midport provides: one Panamax gantry crane, one mobile harbor crane, a refrigerated warehouse, several acres of open yard area for containers and neobulk storage, and eight dockside terminal buildings that are used for passenger facilities. The berth areas adjacent to these terminals are used for both cruise and cargo operations.

Table 11: Specifications for Midport Berths

Berth Number	Length (feet)	Depth (feet)	Width (feet)[1]	Use(s)
14-15	1,400[2]	38	156	Bulk Cement, General Cargo
16-17-18	1,650	38	125	Container, RO/RO, Cruise
19-20	1,300	38	125	Cruise, Navy, RO/RO
21-22	1,707[2]	38	125	Cruise, General Cargo, Navy
23	240	38	125	Miscellaneous
24-25	1,600[2]	40	125	Cruise, Navy, Lay-in
26-27	1,340	40	125	Cruise, General Cargo, Navy
28A	480	27	125	Tugboats
28B	275	27	125	Lay-in
28C	350	27	125	Lay-in
28D	350	27	125	Lay-in
28E	275	27	125	Lay-in
28F	615	27	125	General Cargo, Container
29	1125	40	257	Container, Cruise

Source: Port Everglades Guide, 2010 Guide and Directory, Broward County, Florida.
[1] Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.
[2]Berth lengths reflect an extended length commonly encountered when accommodation of a ship that is longer than the berth is allowed by letting ship extend out past end of berth area, on the order of 200 feet.

The 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 containers/trailer storage and operations. Soutport extends from Berths 30-33C. **Table 12** provides the breakdown of dimensions and usage for berths in Southport. 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 Turning Notch to Berth 33 just north of the Dania Cutoff Canal, **Figure 14**.

Table 12: Specifications for Southport Facilities

Berth No.	Length (feet)	Depth (feet)	Width (feet)[1]	Use(s)
30	900	44	132	Bulk, Container
31-32	2,000	44	132	Container, LO/LO
33A	800	44	125	Container, RO/RO
33B	700	44	125	RO/RO
33C	700	44	125	RO/RO

Source: Port Everglades Guide, 2010 Guide and Directory, Broward County, Florida.
[1] Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.

Figure 14: Turning Notch and Southport (view looking south)

2.4.2 Cargo Movements and Fleet Composition

Port Everglades handles liquid bulk, dry bulk, general cargo, ro/ro cargo, neobulk, breakbulk, cruise ship passengers, and containerized cargo. Total vessel calls during the period of 1993 to 2010 have declined primarily due to a reduction in passenger cruise ship calls. The Port documents 8,203 ship calls in 1993; 11,722 in 2006; 5,496 in 2007; 5,226 in 2008; 4,251 in 2009; 4,079 in 2010; and 4,000 in 2012. Vessel call data from 2012 was made available for use and is shown in **Figure 15**.

In addition to the cargo traffic, Port Everglades is a homeport Port for the major cruise

ship lines. Multi-day cruise lines include: Princess Cruises, Holland America Line, Celebrity Cruises, Carnival, and Royal Caribbean International. Daily cruises include the Balearia Caribbean service to Freeport, Bahamas. Traditionally, Port cruise vessels have supported smaller day cruises accomodating 1,200 passengers or so. Cruise ship trends at Port Everglades are changing and are trending toward larger capacity vessels on the order of 3,000 to 6,000 passengers. Total annual cruise calls is projected to remain around 800-900 annually.

The cruise market has been shifting from day trips to longer voyages and larger vessels. As such, this is not a sign in market decline, but rather a market shift in the type of cruising to higher value, multi-day cruises on the largest, newest vessels deployed in the cruise industry.

There is a U.S. Navy testing facility and a U.S. Coast Guard Station at Port Everglades. Their vessels range in size up to aircraft carriers. The Navy/USCG vessel calls represent on average about 0.4 percent of all calls.

Other vessel calls include tugs and lay-ins (fuel and water bunkering). This type of vessel traffic represents on average about 12 percent of all vessel traffic at the Port.

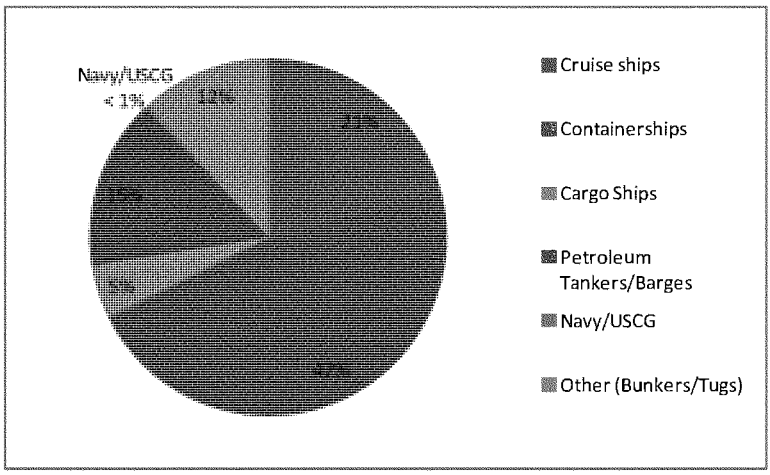

Figure 15: 2012 Annual Vessel Call Characterization

Container vessels are calling at deeper sailing drafts inbound and outbound. For example, container vessel calls with 35-foot sailing draft or greater increased from 35 in 2004 to 104 in 2008, to 190 in 2012. The increase in deeper draft vessels correlates with the increase in number of larger Panamax and Post-Panamax container vessels calling the Port. The liquid bulk fleet (tankers) is primarily Large Range 1 (LR1) in size (45,000 to

79,999 dwt[1]), with a few Aframax vessels (80,000 to 120,000 dwt with Post-Panamax beams[2]). The bulk fleet is typically sailing at or near a 37-foot draft. The dry bulk fleet ranges between 40,000 and 60,000 dwt and is typically all cement or cement production input materials. Section 4.2 of the **Economic Appendix B** discusses the fleet composition in more detail.

The major global services for container vessels calling on Port Everglades are deployments to and from the Far East (FE), Europe (EU), the Mediterranean (MED), and South America (SA). Most of the larger container vessels' calls were either associated with services for the Far East, Mediterranean, Europe, or South America. The FE and MED calls declined in number from 2006 to 2008 due to the global recession, however the larger vessels on EU and MED routes have increased in recent years. The AUST calls in the same time period remained the same, and the SA calls increased.

Analysis of Port Everglades annual tonnages from 1998 to 2012 showed petroleum tonnages peaking in Fiscal Year (FY) 2005 at 18.3 million short tons, and then declining after 2005 to 14.8 million short tons in FY 2012. Cement and other dry bulk peaked in FY 2006 at approximately 2.9 million short tons, and then declined to approximately 500 thousand short tons in FY 2010, but it has increased to approximately 970 thousand short tons in FY 2012. Container tonnage has been resilient at Port Everglades over the past decade despite the economic recession, which elsewhere caused a decline at many major domestic container ports. The growth rate for containerized cargo tonnage at Port Everglades was nearly double the rate of south Florida population growth over the period from 2000 to 2010[3].

Economies of scale (declining cost per unit as volume increases) typically arises for a variety of 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. Origin and destination market share, unique to transportation, produces traffic density on an intercontinental route, using the same ocean leg. 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. Commerce data for 2012 are displayed in **Table 13** and portrayed in **Figure 16**.

[1] dwt = deadweight tonnage; most of the LR1 class vessels calling Port Everglades are in the 45,000 to 60,000 dwt size range

[2] Post-Panamax beam is greater than 106 feet

[3] 2.46% vs. 1.25% compound annual growth rates; sources: Port Everglades and U.S. Census Bureau

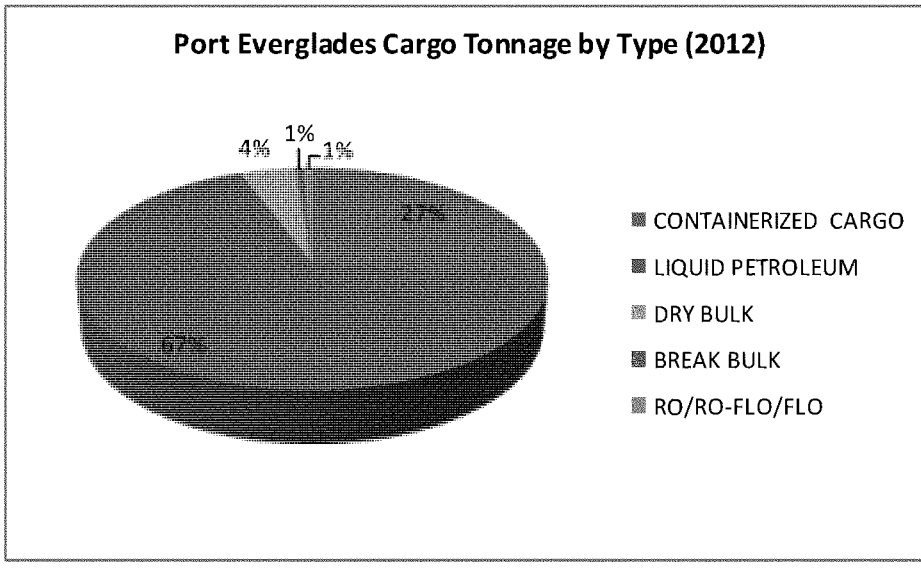

Figure 16: Port Everglades Commerce for Fiscal Year 2012

Table 13: Cruise Passengers and Total Tonnage by Type (2003-2012)

Port Everglades Waterborne Commerce Chart for the Ten Fiscal Years 2012 through 2003 (Unaudited)

FISCAL YEAR	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003
Operating Revenue	**$ 142,931,312**	**$ 139,177,090**	**$ 124,653,452**	**$ 114,441,818**	**$ 121,169,061**	**$ 112,500,017**	**$ 107,577,863**	**$ 105,858,262**	**$ 112,476,658**	**$ 89,386,458**
Expenses	**$ 72,604,326**	**$ 74,182,360**	**$ 73,950,966**	**$ 73,235,677**	**$ 73,093,351**	**$ 72,111,017**	**$ 69,117,148**	**$ 65,232,415**	**$ 56,488,710**	**$ 53,817,229**
Gross Margin	**$ 70,326,986**	**$ 64,994,730**	**$ 50,702,486**	**$ 41,206,141**	**$ 48,075,710**	**$ 40,389,000**	**$ 38,460,715**	**$ 40,625,847**	**$ 55,987,948**	**$ 35,569,229**
TOTAL WATERBORNE OPERATING REVENUE	**$ 122,018,332**	**$ 118,021,876**	**$ 103,312,041**	**$ 92,665,832**	**$ 95,958,452**	**$ 90,737,653**	**$ 85,850,912**	**$ 84,828,184**	**$ 81,516,312**	**$ 68,959,934**
Cruise Revenue	$ 60,159,964	$ 56,754,102	$ 45,724,190	$ 37,428,549	$ 35,217,120	$ 31,483,362	$ 28,146,431	$ 30,000,619	$ 30,601,167	$ 25,223,188
Containerized Cargo Revenue	$ 31,321,019	$ 31,669,031	$ 29,473,963	$ 28,711,223	$ 33,867,064	$ 28,556,927	$ 25,393,178	$ 24,192,949	$ 20,487,292	$ 18,106,809
Petroleum Revenue	$ 25,656,369	$ 25,771,885	$ 25,486,535	$ 23,537,174	$ 23,620,073	$ 23,756,489	$ 22,946,933	$ 22,945,117	$ 22,734,391	$ 19,803,802
Bulk Revenue	$ 2,003,023	$ 1,378,516	$ 925,567	$ 1,090,407	$ 1,599,476	$ 3,251,766	$ 5,661,670	$ 4,836,366	$ 4,595,168	$ 3,986,867
Break Bulk Revenue	$ 1,552,505	$ 1,283,503	$ 872,967	$ 886,826	$ 1,670,354	$ 2,803,198	$ 2,798,064	$ 2,228,132	$ 2,147,521	$ 1,318,299
Lay-In Revenue	$ 1,078,394	$ 806,288	$ 467,859	$ 736,089	$ 692,866	$ 384,696	$ 468,490	$ 388,664	$ 534,936	$ 422,734
Navy Revenue	$ 247,058	$ 358,551	$ 360,961	$ 275,564	$ 291,499	$ 501,215	$ 436,146	$ 236,337	$ 415,837	$ 108,235
TOTAL SHIP CALLS	**4,000**	**4,183**	**4,079**	**4,251**	**5,226**	**5,496**	**5,510**	**5,901**	**6,389**	**5,853**
Cruise Ships	838	969	1,015	1,007	1,676	1,852	1,763	2,362	2,854	2,215
Container Ships	1,867	1,861	1,830	1,980	2,197	2,270	2,185	1,988	1,890	1,880
Cargo Ships	194	180	113	105	157	202	268	247	231	213
Petroleum Tankers/Barges	618	630	661	683	727	732	744	751	763	798
Navy/USCG	16	26	29	34	22	39	29	18	25	17
Other (Bunkers/Tugs)	467	517	431	442	447	401	521	535	626	730
TOTAL CRUISE PASSENGERS	**3,757,320**	**3,952,843**	**3,674,226**	**3,139,820**	**3,227,770**	**3,409,946**	**3,239,154**	**3,801,464**	**4,075,406**	**3,375,671**
Single Day	68,298	288,740	360,018	302,866	591,059	719,888	779,470	1,113,101	1,400,110	1,050,174
Multi-Day	3,689,022	3,664,103	3,314,208	2,836,954	2,636,711	2,690,058	2,459,684	2,688,363	2,675,296	2,325,497
TOTAL CONTAINERIZED CARGO (tons)* **	**5,944,513**	**5,787,961**	**5,216,831**	**5,204,103**	**6,584,747**	**6,060,149**	**5,688,442**	**5,076,403**	**4,145,394**	**3,633,610**
TEUs Loaded	655,046	621,632	552,781	551,862	697,808	665,729	624,524	572,342	486,598	415,186
TEUs Total	923,600	880,999	793,227	796,160	985,095	948,680	864,030	797,238	653,628	569,743
TOTAL PETROLEUM (tons)*	**14,830,384**	**15,325,199**	**15,483,856**	**15,337,063**	**16,143,971**	**17,486,726**	**17,566,394**	**18,338,378**	**17,585,603**	**16,958,171**
Barrels	104,819,812	108,262,845	109,380,437	108,356,216	113,941,485	122,979,685	123,479,901	128,842,410	123,734,414	119,100,503
TOTAL BULK (tons)*	**973,191**	**531,572**	**511,467**	**566,820**	**895,147**	**1,752,974**	**2,954,310**	**2,848,333**	**2,854,588**	**2,535,057**
Bulk Cement	613,051	375,050	264,211	306,727	494,054	1,432,837	2,465,753	2,222,492	2,333,142	2,164,610
Dry Bulk	346,976	141,189	234,068	246,988	387,383	307,825	475,084	607,063	509,891	354,444
Liquid Bulk (Non-petroleum)	13,164	15,333	13,188	13,105	13,710	12,312	13,473	18,778	11,555	16,003
TOTAL BREAK BULK (tons)* **	**120,812**	**94,921**	**69,960**	**67,462**	**91,007**	**302,301**	**376,535**	**279,139**	**297,678**	**161,195**
Steel/Coils/Rebar	53,055	27,180	15,192	15,523	17,660	175,361	256,271	159,353	150,951	76,471
Other Break Bulk	67,757	67,741	54,768	51,939	73,347	126,940	120,264	119,786	146,727	84,724
TOTAL VEHICLES & YACHTS (tons)* **	**166,237**	**180,986**	**181,169**	**172,361**	**240,129**	**196,014**	**152,549**	**125,166**	**104,167**	**87,862**
Trucks/Trailers	28,222	28,112	34,105	40,903	69,712	57,390	28,729	23,400	18,536	17,454
Tractors	76,163	83,337	79,210	65,255	69,552	52,089	45,462	26,630	18,812	14,160
Yachts/Boats	55,198	60,812	54,396	53,871	75,729	63,999	57,668	32,866	42,940	37,310
Autos	4,307	7,253	12,972	11,314	23,845	20,184	16,983	23,491	22,104	14,393
Buses	2,347	1,472	485	1,018	1,291	1,720	3,708	1,917	1,775	2,223
TOTAL WATERBORNE COMMERCE (tons)* ***	**22,116,275**	**22,987,515**	**21,640,144**	**21,503,720**	**24,227,435**	**26,400,271**	**27,114,362**	**27,159,194**	**25,492,798**	**23,870,023**

*Tonnage is measured in 2,000-pound short tons.
**Vehicles & Yachts tonnage is presented in detail in its own section for informational purposes, but this tonnage is accounted for in other areas above.
***Total includes other amounts that are not part of the tonnage presented above for the primary revenue centers.

Source: Port Everglades Commerce Report FY2012
Notes: Short tons. Cruise Passengers are counted at embarkation and debarkation.

3.0 FUTURE WITHOUT-PROJECT CONDITIONS

3.1 BASE YEAR AND PROJECT LIFE

USACE guidance requires forecasting of without-project conditions throughout the 50-year period of analysis. The Base Year is 2023 and is defined at the time when project construction will be complete. The 50-year period of analysis is 2023 to 2073.

3.2 PHYSICAL CONDITIONS

Most of the physical conditions that were outlined in the existing conditions section are expected to remain the same under the future with and without-project scenarios. This includes the current trends for climate, winds, waves, tides, currents, salinity, littoral processes, geology and sediments. It is assumed that these trends will not impact the design of the project nor any mitigation activities. One aspect of the physical conditions that is expected to change under the future without-project condition is the sea level. A range of sea level rise estimates were determined based on the local historic sea level rise rate, the construction (base) year of the project, and the design life of the project. Based on a 50-year period of analysis, the low, intermediate, and high sea level rise values are projected to be 0.39 feet, 0.84 feet, and 2.25 feet, respectively. A description of this analysis is presented in section 7.2.4 of this report. Further details can be found in the **Engineering Appendix, Section 1.1.1** and the **EIS Section 4.26.3**.

3.3 ENVIRONMENTAL RESOURCES

In the future without-project scenario, the physical conditions are expected to remain consistent, so limited impacts to the environmental resources are expected. As previously discussed in accordance with ER 1110-2-8162, a sea level rise analysis was conducted and a low, intermediate, and high rate for anticipated increase in the sea level was produced. In the low and intermediate rate, no impacts to environmental resources are expected due to the insignificant rise in sea level. For the high rate the increased water depth could potentially have a negative impact on sea grasses. The proximity of the project to open ocean leads to no significant change in salinity and therefore no effect to environmental resources are expected due to a change in salinity.

3.4 ECONOMIC CONDITIONS

One indicator of the future economic conditions for the project area is population growth. Population growth in the area has been rapid since 1950. This growth can be attributed to Florida's ideal climate, historically low property costs, and abundant recreation opportunities. Over the last 60 years Broward County population increased from 83,933 in 1950 to 1,748,066 in 2010, an increase of over 2000%. Due to a more established

community, Miami-Dade County achieved less growth than Broward County, or the State as a whole. Florida population grew over 500% in the 60-year span.

As a subset of Florida population, the summed total of the nine counties in the project hinterland comprises a slowly increasing percentage share of the Florida state population over most of the period. Although the populations of the counties were increasing in absolute numbers from 1970-2000, their share of Florida's population did not change substantially over this period. However, from 2000 to 2010, the South Florida regional share of Florida state population increased to its highest percentage share ever at 40.6%. More detail on the projected growth rates and population can be found in the **Economic Appendix B Section 2.**

The majority of the Port's annual total commodity tonnages come from petroleum, cement, and containers. The growth rates for cement were affected by the economic slowdown that has characterized south Florida since 2006. Petroleum and container tonnage continued to grow through 2012. The container tonnage historical growth rates, further discussed in the **Economic Appendix Section 3**, were generally more conservative than other major U.S. container ports, reflecting that Port Everglades is historically a regional hinterland largely confined geographically to the southern part of Florida. The newly constructed Intermodal Container Transfer Facility (ICTF) will allow the Port to move cargo more efficiently.

The projected near-term annual growth rate for containerized cargo range from 3.81% to 4.27%, as outlined in the **Economics Appendix B Section 5**. A factor that will affect this rate is the resumption of discontinued container services by Panamax vessels.
The design vessels used for the formulation of measures are shown in **Table 14**. There were two categories of design vessels, the vessels for which the channel measures were specifically designed, and the vessels that were used as berthed vessels and test case vessels to improve the reality of ship simulation modeling. The primary Post-Panamax container design vessel is an S-Class. Refer to the **Engineering Appendix** A for a more detailed discussion. In order to accommodate projected growth in containerized cargo traffic at Port Everglades, it was determined that regions of the harbor require deepening and widening. The design vessels are the primary tool used in the evaluation of structural measures for Port improvement.

The containership fleet is expected to shift towards larger vessels. Over time, more new builds of Post-Panamax container vessels are expected to come into service. These vessels will be deployed on strings that call Port Everglades, as they do now, in a draft-constrained condition, without being able to fully utilize vessel capacity. Additionally, container liners would not be able to fully utilize the vessel fleets that will be available to them. The liners are not anticipated to deploy as many Generation 2 Post-Panamax vessels onto strings that service Port Everglades in the future without-project condition.

Table 14: Design Vessels

Design Vessel	Beam (ft)	Draft (ft)	Length (ft)	Project Component
Post Panamax"S-Class"	141	48	1,139	OEC, IEC, MTB, Widener, SAC, TN
Liquid Bulk	≤ 142	≤ 55	≤ 900	OEC, IEC, MTB
Future Cruise "Voyager"	156	28	1,020	OEC, IEC, MTB, Widener, SAC
Panamax "Bellatrix"	82	29	524	DCC
South Turning Basin	106	43	926	STB
Pleasure Craft[1]	20	N/A	N/A	All
[1] Pleasure Craft design vessels were used as "passing vessels" in the determination of channel and turning basin dimensions				

Mediterranean Shipping Company's MSC Maeva, a 1,066-foot-long, 140-foot wide, 105,007 dwt containerized cargo ship (**Figure 17**) is the first of three ships in its class that will carry cargo to and from Port Everglades as part of a weekly ocean shipping service. The first transit of this 8100 TEU capacity vessel to Port Everglades was reported to have occurred on March 29, 2011. As a result of this service, Pilot restrictions have been increased for vessels of this size. Under future without-project conditions, the extent of this service would be restricted due to traffic congestion; wind, wave and outer channel cross-current limitations; and existing insufficient channel depths for fully loading.

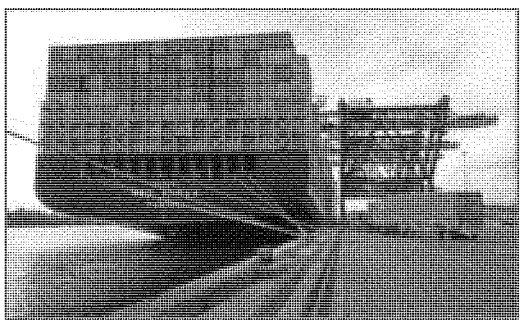

Figure 17: MSC Maeva

3.5 Without-Project Assumptions

Based on ER 1105-2-100 (USACE 2000), the following assumptions are made regarding without-project conditions:

- The period of analysis is 50 years.
- The use of navigation restricitons as set by the port pilots (use of tide, additional tugs) will continue to be used under the without-project condition.

- Normal operation and maintenance practices are assumed to be performed over the period of analysis.
- In projecting commodity movements involving intermodal movements and in projecting traffic movements on other modes, sufficient capacity of the hinterland transportation is assumed (a hinterland analysis can be found in the **Economics Appendix B Section 2**).
- Infrastructure planned to be implemented by the Port will be constructed on schedule including the extended expansion of the Turning Notch which is currently underway.
- The existing quality and extent of environmental resources is assumed remain consistent throughout the period of analysis.

The Port conducted an indepth analysis of Turning Notch (TN) expansion alternatives independent of this study, and arrived at an optimum length of the TN that would result in maximum additional throughput at minimum construction costs. Extension of the TN is an important port infrastructure improvement to increase the number of cargo berths in Southport. This extension involves moving ships and cranes closer to the Ft. Lauderdale Airport runway.

The Port is currently moving forward with the Turning Notch (TN) extension project. Planning, design, permitting, and engineering for this expansion is underway. This project will lengthen the existing TN from 900 feet to 2,400 feet at the existing depth of 42 feet (+2). The project will provide for up to five additional berths. A critical part of the TN extension project includes replacing approximately 8.7 acres of an existing mangrove conservation easement with an approximately 16.5-acre upland enhancement of approximately 70,000 new mangroves and transitional plants, as well as completing additional mitigation in West Lake Park. The Port worked closely with port users, the environmental community, and the Florida Department of Environmental Protection (FDEP) to develop a plan for the new mangrove habitat. This effort resulted in an agreement between Broward County's Port Everglades and the FDEP for the partial release of the conservation easement which was executed on September 3, 2010.

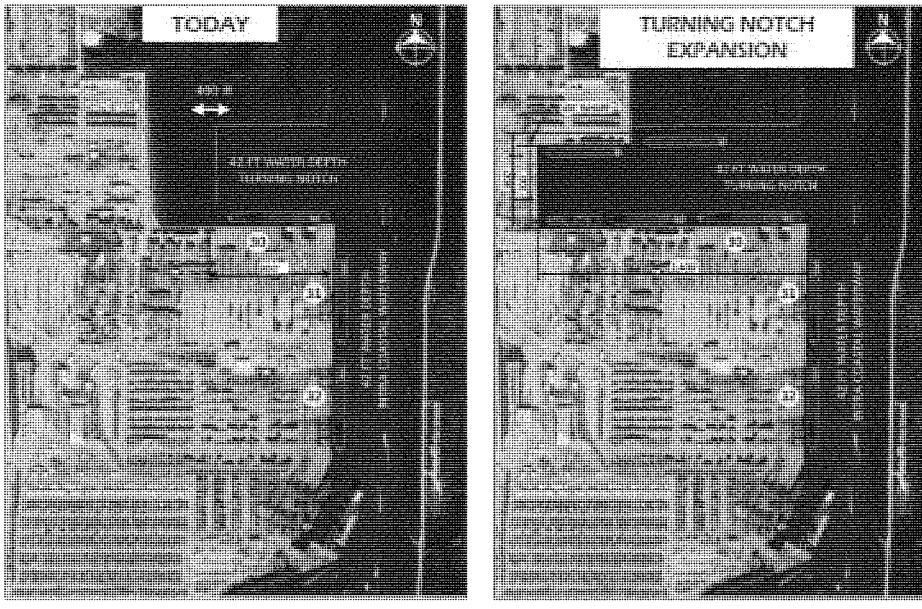

Figure 18: Sponsor's Turning Notch Expansion

4.0 PROBLEMS AND OPPORTUNITIES AND FORMULATION

The following paragraphs present the culmination of the iterative plan formulation process.

4.1 THE PLANNING PROCESS

The USACE planning process follows the 6-step process defined in the Principles and Guidelines. This process is used for all planning studies conducted by the USACE, provides a structured approach to problem solving, and provides a rational framework for sound decision making. The six steps are:

Step 1: Identify problems and opportunities
Step 2: Inventory and forecast conditions
Step 3: Formulate plans
Step 4: Evaluate plans
Step 5: Compare plans
Step 6: Select a plan

4.2 PROBLEMS AND OPPORTUNITIES

Meetings and coordination with the non-federal sponsor (Broward County represented by its Board of County Commissioners), terminal operators, Port Everglades Pilots Association, the U.S. Coast Guard (USCG), Florida Department of Environmental Protection (FDEP), NOAA Fisheries, Florida Fish and Wildlife Conservation Commission (FWC), Nova Southeastern University, National Marine Fisheries Service (NMFS) Habitat Conservation Division (HCD), and additional environmental resource agencies provided valuable information related to existing problems and opportunities.

Representatives from the Port, Port Pilots' Association, USCG, Navy, and USACE met to discuss the problems investigated by this study. Two categories of problems were identified: (1) navigation problems occurring under existing conditions, and (2) existing channel design as a factor limiting Port expansion and promotion of additional business growth. The Pilots resolved that before comprehensive port expansion and growth can occur, congestion, restricted manueverability, turning, passing, and lightloading problems due to insufficient depths and widths must be solved.

Existing problems include;

i Outer Entrance Channel (OEC) existing dimensions and strong unpredictable cross currents combine to make entrance transit difficult under 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. Vessel delays

due to often difficult conditions in the OEC result in increased transportation costs. (**Figure 19**);

ii The Knuckle area configuration restricts maneuverability and transiting operations, especially when vessels are at Berths 25 and 26. Delays due to these restrictions result in increased transportation costs. (**Figure 20**);

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, (**Figure 20**);

iv The existing Southport Access Channel (SAC) width restricts transiting past berthed cruise ships which causes vessel delays due to these restrictions;

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

vi Depth and width of channels and basins constrains fully loaded vessel realization for both existing and future fleet;

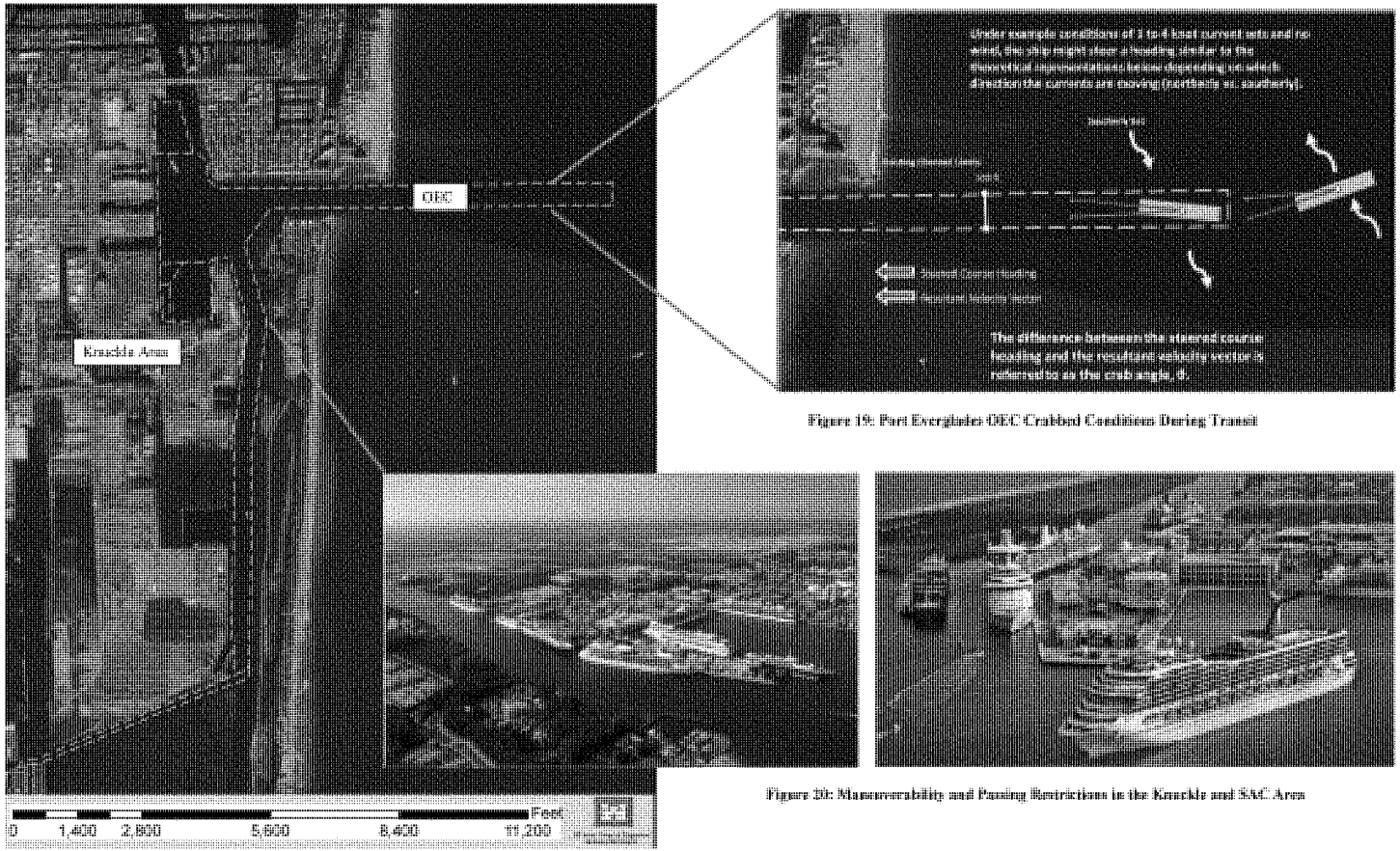

Figure 19: Port Everglades OEC Crabbed Conditions During Transit

Figure 20: Maneuverability and Passing Restrictions in the Knackle and SAC Area

The problems identified stem from the fact that the existing Federal navigation channel at Port Everglades was designed in the 1970's for use by sub-Panamax vessels. Under existing conditions, Panamax and Post-Panamax vessels use Port Everglades daily with restrictions. Both the proportion and sizes of Post-Panamax vessels at Port Everglades are projected to increase over time.

The most impacted vessel type is the container ships which transit the Federal navigation channel leading to the Southport container terminal. Cruise ship operations are restricted in the Federal navigation channel leading to two of the Port's cruise terminals. Petroleum vessels transit light loaded. In addressing existing problems, the Port has developed operational rules and restrictions which increase transportation costs for the cargo and cruise ship industries.

The primary problems identified in this analysis relate to the inefficient operation of containerships, petroleum vessels, and cruise ships in the Federal channel at Port Everglades which affect the Nation's international trade transportation costs and cruise industry operating costs. Inefficiencies include the following:

1. Transportation cost inefficiencies due to light loading, congestion delays, currents, and tidal delays;
2. Light loading, congestion delays, and tidal delays will increase as present harbor users increase their annual tonnage and as larger, more efficient ships that require deeper and wider channels replace older, smaller ones;
3. Existing ships are experiencing maneuverability and efficiency problems in the Federal navigation channel associated with restricted access to portions of the Federal navigation channel during typical port operations;
4. The severity of problems associated with maneuverability and restricted access to the Federal navigation channel will increase as vessel size and the proportion of larger vessels increases.

The inefficient operation of cargo vessels, petroleum vessels, and cruise ships at Port Everglades directly result from insufficient depth and width of the Federal channel. The existing channel depth constraint causes some carriers to light-load vessels and restricts the efficient vessel size used by carriers. Examples of light loading are exhibited in containership operations. Restrictions on efficient vessel size are exhibited by liquid bulk and dry bulk operations, which have the landside capacity to use larger vessels, but the existing channel depth restricts the efficient use of these larger vessels. Containership size is also restricted by the existing Federal navigation channel depth (and width). Some of the largest containerships calling at Port Everglades have been pulled and redeployed elsewhere because of the restrictions on vessel operations imposed by existing channel constraints. Light-loading, restricted vessel size, and pulling large vessels from Port Everglades may increase cargo transportation costs.

The Port has developed restrictive operational rules in response to the difficulties associated with navigating a modern fleet in outdated narrow channel conditions. There are by-passing restrictions on vessels transiting the Southport Access Channel, which stop all Panamax and Post-Panamax vessel traffic in the Southport Access Channel, when

Panamax vessels are moored alongside berths 25, 26/27, and 29. Additional tugs are required for Panamax and Post-Panamax vessels transiting the Southport Access Channel if sub-Panamax vessels are moored alongside. Additional tugs are required for all Post-Panamax containerships with a beam greater than 140 feet. These operational rules increase cargo and cruise ship transportation costs by causing delays, increasing fuel consumption, and by requiring additional tugs. These existing problems are projected to increase as future cargo tonnage and vessels sizes increase at the Port.

Navigation improvements will provide the following opportunities:

i. Accommodate transit of larger Post-Panamax class containerized cargo vessels
ii. Accommodate transit of deeper draft bulk cargo vessels
iii.
iv. Accommodate new generation cruise ships
v. Allow for more efficient transit of existing and future fleets
vi. Accommodate future vessel demands

4.3 Planning Objectives and Constraints

4.3.1 Federal Objective

The Federal objective of water and land resource planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to the NED outputs are increases in the net value of the national output of goods and services, expressed in monetary terms. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

The objective of this feasibility study is to provide solutions to the previously defined problems in accordance with the Federal objective, and objectives of the non-federal sponsor and other interested parties. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. The planning objectives represent the desired positive changes from the without project conditions.

Four accounts are established in the Principles and Guidelines (P&G) to facilitate the evaluation and display of effects of plans. The accounts are:

1. NED: The national economic development account which displays changes in the economic value of the national output of goods and services;
2. EQ: The environmental quality account displays non-monetary effects on ecological, cultural, and aesthetic resources including positive and adverse

effects of ecosystem restoration plans;

3. RED: The regional economic development account displays changes in the distribution of regional economic activity (i.e. income and employment);
4. OSE: The other social effects account displays plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation, and others.

4.3.2 Planning Objectives

The planning objectives are shown in **Table 15**. Incorporation of the USACE seven Environmental Operating Principles (EOP) is an incorporated component of the project. USACE feasibility studies aim to protect the environment to the maximum extent practicable, while meeting the stated goals of the applicable feasibility study.

Table 15: Study Objectives

Objective 1	Decrease costs associated with vessel delays from congestion and channel passing restrictions at Port Everglades through the 50-year period of analysis.
Objective 2	Decrease transportation costs through increasing economies of scale for cargo and petroleum vessels at Port Everglades through the 50-year period of analysis.
Objective 3	Increase channel efficiency and maneuverability at Port Everglades for the existing fleet and larger vessels through the 50-year period of analysis.

4.3.3 Planning Constraints

Constraints are restrictions that limit the planning process. Acceptable plans are those that will achieve the study objectives without violating the constraints. The following constraints were identified to be relevant to this study:

- Sensitive environmental resources exist within the study area. The sensitive environmental resources in the area, presented in **Section 2**, include wetlands, seagrass communities, nearshore habitat, essential fish habitat, and threatened and endangered species. Any impacts to these resources will be avoided or minimized to the extent practical.

- State park lands (John U. Lloyd Beach State Park) border the project area. There is a large area of mitigation (mangroves) along the SAC that was constructed as part of the Port's dredging of the TN in 1989. Additionally, impacting John U. Lloyd state park lands would require going before the Governor/Cabinet for a permanent release of state lands. The state sent USACE a letter in 1999 stating they would not support this. The project will seek to avoid impacts wherever practicable.

- FAA flight surface restrictions are due to the relatively low flight patterns of aircraft as they prepare to land or have just taken off from the Ft. Lauderdale International Airport. Any new post-Panamax cranes may not infringe on this flight surface.

- The U.S. Coast Guard station is within the project area. This facility is necessary and cannot be removed. All project alternatives include keeping the station active.

- Nova Southeastern University (NSU) property is within the project area. All project alternatives are formulated to ensure there are no impacts to NSU.

An iterative process was used to formulate, scope, design, screen, and refine plans. A no-action plan, non-structural plans, and structural plans were considered throughout the process. A series of meetings with interested stakeholders were held to facilitate an open planning process. A web page was created to make meeting information available. The study takes into account all applicable county, state and Federal laws, permitting requirements, regulations, and environmental guidance.

4.4 Environmental Operating Principles

The USACE Environmental Operating Principles (EOP's) were developed in 2002 to help provide direction on how to better achieve stewardship of air, water, and land resources, and to demonstrate a positive relationship between management of these resources for the protection and improvement of a sustainable environment. These EOP's were later revisited with more emphasis on proactively implementing these principles.

The EOP's are:

1. Foster sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all USACE activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet USACE corporate responsibility and accountability under the law for activities undertaken by the USACE 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 USACE actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

The EOP's were considered during each step of the plan formulation process. The Jacksonville District USACE and the non-federal sponsor recognize the high quality of

the reef system within the project area and the diverse marine life that it supports, including threatened and endangered species. Accordingly, interagency meetings were held on potential coral reef impacts, recovery and mitigation. Taking into consideration the views expressed by stakeholders, and in conformity with the EOP's, the project delivery team (PDT) selected a plan which provides the best balance of environmental sustainability and efficient use of navigation. Some of these principles are presented below.

- Blasting protection protocols to protect marine mammals and sea turtles
- Use of the standard manatee protection protocols during construction
- Pre-construction (baseline), during construction, and post-construction monitoring of coral and hardbottom habitats adjacent to the channel
- Monitoring of impacts to fishes associated with blasting events
- Relocation of hard corals from the 3rd reef entrance channel extension to mitigation site artificial reef
- Sustainability of proposed mangrove and seagrass restoration by coordination with a larger mangrove and seagrass restoration project within Broward County, inside a county park that will ensure long term protection of the created habitats.

4.5 Planning Process

Figure 21 shows the planning process from formulation to selection of the Recommended Plan.

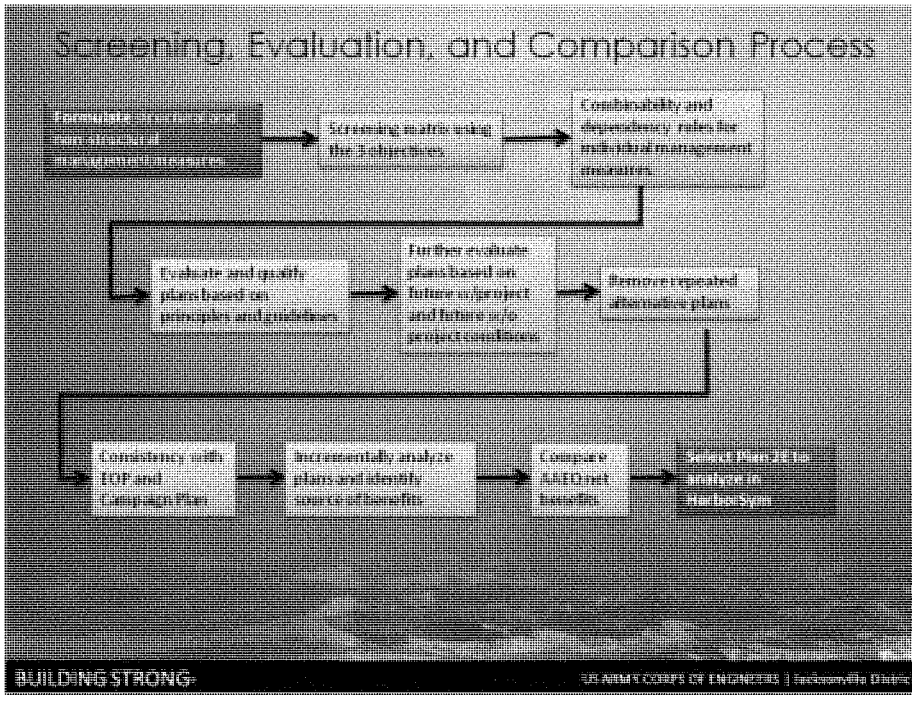

Figure 21: USACE Planning Process

4.6 Management Measures

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. Management measures are used to create plans and can be categorized as non-structural or structural. Non-structural measures includes measures that can be implemented by non-federal agencies and project users that reduce or eliminate the need for a Federal project investment. This can include operational practices or structural alternatives that are implemented by project users. Non-structural measures do not require physical alteration of the Federal channel. Non-structural measures are listed in **Table 16**. Structural measures involve the physical alteration of the Federal waterway. Structural measures that were proposed and considered are listed in **Table 17**.

Table 16: Non-Structural Measures

Measure	General Description
1. No-Action	Allow Port to continue to operate the same
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	Import commodities to another port and truck as needed
5. Off-loading Cargo	Completely off-load cargo before entering the Port to a smaller vessel or vessels from vessels with greater than allowable drafts.
6. Light-loading Vessels	Light-load larger vessels to achieve lesser drafts that allow port entry
7. Lightering	Partially off-load larger vessels offshore onto smaller vessel to allow port entry at existing channel depths
8. Off-Shore Petroleum	Create an offshore petroleum facility to unload tankers with deeper drafts prior to entering the Port. Use pipelines to transport products.
9. Rail Alternative	Transport petroleum materials into Port Everglades by rail rather than ship.
10. NOAA Ports	Use the NOAA Physical Oceanographic Real-Time System to predict current direction and magnitude.

4.6.1 Non-Structural Measures

1. No-Action

This measure is equal to the without-project condition. This measure assumes no project would be implemented by the Federal Government or local interests to achieve planning objectives. The Port operations will continue current operations. The OEC will continue to be affected by strong and unpredictable cross currents that create hazardous and unreliable conditions. Maneuverability and passing operations of larger vessels will continue to be restricted. Channel and basin depths will restrict future vessel sizes, and the amount of goods that some vessels can carry. Pilot induced restrictions will continue to increase as vessel sizes also increase. Vessels will continue to be inefficiently distributed throughout Port Everglades or be unable to call. The no action plan may hinder opportunities for development and growth. The no action plan does not provide a solution to the study problems. The no action plan is carried forward in the analysis for comparison purposes however it is not recommended.

2. Additional Tugs

More tugs could be added to the Port with Ship Docking Module (SDM) technology. These tugs are an innovation tractor tug technology that can move in any direction with full power. They have the ability to safely maneuver ultra-large vessels within narrow channels and environmentally sensitive waterways, due to the specifically designed

manatee guards. Upon analysis, the Port indicated that currently there are sufficient SDM's and similar functioning tugs at Port Everglades to handle the existing fleet. It is the Port's intention to have sufficient SDM's and tractor tugs to handle the future fleet. It was determined that the Port was already using additional tugs and this measure would provide no added benefits.

3. Clear Berthed Vessels

Larger vessels have trouble transiting the SAC when vessels are berthed along the knuckle area. Berths 24 through 29 need to be cleared to allow safe transit. This is a current Pilot imposed restriction. This measure occurs under the without-project condition.

4. Bypass Port Everglades

Vessels that cannot be accommodated at the Port would be redirected to other ports. The commodities would then be trucked as needed or shipped on smaller vessels with use of a trans-shipment facility (such as Freeport). This measure is currently being implemented on container services that have recently left Port Everglades due to channel depth restrictions. This measure could reduce port congestion so it met objective 1, but increases transportation costs by added trucking costs or additional costs of another port.

5. Off-Loading Cargo

Vessels with a draft greater than the entrance channel allows would be off-loaded. The most common practice of off-loading involves the larger vessels to visit alternative deep water ports to transfer its cargo to smaller vessels. Congestion in the harbor would be increased as additional vessels would be entering rather than the original, larger vessel. Additional vessels causes increased delays and operating expenditures, therefore existing conditions indicate a preference to light-load large vessels rather than off-load them. This measure does not meet the study objectives.

6. Light-Loading Vessels

This measure would limit the ability of vessels entering the Port to load to their optimum capacity. Some vessels, despite any loading alternatives, would not be able to enter the Port without enlarging the entrance channel. With this measure, some larger vessels would still enter the Port at the existing drafts by light-loading; that is to not load the vessel to its most efficient capacity and thereby reduce the required channel depths. This would be similar to the no-action plan and is assumed to occur under the future without-project condition. The likely effect is to increase transportation costs due to additional transits required and resulting congestion. Larger container vessels are difficult 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. Light-loading vessels does allow for larger vessels to transit the harbor however restricts the optimal loading which may be partially loaded as is normal operating practices for container vessels.

7. Lightering Vessels

Lightering vessels is off-loading part of the cargo onto a smaller vessel outside of the

Port to allow entry into shallower ports. The reduced load of the original vessel reduces the required depth and thus allows entry into port. Both the smaller and larger vessel would enter the Port and unload there. Lightering is typically done at a designated anchorage or protected offshore area, neither of which are in close proximity to Port Everglades. This measure could increase channel efficiency and improve maneuverability so it met objective 3, but increases transportation costs due to double handing of cargo.

8. Off-Shore Petroleum

This measure would build an offshore facility for the petroleum vessels. Deeper tankers would unload oil at this platform to reduce its draft and enable entry to the Port. Tankers could possibly avoid entering port if all petroleum is unloaded at this platform. A pipe could be run along the ocean floor or micro-tunneling used to transport the petroleum to shore. Significant environmental concerns would be likely over the siting of the facility, pipeline routes, and operations. This measure meets objective 2 to decrease transportation costs, but would significantly increase landside costs and increase adverse impacts to the environment.

9. Alternative Rail

This measure was considered but discarded immediately because there is no rail infrastructure in South Florida to deliver the high volume required, therefore, this is not a feasible non-structural measure. More information on this measure is included in the **EIS** Section 2.5.

10. NOAA Ports

This measure was considered but discarded immediately as the USACE has no mechanism to require the Port or the pilots to adopt and implement PORTS. This alternative partially addresses Objective 3, 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, and as such this plan was eliminated from further detailed analysis. More information on this measure is included in the **EIS Section 2.5**.

Table 17: Structural Measures

Measures	General Description
a. Widen OEC	Widen the existing Outer Entrance Channel
b. Deepen OEC, IEC	Deepen the Outer and Inner Entrance Channel, and associated berths
c. Widen MTB	Increase Main Turning Basin footprint
d. Deepen MTB	Deepen Main Turning Basin and associated berths
e. Deepen NTB	Deepen north extension of Main Turning Basin and berths
f. Deepen STB	Deepen the western portion of the south extension of Main Turning Basin and berths
g. Widener	Deepen and widen the channel where it connects the Inner Entrance to the Southport Access Channel
h. Widen SAC	Widen the Southport Access Channel
i. Deepen SAC	Deepen the Southport Access Channel and associated berths
j. Widen TN	Widen the Turning Notch and associated berths
k. Deepen TN	Increase depth to match Southport Access Channel deepening
l. DCC TB	Create a southern turning basin at the confluence of the Dania Cut-off Canal and the Southport Access Channel
m. Widen and Deepen DCC	Widen and deepen the Dania Cut-off Canal
n. Extend North Jetty	Extension of north jetty could prevent adverse cross-currents, reduce northwest waves in the channel, and limit adverse conditions to deeper water where vessels have more maneuvering room.

4.6.2 Structural Measures

a. Widen and Extend Outer Entrance Channel (OEC)

This measure would widen and extend 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, **Figure 22**. Presently, pilots are required to line up with the

channel early and transit into the Port at increased speeds to remain aligned within the channel, as was learned during the ship simulation studies with the Pilots. Rapid deceleration of the vessel is then required for safe negotiation of the entrance jetties. Several tugs assist in stopping the vessel. To alleviate the need for potentially dangerous maneuvering for the existing and future design fleet, the OEC should first be widened to a a maximum width of 800 feet at its present outer most limit and then extended 2,200 feet offshore past the third outer reef. The extension is necessary to to achieve the required channel depth for the design fleet. It also reduces the affects of the difficult crosscurrents in this area. This measure should be combined with the Deepen OEC measure to accommodate the design vessel. The measure would increase efficiency and maneuverability for vessels, satisfying objective 3. This measure only meets objectives 1 and 2, if combined with the Widen SAC (i) and Widener (h) measures. This combination of measures would provide ample turning space for the design vessel to transit from the OEC to the SAC berths.

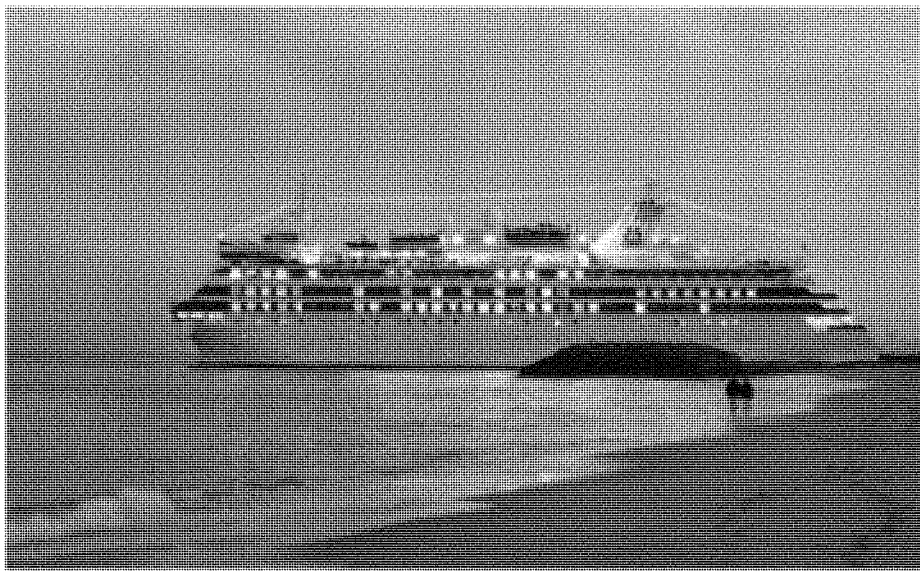

Figure 22: Radisson Diamond Cruise Vessel in the OEC (looking south)

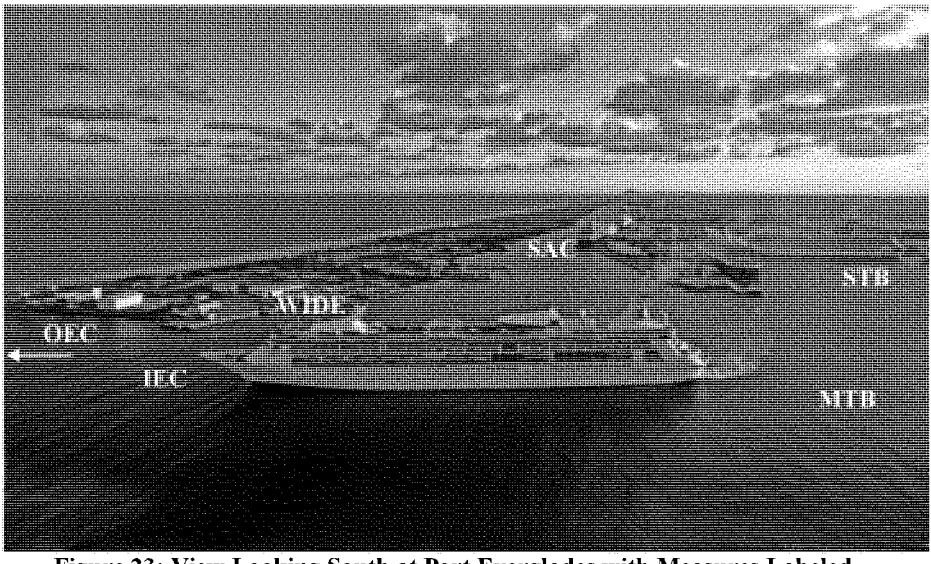

Figure 23: View Looking South at Port Everglades with Measures Labeled

b. Deepen OEC and Inner Entrance Channel (IEC)

This measure would deepen the existing outer and inner channels to allow deeper draft vessels to enter. Presently the depths in the Main Turning Basin (MTB) restrict the size of bulk carriers and draft of container ships for transit to berths in the midport and southport regions. Deeper draft vessels can carry the same cargo on fewer vessels. This reduces port congestion delays and transportation costs through economies of scale. However, this measure only meets objectives 1 and 2, if the Widen OEC, Deepen MTB and/or the Deepen SAC with Widener measure are combined with deepening of entrance channels (**Figure 23**). A deeper channel also increases vessel maneuverability; therefore, objective 3 is met.

c. Widen MTB:

This measure would eliminate some shoals adjacent to the existing turning basin. Smaller vessels would then 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 and 3, and 2 when combined with other measures.

d. Deepen MTB:

This measure would deepen the MTB and associated berths. Presently the depths in the MTB restrict the size of bulk carriers able to transit to berths in the main harbor. This measure would meet objectives 1 and 2; decreasing costs associated with vessel delays from congestion and channel passing restrictions, if combined with deepening of IEC and OEC. In addition, this measure would improve maneuverability and economies of scale when combined with these measures to meet objective 3.

e. Deepen NTB:

The deepen NTB measure is a north extension of the MTB and would be deepened for future cruise vessels. However, further research showed that the current depth of 31 feet MLLW was anticipated to be sufficient to accommodate future cruise ships. The present design depth of 31 feet in the NTB is adequate to accommodate the full draft of an Statendam (S) Class cruise ship (average length 712 feet) with an accepted underkeel clearance of 3 feet. Additionally, the existing fleet is not likely to rely on the NTB measure for additional maneuverability or expansion due to port traffic patterns and current configurations.

f. Deepen STB:

The western portion of the STB, which is the south extension off of the MTB, would be deepened under this measure. The Navy uses the eastern berths and Navy vessels do not require any additional depth over the existing condition. The existing depth is less than the MTB and the Navy's future vessels are not likely to benefit from any depth greater than the existing depth. Therefore, the depth would be equal to or less than 42 feet. Deepening would accommodate smaller container vessels and reduce congestion in the SAC. This measure may improve maneuverability by adding additional turning room that could improve maneuverability for some vessels. This measure would not induce any cost savings from economies of scale. This measure meets objectives 1 and 3. **Figure 24** shows the STB location.

g. Widener (WIDE):

This measure would remove the shoal located at the confluence of the SAC, 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 (**Figures 25** and **26**). 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 **Figure 26**. This measure would create a straighter channel which is more safe and efficient. 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 the study objectives.

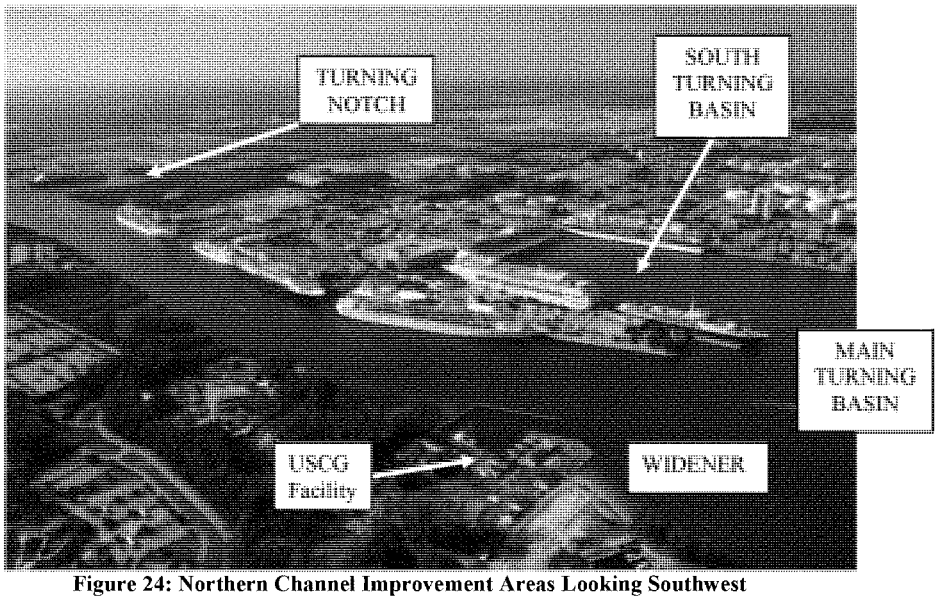

Figure 24: Northern Channel Improvement Areas Looking Southwest

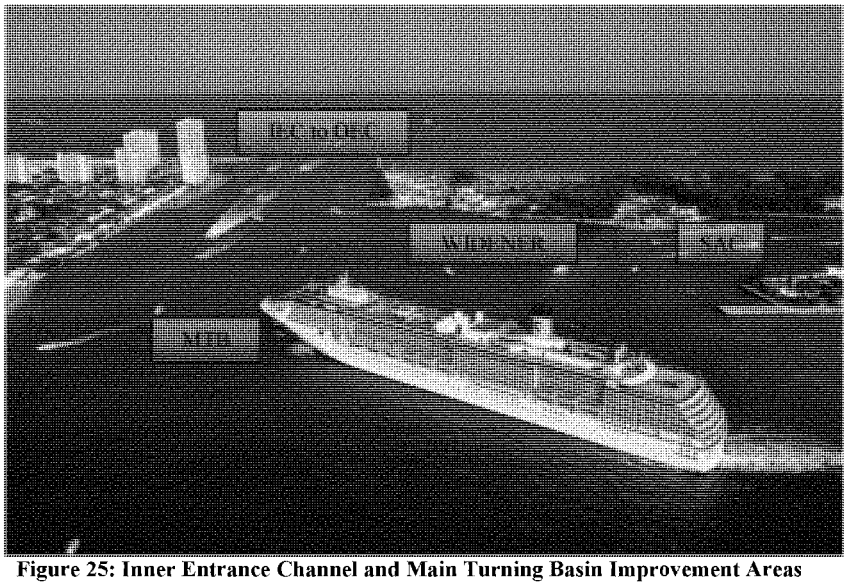

Figure 25: Inner Entrance Channel and Main Turning Basin Improvement Areas

h. Widen SAC:

Widening the SAC would allow vessels to safely transit and pass berthed vessels along the channel (**Figure 26**). It would also allow for larger vessels to safely transit and pass, which is currently a risky to nearly impossible manuever for larger vessels. Transportation costs would decrease from larger container vessels having economies of scale. Fewer vessels would 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 the study objectives when combined with other measures.

i. Deepen SAC:

Deepening the SAC 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 the Widener measure to 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 meets the study objectives when combined with other measures.

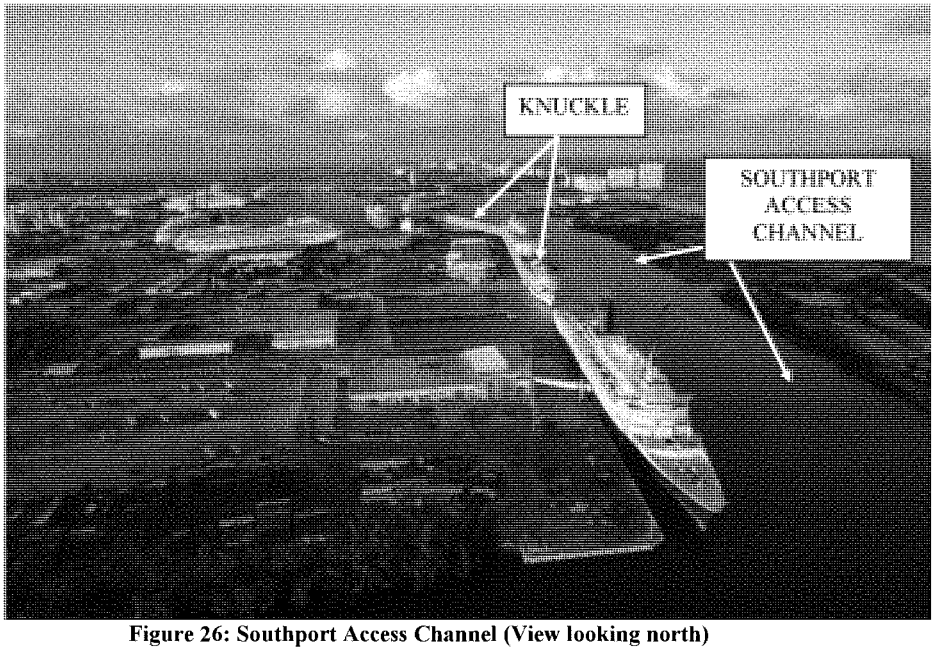

Figure 26: Southport Access Channel (View looking north)

j. Widen TN:

This measure would widen the TN to 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 when combined with the Widener, and the Widen SAC measures will more efficiently achieve the study objectives. Without the combined measures, there could still be a transportation cost savings however there may still be increased congestion and increased transit hazards. This measure meets the study objectives when combined with other measures.

k. Deepen TN:

Widening and deepening the TN to match the SAC depth when combined with the Deepen SAC measure would allow for more efficent turning of large container vessels. This measure 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 the study objectives. This measure meets the study objectives when combined with other measures.

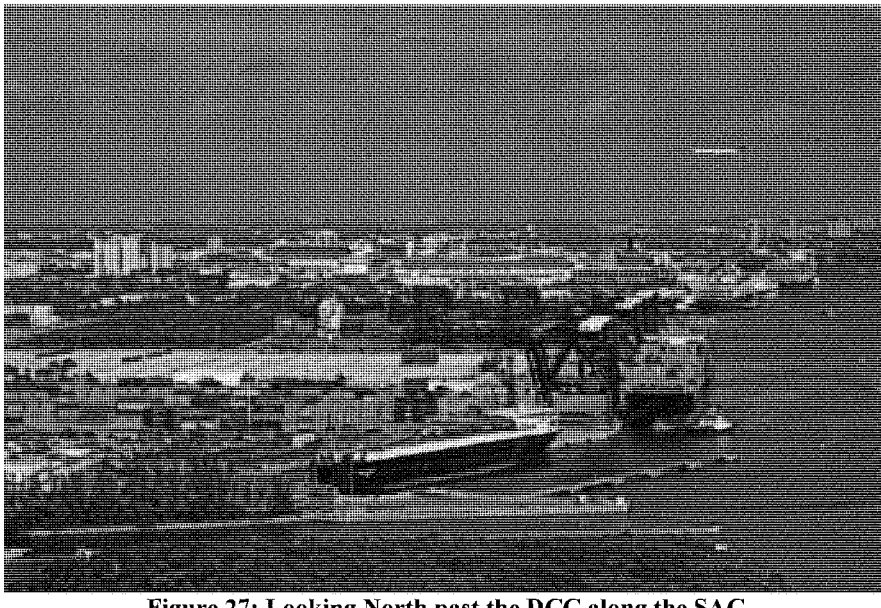

Figure 27: Looking North past the DCC along the SAC

l. DCC TB:

This measure would create a turning basin for smaller container vessels. The turning basin may improve maneuverability 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 (measure m), **Figure 27**. This measure meets objectives 1 and 3 however it does not provide sufficient NED benefits and was eliminated from further study.

m. 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 decrease congestion in other parts of the Port. Maneuverability 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, **Figure 28**. This measure meets objectives 1 and 3 however it does not provide transportation cost savings from economies of scale benefits. There are also substantial environmental concerns with this measure.

n. Extend North Jetty:

Extension of the north jetty could reduce the impact of the currents on transiting vessels , reduce northwest waves in the channel, and limit adverse conditions to deeper water where vessels have more maneuvering room. However, strong cross-currents in the Outer Entrance Channel result primarily from the proximity of the Gulf Stream/Florida Current. Migration of the current toward shore and the shedding of shoreward moving eddy currents occur at variable times and locations throughout the entire length of the OEC. There is no feasible structural alternative that can inhibit or deflect these currents, which can impact vessels over the full (1 mile +) length of the OEC. In the nearshore, extension of the jetties might have a localized impact on longshore currents, but will not affect the cross-currents that result due to the Gulf Stream/Florida Current. Longshore currents are not a significant impedance to vessel maneuverability, so a jetty extension is not a solution to the problem of vessel maneuverability. This measure does not meet the study objectives.

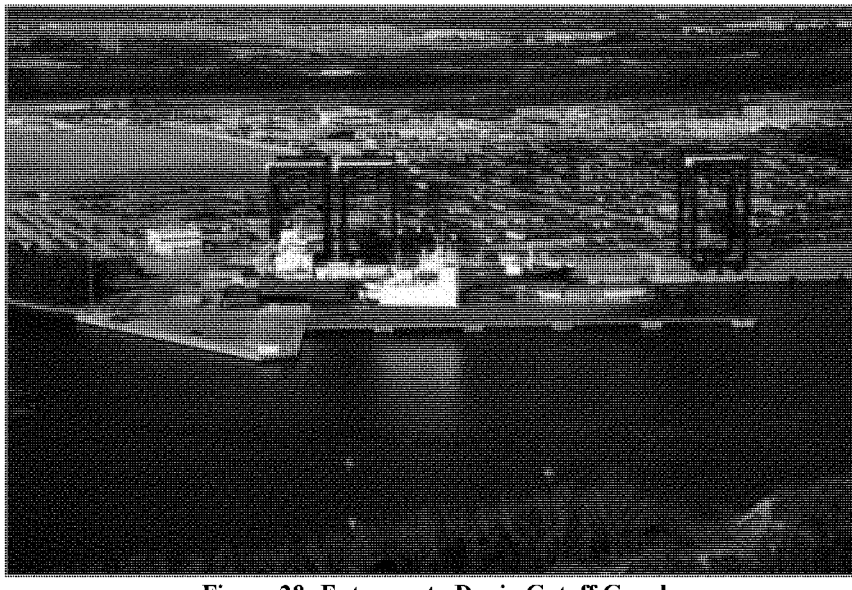

Figure 28: Entrance to Dania Cutoff Canal

Several of the non-structural measures could be combined with the structural measures to provide for more efficient navigation, however none of the non-structural measures when combined, reduced the scope of the structural improvements necessary to achieve a complete and fully functional project, per the study objectives.

4.7 Initial Screening

A wide variety of measures were considered and evaluated on their ability to meet the study objectives, as is presented in **Table 18**. Measures that met the study objectives were then evaluated based on technical, economic, and environmental criteria. Each measure was assessed and a determination made whether it should be retained in the formulation of alternative plans. Measures were then combined to form alternatives.

Table 18: Management Measure Evaluation Matrix

	Decrease costs associated with vessel delays from congestion, channel passing restrictions, and berth deficiencies? Objective 1	Decrease transportation costs through increasing economies of scale for cargo vessels? Objective 2	Increase channelmaneuverability at Port Everglades? Objective 3	Does this measure meet at least one objective? (if No = eliminated from formulation)
Non-Structural Measures				
1. No Action	No	No	No	**No**
2. Additional Tugs	No	No	No	**No**
3. Clear Berthed Vessels	No	No	No	**No**
4. Bypass Port	Yes	No	No	Yes
5. Off-loading Cargo	No	No	No	**No**
6. Light-loading Vessels	No	No	Yes	Yes
7. Lightering	No	No	Yes	Yes
8. Off-shore Petroleum	No	No	No	**No**
9. Rail	No	No	No	**No**
Structural Measures				
a. Widen OEC	Yes, when combined	Yes, when combined	Yes	Yes
b. Deepen OEC,IEC	Yes, when combined	Yes, when combined	Yes	Yes
c. Widen MTB	Yes	Yes, when combined	Yes	Yes
d. Deepen MTB	Yes, when combined	Yes, when combined	Yes, when combined	Yes, when combined
e. Deepen NTB	No	No	No	**No**
f. Deepen STB	Yes	No	Yes	Yes
g. Widener	Yes	Yes	Yes	Yes
h. Widen SAC	Yes, when combined	Yes, when combined	Yes, when combined	Yes, when combined
i. Deepen SAC	Yes, when combined	Yes, when combined	Yes, when combined	Yes, when combined
j. Widen TN	Yes, when combined	Yes, when combined	Yes, when combined	Yes, when combined
k. Deepen TN	Yes, when combined	Yes	Yes	Yes
l. Dania TB	Yes	No	Yes	Yes
m. Widen and Deepen Dania	Yes	No	Yes	Yes
n. Extend N. Jetty	No	No	No	**No**

4.8 DEVELOPING ALTERNATIVE PLANS

When meausures are combined to form the study alternatives; they must meet the following four criteria from the P&G.

Completeness: The extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
Effectiveness: The extent to which the plan contributes to achieving the planning objectives
Efficiency: The extent to which the plan is the most cost effective means of achieving the objectives
Acceptability: The extent to which the plan is acceptable in terms of applicable laws, regulations, and public policies.

4.8.1 Measures Used to Formulate Non-Structural Alternatives

As is discussed in **Section 3,** if there is no action to modify the facilities at Port Everglades, the most probable future conditions consist of the Port continuing operations under the current conditions. The OEC channel will continue to be affected by strong shore-parallel currents that combine to make entrance transit difficult for the Port Pilots. Maneuverability and passing operations will be restricted. Depths of channels and basins throughout the Port will restrict fully loaded vessel usage. Inefficient distribution of vessel types and sizes will continue to exist throughout the Port.

The no-action alternative is considered throughout the planning process. Structural and non-structural alternatives are compared to the no-action alternative. Non-structural alternatives were formulated to achieve study objectives without violating study constraints. However, non-structural alternatives do not always address the potential opportunities for future traffic, efficiency, and utilization as noted above. Specific examples include improving transit from the OEC through to Southport, developing the DCC to accommodate mid-size vessels, providing additional berthing and turning capabilities in the TN, and accommodation of larger generation cruise vessels. These improvements cannot be achieved with non-structural measures. Mid-size vessels (approximately 500 feet in length overall (LOA), draft >20 feet) cannot transit into the DCC which can only accommodate smaller vessels (200 feet LOA vessels with a draft <10 feet) without structural improvements. These improvements are not being implemented therefore the DCC was eliminated from further study. Similarly, cruise vessels cannot utilize facilities without sufficient basin depth, and accommodation of additional berthing and/or turning capabilities within the TN cannot occur without structural improvements. Four of the non-structural measures (1, 4, 6, 7) as outlined in Table 18 were carried forward and evaluated. Other non-structural measures were eliminated due to not meeting any of the study objectives.

<u>Measure NS-1: No-Action</u>

There are no benefits under this plan and the no action alternative. Under the no-action alternative vessels would continue to be constrained by the existing channel depth and width. **The no-action alternative is not recommended however, the no-action alternative must be carried through the analysis for comparison purposes.**

<u>Measure NS-4: Bypass Port</u>
Importing commodities to another port and then trucking to original destinations increases total transportation costs, **Measure NS-4 was eliminated**.

<u>Measure NS-6: Light-loading Vessels</u>
Light-loading vessels does allow for larger vessels to transit Port Everglades, light loading when combined with widening measures was carried forward, **Measure NS-6 Light-Loading Vessels was carried forward for consideration when combined with other structural measures**.

Measure NS-7: Lightering Vessels
Lightering increases total transportation costs due to a second cargo handling and use of an additional vessel, **Measure NS-7 was eliminated**.

4.8.2 Measures Used to Formulate Structural Alternatives

Twelve structural measures were carried through initial screening; these measures are used to form the structural alternatives. The following structural measures were retained during the intermediate plan formulation process for the reasons outlined below.

Measure S-a: Widen OEC
Currents in the OEC are a hazard to the existing and future fleet. The flared widening of the OEC allows pilots to safely line up in the channel while transiting through the reefs. The widening also allows for more room when vessels are crabbing. **S-a is carried forward**.

Measure S-b: Deepen OEC, IEC
The design vessel (S-Class) needs additional depth in both the OEC and IEC. Vessels must speed up to navigate the currents and eddies around the OEC; this causes the vessels to squat and require a deeper underkeel clearance. Underkeel clearance requirements for each of the Port Everglades project components are discussed in detail in Engineering **Appendix A Section 3.4.11**. **S-b is carried forward**.

Measure S-c: Widen MTB
Widening the MTB increases efficiency and maneuverability of the vessels in the turning basin and allows smaller vessels to transit past turning vessels. **S-c is carried forward**.

Measure S-d: Deepen MTB
Additional depth is needed for liquid bulk vessels to get to berths 7-15 and to bring the design vessel to berth 31/32. Of note: The Northern Turning Basin (NTB) portion was eliminated as it is only used for cruise operations and has sufficient depth. **S-d is carried forward but must be combined with additional measures**.

Measure S-f: Deepen STB
This deepening allows for a fully loaded design vessel to turn here. Only a partial cut is needed for maneuverability. **The STB was originally carried forward in combination with the MTB however it was later eliminated due to lack of benefits.**

Measure S-g: Widener
A safer, wider turning radius in this area reduces congestion by allowing smaller vessels to transit past larger vessels. **S-g is carried forward.**

Measure S-h: Widen SAC
A widened SAC allows the S-Class container design vessel to transit past berthing cruise ships and berth at 30, 31, and 32. The widening is designed to minimize environmental impacts. **S-h is carried forward.**

Measure S-i: Deepen SAC
Deepening is needed for the design vessel to transit the SAC. **S-i is carried forward.**

Measure S-j: Widen TN
Widening the TN allows the design vessel to berth in the TN and turn in the TN to berth at 31/32. **S-j is carried forward.** *This was combined with S-k to become a sponsor measure "S_TN" and is included in the existing condition to match to sponsor's Port Master Plan.

Measure S-k: Deepen TN
Deepening the TN allows the design vessel to berth in the TN and turn in the TN to berth at 31/32. **S-k is carried forward.*** This was combined with S-j to become a sponsor measure "S_TN" and is included in the existing condition to match to sponsor's Port Master Plan. Both measures S-j and S-k were added later as the non-federal sponsor moved forward with plans to deepen the Turning Notch, which is currently underway.

Measure S-l: DCC TB
This TB is needed to accommodate the panamax class vessel "Bellatrix" to berth in the DCC. **S-l was originally carried forward but later eliminated as the DCC was eliminated from further study due to lack of benefits.**

Measure S-m: Widen and Deepen DCC
This is needed to accommodate the panamax class vessel "Bellatrix" to berth in the DCC. Deepening in the DCC does not offer benefits to larger vessels; panamax vessels can already transit the harbor. Therefore there is no added national economic benefit to deepen this area. **S-m was originally carried forward but later eliminated as the DCC was eliminated from further study due to lack of benefits.**

4.9 Evaluation of Intermediate Plans

The final measures are combined to form intermediate plans, and ultimately the NED Plan. The plan that reasonably maximizes net benefits while being consistent with protecting the nation's environment is the NED plan. If two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan. Environmental impacts were avoided or minimized to the extent practicable. Where unavoidable impacts occurred, mitigation is proposed. The **EIS** addresses in greater detail study objectives from **Table 15**.

4.9.1 Non-Structural Plan Screening

No-Action Plan: The no-action plan is not recommended as there are no NED benefits with this plan however structural and non-structural plans are compared to the no-action plan.

4.9.2 Structural Plan Screening

Structural measures were refined to determine recommendations in each segment of the channel. The Outer Entrance Channel, Inner Entrance Channel, Main Turning Basin, Southport Access Channel, and the Turning Notch were evaluated further to determine the optimal footprint for navigation improvements as follows.

Outer Entrance Channel (OEC) and Inner Entrance Channel (IEC) (measures S-a and S-b)

Under conditions of strong, variable currents, the 500 foot OEC presents a hazard to both the existing and future design fleet. Presently, Pilots are required to line up with the channel before the outer marker and bring vessels in at high speed to maintain a straight course. Rapid deceleration of the vessel is then required for safe negotiation of the entrance jetties. As determined by ship simulation; to alleviate the need for potentially dangerous maneuvering for the existing and future design fleet, the OEC requires lengthening as well as widening of the seaward end of the channel. By extending and expanding the outer end of the existing channel and then tapering evenly over a distance back to the original design width, a "flare" is created. The flared entrance allows the vessel room to maneuver in the presence of strong currents while still maintaining safe speeds when lining up to the entrance channel.

Prior to determining the final dimensions and alignment as described above and to further minimize impacts to the third reef, several alignments for the OEC were considered. The proposed configurations included two "dogleg" turns at the seaward end of the channel and two alignments that would make use of natural gaps in the outermost reef tract. The latter would require vessels to transit between the second and third reefs until reaching the existing entrance channel location. Navigation concerns were raised due to the sharp turns, adjacent reefs, and strong cross-currents. Navigation and environmental concerns were raised, associated with impacting the adjacent reef tracts during transit and security issues were raised by the USCG, the U.S. Navy, and the Port Everglades Pilot Association. Therefore, the four alternative alignments were removed from consideration and the flare alignment was recommended. Refer to **Engineering Appendix A, Section 3.4.2.3** for additional details.

The OEC is recommended to be extended in a flare alignment, widened and deepened to allow for larger vessels to transit Port Everglades under the with-project condition. Included for recommendation is the deepening of the Inner Entrance Channel (IEC) that connects the OEC to the MTB.

Main Turning Basin (MTB) (measures S-c and S-d)
Deepening the MTB would accommodate both the turning of S-Class design vessels and to provide additional depth for the Aframax design vessel. Originally, ship simulation resulted in a preliminary design to deepened only a portion of the existing authorized footprint, based on the turning requirements of the "S Class" container vessel. However, consultation with the Port Everglades Pilots determined that while the reduced MTB footprint would technically allow for vessel turning it generated significant risks to vessel safety. Specifically the reduced footprint did not allow adequate room to slow or turn a vessel in the event of tug failure. This scenario has occurred in the past at Port Everglades and would result in significant vessel damage and possible risk to human life if it occurred with a deep draft vessel in the confines of the proposed turning area. The sharp difference in depth between the deeper proposed turning area and the surrounding 42 foot existing depth also has the potential of creating hydraulic conditions that would make vessel maneuvering difficult and unpredictable. Based on these concerns two additional alternatives were proposed, an extension of the turning area to the western existing Federal limits with a small "flare" to the south and an extension to the west with "flares" to both the south and the north.

While the expansion of the turning area and the addition of flares alleviated some concerns regarding emergency maneuvering, the potential for difficult and unpredictable vessel handling due to the depth differences in the confined turning area could not be eliminated. Of particular concern was the proximity of the depth transition (essentially a vertical rock shelf) to the oil tanker slips at the west end of the MTB. A small course deviation, resulting in impact with the shelf could result in serious environmental consequences. Therefore, in coordination with the Port Everglades Pilots, deepening of the MTB is recommended for the existing MTB footprint, additional details are in **Engineering Appendix A Section 3.4 and Engineering Sub-Appendix A**.

Southport Access Channel (SAC) (measures S-h and S-i)
Six initial designs were developed for the SAC to address transit of the S-Class Post-Panamax vessels from the MTB to berths 30 – 32. Initial screening and ship simulation of the six component designs resulted in elimination of all but one design. Eliminations were also made due to significant environmental impacts including the removal of land in the John U. Lloyd State Park (designs 2 – 4) and excessive impacts to Port infrastructure and adjacent cargo/passenger facilities (alternative components 5 and 6). South of the knuckle bend, in the general area of berths 26-29, the channel would be shifted to alleviate restrictions due to non-Federal berths. The cost of this shift is included in the berthing area dredging costs which are 100% non-federal. Details of these six component designs can be found in the **Engineering Appendix A, Section 3.4.8**.

The SAC is recommended for widening and deepening to allow for larger vessels to transit Port Everglades under the with-project condition.

Turning Notch (TN) (measures S-j and S-k)
Originally, expansion of the TN was investigated as two separate alternatives, a "Turning Only" alternative that included only those modifications necessary to turn the S-Class

vessel (widening along the east and west SAC) and a "Turning and Berthing" alternative that included a 400-foot expansion of the TN to the west plus the additional widening along the SAC. However, during the course of the study, the sponsor made the decision to proceed with expansion of the existing TN to a 2,400-foot dimension. The Port's expansion of the TN (to a depth of 42 feet MLLW) is currently under design and is included in the future without-project condition. Widening the SAC to the north and east of the TN, to accommodate vessel turning, as well as deepening the expanded 400 foot portion of the TN will remain components for further plan formulation analysis.

The TN is recommended for deepening with minor widening to allow for larger vessels to transit and turn in the SAC under the with-project condition.

Widener (WIDE) (measure S-g)

A widener is required in the area of the USCG current facility. This widener is required for larger vessels to transit Port Everglades from the Inner Entrance Channel to the Southport Access Channel. The study team has extensively coordinated with the USCG staff located at the Fort Lauderdale Station and USCG District 7 and they continue to remain involved. Extensive effort has been made to coordinate with the U.S. Navy through additional meetings and correspondence. U.S. Navy staff from Naval SurfaceWarfare and NAVFAC Engineering Division have participated. Specifically, design of the Widener has been coordinated with the U.S. Navy. Coordination with the USCG and U.S. Navy will continue during the design phase.

The Widener is recommended for widening and deepening to allow for vessels to transit under the with-project condition.

4.10 FINAL ARRAY OF PLANS

The selection of the structural measures uses a combination of planning objectives and goals to form plans for economic analyses and final plan selection. The structural measures are grouped together in various combinations to specific plans. **Table 19** shows how the structural measures were combined into these various alternative plans and how they match with the study objectives. The plans were also matched with the benefiting fleet to determine what combination would offer the maximum benefits and thus the recommended channel segments for deepening and widening.

The structural measures were grouped into six different plans based on structural characteristics, environmental impacts, and economic channel segments.

- *Plan 1* allows for benefits from petroleum vessels
- *Plan 2* allows for benefits from larger container vessels, which incidently provides benefits from larger petroleum vessels
- *Plan 3* allows for additional berthing capacity to improve navigation at the port through relocating fleets without impacting other environmentally sensitive areas

- *Plan 4* provides for more operational efficiency in the MTB with minimized environmental impact
- *Plan 5* allows for benefits from larger container vessels, which incidently provides benefits from larger petroleum vessels and provides more efficient operations at the port, and
- *Plan 6* allows for light-loaded Post-Panamax container vessels to transit with a lesser impact on environmentally sensitive areas.

Table 19: Combining Structural Measures

	Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB), South Turning Basin (STB), Widener (WIDE), Sandspur Access Channel (SAC), Turning Notch (TN), Sandspur Turning Notch (S-TN), Dames Point Canal (DCX)
☆	*Plan 1A – OEC, IEC, MTB*
☾	*Plan 1B – OEC, IEC, MTB, STB*
☆	*Plan 2A – OEC, IEC, MTB*
	Plan 2B – OEC, IEC, MTB, WIDE, SAC
	Plan 2C – OEC, IEC, MTB, WIDE, SAC, TN (berth&turn)
	Plan 2D – OEC, IEC, MTB, WIDE, SAC, TN (turn only)
	Plan 2E – OEC, IEC, MTB, WIDE, SAC, S-TN (berth&turn)
	Plan 3A – DCX
	Plan 4A – STB
☆	*Plan 5A – OEC, IEC, MTB*
☾	*Plan 5B – OEC, IEC, MTB, STB*
	Plan 5C – OEC, IEC, MTB, WIDE, SAC, STB
	Plan 5D – OEC, IEC, MTB, WIDE, SAC, STB, TN (berth&turn)
	Plan 5E – OEC, IEC, MTB, WIDE, SAC, STB, TN (berth&turn), DCX
	Plan 5F – OEC, IEC, MTB, WIDE, SAC, STB, TN (turn only)
	Plan 5G – OEC, IEC, MTB, WIDE, SAC, STB, TN (turn only), DCX
	Plan 6A – WIDE
	Plan 6B – OEC, WIDE, SAC
	Plan 6C – OEC, WIDE, SAC, TN (berth&turn)
	Plan 6D – OEC, WIDE, SAC, TN (berth&turn), DCX
	Plan 6E – OEC, WIDE, SAC, TN (turn only)
	Plan 6F – OEC, WIDE, SAC, TN (turn only), DCX

☆ Note the Plans with the same combination of measures-these are considered one feasible alternative.
☾ Note same as above.

Table 20: Proposed Combinations of Measures for Structural Plans

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, IEC	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 has no deep draft deepening of the harbor for accommodation of Post-Panamax vessels. Plans 1-5 examine the existing and greater depths incrementally.						

Table 20 outlines the project measures combined into the six economic alternative plans (Plans 1 – 6). The six plans were then subjected to incremental justification and consisted of plan levels of incremental measures A through G. These plans represent the additional measures combined. At each level an additional measure was added. This resulted in 18 different feasible combinations of measures. For each of the plans, an incremental optimization of the depth was performed to determine at which depth the greatest net benefits from lower costs per unit good were achieved, and/or the improved port operational efficiency achieved. In addition, a harbor widening simulation and delay time savings is conducted for each of the feasible alternatives.

Figures 29 through **34** show plans with proposed measures. While each plan was developed to address the study objectives, incremental optimization of the plans resulted in some plans in the final array being identical due to the fact certain structural features address multiple objectives.

Alternative Plans 1 through 6

Plan 1: This plan addresses petroluem vessel access to slips 1, 2 and 3 located adjacent to the MTB by creating opportunities for improving vessel efficiency at greater depth. This plan is broken down into two plan levels of incremental measures A and B.

PORT EVERGLADES Alternative Plans 1A and 1B

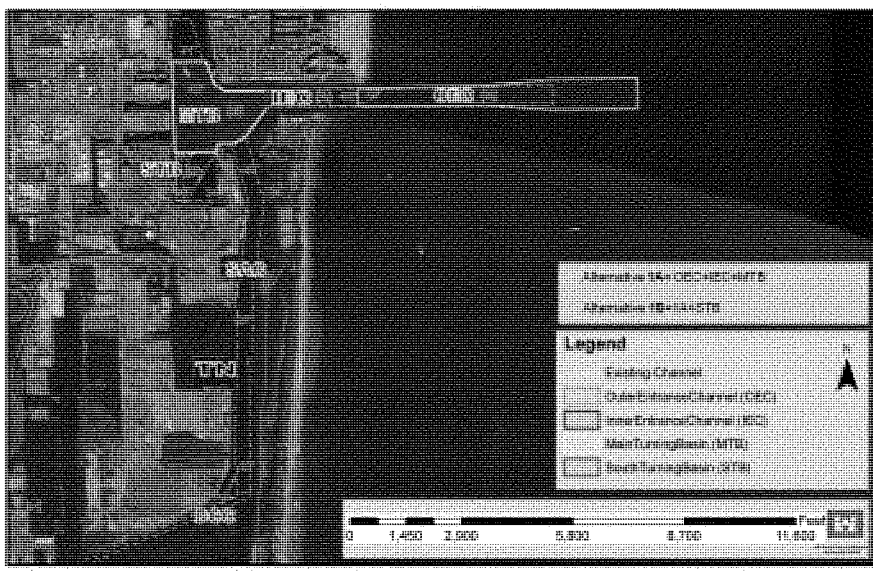

Figure 29: Alternative Plans 1A and 1B

Plan 1A: This plan would analyze depths incrementally from existing 45 ft to 57 feet in the OEC, and from existing 42 to 50 feet in the IEC and MTB to allow deeper draft tankers to safely transit through the harbor. Depth will be optimized to achieve the greatest net benefits by analyzing one foot increments. It is assumed that the Port will deepen the connecting berths to the optimized USACE project depth.

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

Plan 1B: This plan expands from plan 1A to include an incremental analysis of deepening the South Turning Basin. This plan would analyze depths in the STB from 31 feet to 45 feet. This plan would improve port operating efficiency. Deeper draft vessels could use this area for additional turning room or to reduce congestion in the MTB.

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

Deepen adjacent berths
Deepen the South Turning Basin

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 efficiency of navigation.

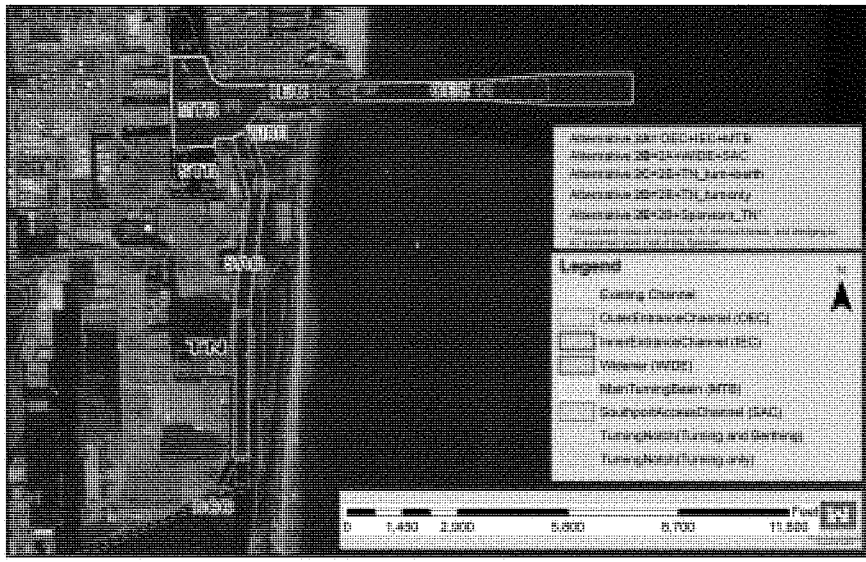

Figure 30: Alternative Plans 2A, 2B, 2C, 2D, and 2E

Plan 2A: This combination of measures is the same as Plan 1A.

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 WIDE and SAC measures. This Plan analyzes incremental depths in the SAC and the WIDE from 42 to 50 feet.

Structural Improvement:
Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
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 improve maneuverability 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 depths incrementally from 42 to 50 feet in the TN. The TN is important to fully realize all potential benefits for container vessels. This measure would allow Post-Panamax container vessels to berth and turn in Southport.

Structural Improvement:
Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
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 takes an element away from Plan 2C. Plan 2D includes only deepening of the TN, analyzing depths incrementally from 42 to 50 feet and not expanding the width of the TN.

Structural Improvement:
Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
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 Sponsor's intent to expand the TN as a future without-project condition. Therefore this plan examines deepening the 400 foot widened portion of the TN and the existing TN footprint from a future without project depth of 42 feet, in addition to the widening increments in the SAC. Depths will be analyzed incrementally from 42 to 50 feet. Plan 2E includes deepening the TN footprint (including the expanded portion that is currently under design).

Structural Improvement:
Widen and deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
Widener measure

Widen and deepen the Southport Access Channel
Sponsor widens and deepens a 400 ft portion of the Turning Notch
Deepen existing and sponsor expanded portion of the TN
Additional widening and deepening of the Southport Access Channel to allow turning

Plan 3: This plan would improve port operational efficiency and create additional berthing areas.

Plan 3A: Plan 3A would optimize the DCC depth at the point where benefits from efficiency are the greatest. Depths analyzed will be in one foot increments ranging from 11 to 34 feet. This plan does not reduce the cost per unit good, but it relocates some of the existing fleet to increase berth space and port efficiency overall. The DCC was later eliminated from further study as the benefits are not significant, as is discussed in Section 5.4.

Structural Change:
Widen and Deepen the Dania Cut-off Canal
Create through Widening and Deepening the Dania Cut-off Turning Basin
Create Berths

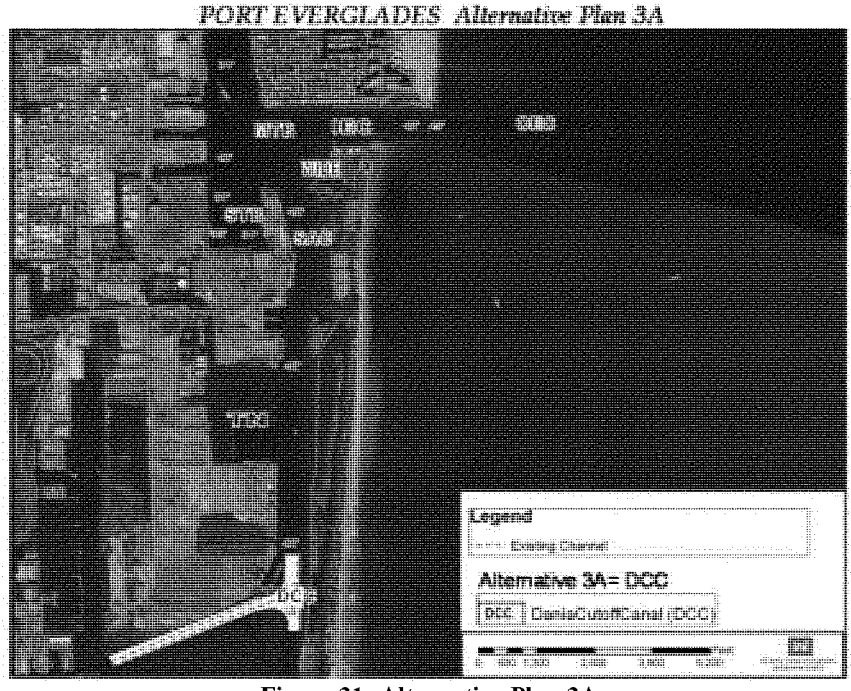

Figure 31: Alternative Plan 3A

Plan 4: This plan would improve port operational efficiency and create additional berthing areas.

Plan 4A: This plan includes deepening the STB, and would analyze incremental depths from 31 feet to the 45 feet. Deeper draft vessels could use this area for additional turning room to reduce congestion in the MTB.

Structural Improvement:

Deepen the South Turning Basin

Deepen adjacent berths

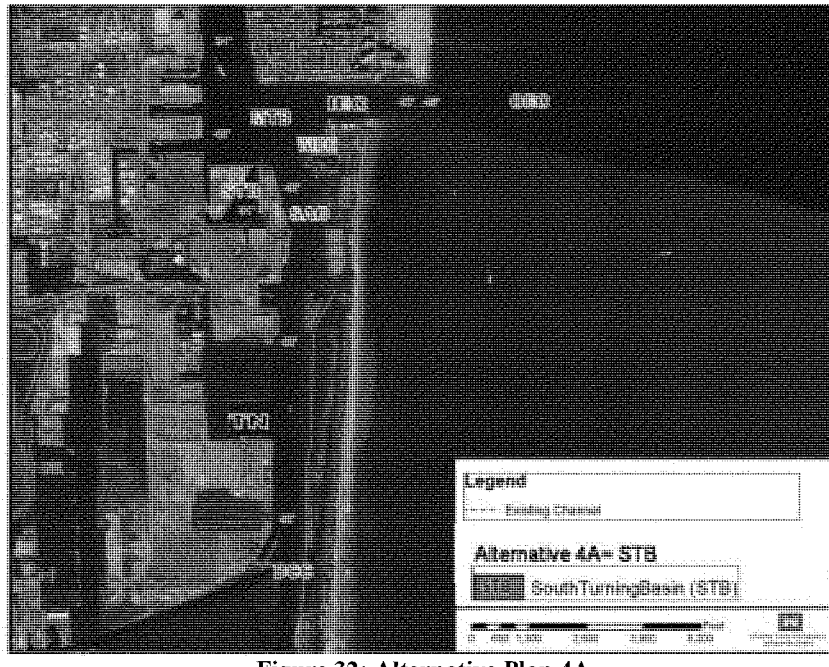

Figure 32: Alternative Plan 4A

Plan 5: This plan would resolve problems and create opportunities by allowing deeper draft petroleum and container vessels to enter the Port while improving navigation efficiency. The main differencees between the array of alternatives in Plan 5 and Plan 2 is the incorporation of the STB and the DCC into Plan 5's array.

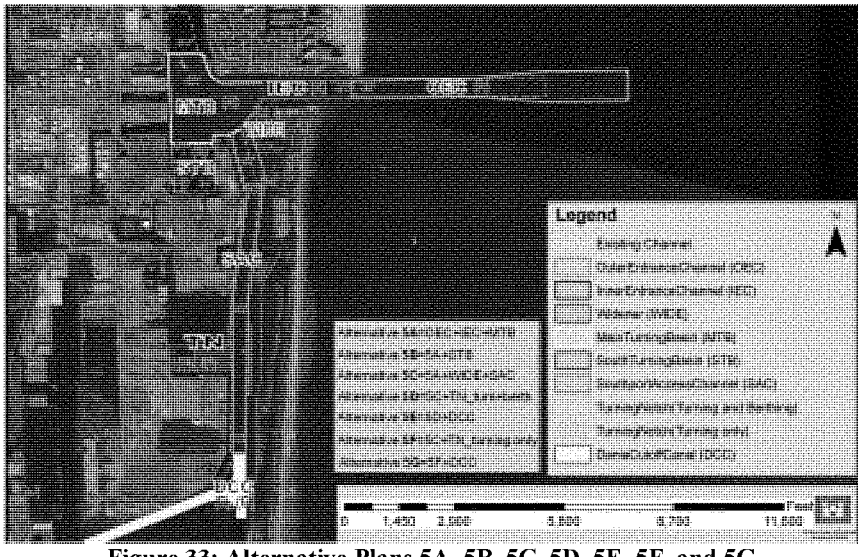

Figure 33: Alternative Plans 5A, 5B, 5C, 5D, 5E, 5F, and 5G

Plan 5A: This contains the same combination of measures as Plan 1A and 2A.

Plan 5B: This contains the same measures as Plan 1B.

Plan 5C: This plan expands on Plan 5B and would accommodate Post-Panamax container vessels that could not transit the Port under the without-project condition. This plan will allow deeper draft container vessels to transit thus decreasing the unit cost per good. Depths from 42 feet to 50 feet were analyzed at one-foot increments in the SAC and the WIDE. Post-Panamax container vessels would be required to turn in the MTB and use only one berth without plan 5C which could cause congestion and delays.

Structural Improvements:

Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
Deepen the South Turning Basin
Widener measure
Widen and Deepen the Southport Access Channel

Plan 5D: This plan expands on Plan 5C and involves the widening and deepening of the TN. Incremental depth analysis was conducted in the TN from 42 to 50 feet. This plan is important to fully realize all potential benefits for container vessels. Post-Panamax containers vessels and others transiting

the SAC would transit more efficiently. This component would allow Post-Panamax container vessels to berth and turn in Southport which could not be done without this change.

Structural Improvements:

Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
Deepen the South Turning Basin
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 5E: This plan expands on Plan 5D and would optimize the DCC depth at the point where benefits from efficiency are the greatest. Depths analyzed are in one foot increments from 11 to 34 feet. This plan does not reduce the cost per unit good, but it relocates some of the existing fleet to increase berth space and port efficiency overall. The DCC was later eliminated from further study as the benefits are not significant, as discussed in Section 5.4.

Structural Improvements:

Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
Deepen the South Turning Basin
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
Widen and Deepen the Dania Cut-off Canal
Create through Widening and Deepening the Dania Cut-off Turning Basin
Create and deepen Berths

Plan 5F: Plan 5F involves deepening the TN, and therefore is an added increment from 5C. Incremental depth analysis was conducted in the TN from 42 to 50 feet. This plan is important to fully realize all potential benefits for container vessels. Post-Panamax containers vessels and others transiting the SAC would transit more efficiently. This plan would allow Post-Panamax container Vessels to berth and turn in Southport which could not be done without this change.

Structural Improvement:

Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
Deepen the South Turning Basin
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 5G: This plan expands on Plan 5F. Plan 5G would optimize the DCC depth at the point where benefits from efficiency are the greatest. Depths analyzed will be in one foot increments from 11 to 34 feet. This plan does not reduce the cost per unit good, but it relocates some of the existing fleet to increase berth space and port efficiency overall. The DCC was later eliminated from further study as the benefits are not significant, as discussed in Section 5.4.

Structural Improvement:

Widen and Deepen the Outer entrance channel
Deepen the Inner Entrance Channel
Deepen the Main Turning Basin
Deepen adjacent berths
Deepen the South Turning Basin
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
Widen and Deepen the Dania Cut-off Canal

Plan 6: This plan would require Post-Panamax container vessels to enter the Port light-loaded and use the existing depth at Port Everglades. This plan would reduce the environmental impacts compared to other plans as it avoids impacts to offshore reefs by avoiding additional deepening in the OEC.

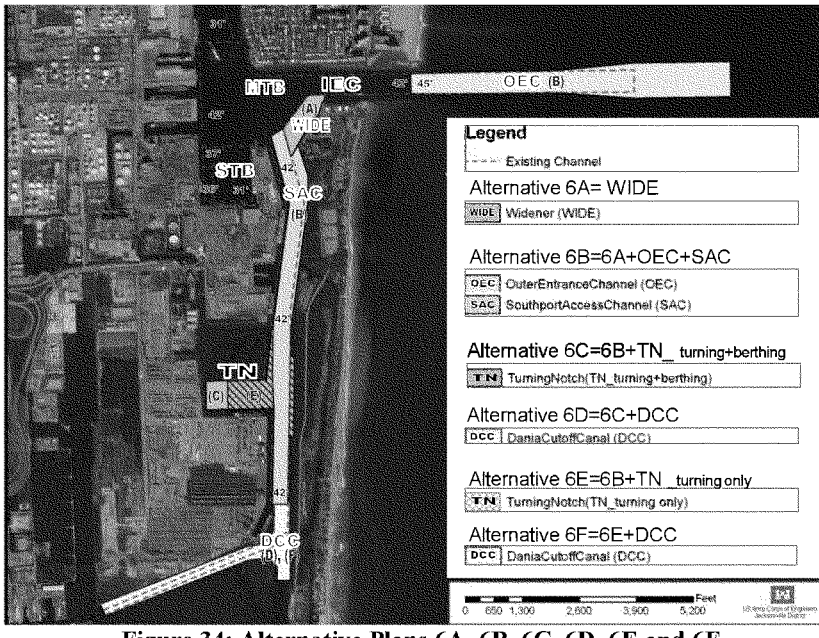

Figure 34: Alternative Plans 6A, 6B, 6C, 6D, 6E and 6F

Plan 6A: This plan would improve the maneuverability and efficiency of the existing fleet and does not involve deepening beyond the existing 42 foot channel depth.

Structural Improvement:
Widen the Widener measure

Plan 6B: This plan is the next added increment to Plan 6A and involves the widening of the OEC and the SAC. This plan would accommodate Post-Panamax container vessels drafting less than or equal to 39 feet (to allow for 3 feet of underkeel clearance) that could not transit without this change. This plan will allow the project's container design vessel to transit potentially light loaded, which would decrease the unit cost per good.

Structural Improvement:
Widen the Widener measure
Widen the Outer Entrance Channel
Widen the Southport Access Channel

Plan 6C: This plan is important to fully realize all potential benefits for light-loaded Post-Panamax container vessels and expands on Plan 6B to include the widening of the TN. Benefits are predicated on delay time savings, and depths are assumed current existing conditions for the OEC, SAC, and the TN.

Vessels will benefit from the more efficient passage and safer passing distances, thus improving transit times. This component would allow light-loaded Post-Panamax container vessels to berth and turn in Southport which could not be done without this change.

Structural Improvement:
Widen the Widener measure
Widen the Outer Entrance Channel
Widen the Southport Access Channel
Widen the Turning Notch
Additional Widening of the Southport Access Channel to allow turning

Plan 6D: This plan expands upon Plan 6C and would optimize the DCC depth at the point where benefits from efficiency are the greatest. Depths analyzed will be analyzed in one foot increments from 11 to 34 feet. This plan does not reduce the cost per unit good, but it relocates some of the existing fleet to increase berth space and port efficiency. The DCC was later eliminated from further study as the benefits are not significant, as discussed in Section 5.4.

Structural Improvement:
Widen the Widener measure
Widen the Outer Entrance Channel
Widen the Southport Access Channel
Widen the Turning Notch
Additional Widening of the Southport Access Channel to allow turning
Widen and Deepen the Dania Cut-off Canal
Create the Dania Cut-off Turning Basin
Create Berths

Plan 6E: This plan expands upon Plan 6B and would accommodate Post-Panamax container vessels drafting less than or equal to 39 feet that could not transit without this change. This plan will allow the container design vessel to transit potentially light loaded, which would decrease the unit cost per good. This measure would allow light loaded Post-Panamax container vessels to berth and turn in Southport.

Structural Improvement:
Widen the Widener measure
Widen the Outer Entrance Channel
Widen the Southport Access Channel
Additional widening and deepening of the Southport Access Channel to allow turning in the TN

Plan 6F: This plan expands upon Plan 6D and would accommodate Post-Panamax container vessels drafting less than or equal to 39 feet that could not transit without this change. This plan would optimize the DCC depth at the point where benefits from efficiency are the greatest. Depths analyzed are in one foot increments from 11 to 34 feet. This plan does not reduce the cost per unit good, but it relocates some of the existing fleet to increase berth space and port efficiency. The DCC was later eliminated from further study as the benefits are not significant, as discussed in Section 5.4.

Structural Improvement:
Widen the Widener measure
Widen the Outer Entrance Channel
Widen the Southport Access Channel
Additional widening and deepening of the Southport Access Channel to allow turning in the TN
Widen and Deepen the Dania Cut-off Canal
Create the Dania Cut-off Turning Basin
Create Berths

Plan 1 focused on solutions for petroleum vessel constraints. *Plan 2* focused on container ship constraints (which incidentally solves the petroleum vessel constraints). *Plan 3* focused on increasing the number of berths and improving port operations by relocating fleets without impacting environmentally sensitive areas. *Plan 4* focused on improving operational efficiency in the Main Turning Basin while minimizing environmental impacts. *Plan 5* focused on solutions for all of the Port constraints and creating opportunities for efficiencies. *Plan 6* focused on accommodating light-loaded Post-Panamax container vessels and reduced impacts on environmentally sensitive areas.

5.0 EVALUATION OF ALTERNATIVE PLANS

National Economic Development (NED) benefits were assessed following the methodology for deep draft commercial navigation analysis described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, and other relevant USACE analyses and policy guidance.

The benefits estimated for the separable elements of each alternative were compared to their cost to determine their economic justification. The plan that reasonably maximizes net benefits (benefits less costs) is the National Economic Development (NED) Plan. If there are two cost-effective plans that produce no significantly different levels of net benefits; the less costly plan is to be the NED plan.

The two primary benefiting vessel types of the self-propelled deep-draft fleet are Aframax tankers and Post-Panamax container vessels. The tanker fleet benefits mainly from greater channel depths, whereas the container fleet benefits from both greater depth and improvements to access to Southport via the Southport Access Channel (SAC). In addition, cruise vessels will benefit from reduced congestion and wait times at the "knuckle" (berths 24-27). Vessels will also experience reduced congestion within the harbor due to fewer overall vessel calls under the with-project condition.

The benefits that were considered in the economic analysis were transportation cost savings benefits that result from (1) the vessels being able to carry more cargo, which applies to deepening benefits, and (2) delay reduction or time savings benefits due to increased vessel maneuverability and removal of transit time restrictions which applies to widening benefits.

5.1 VESSEL UTILIZATION SAVINGS (DEEPENING BENEFITS)

Deepening benefits affect the containership fleet and petroleum tanker fleet. Large Panamax vessels and future Post-Panamax vessels transiting the Trans-Atlantic and North-South global trade routes are the key benefitting containership classes. Foreign-flagged petroleum tankers will transition to larger Aframax tankers. Refer to the **Economic Appendix B** for further detailed analysis. Older, smaller Sub-Panamax vessels that serve the regional Caribbean basin trade are not expected to expand sufficiently in size to require channel deepening. The benefits for container vessels are computed on three size categories: Panamax 2 (4800 TEU average capacity), Post-Panamax Generation 1 (6500 TEU average capacity), and Post-Panamax Generation 2 (8000 TEU average capacity).[4] Panamax 2 and Post-Panamax Generation 1 vessels currently transit the harbor under restricted conditions.

Under with-project conditions, it is predicted that the vessels which can benefit from

[4] **Post-Panamax Generation 2 vessels can range from 8,000 to 10,000 TEUs. This Post-Panamax Generation 2 vessel is a representation from this range.**

channel deepening will carry more cargo and/or make fewer vessels trips. In the initial screening-level economic assessment, Panamax 2 and Post-Panamax 1 vessels were assumed to transfer an average of 8,000 tons/call (based on averaged 800 TEUs transferred and 10 tons/TEU). Post-Panamax-2 vessels are estimated to transfer 10,000 tons/call. To date, the largest container vessel to call on the harbor is of the Post-Panamax Generation I vessel class. Deepening will allow for a greater share of Post-Panamax vessels as these vessels become more prominent in the world fleet. By the base year, 2023, approximately 26% of container vessel calls at Port Everglades will be Post-Panamax vessels. By 2030, that percentage is anticipated to increase to 31% and continues to increase throughout the 50-year period of analysis with containerized cargo. With each foot of increased depth at Port Everglades, the costs per containership increase as more cargo is moved per call. However, the gross cargo volume increases at a greater rate than the increased voyage related costs, resulting in a lower cost per TEU transported and fewer ships required to deliver the same total volume of cargo to the Port which is the primary source of the deepening benefits.

5.2 Vessel Delay Reduction Benefits (Widening Benefits)

The proposed improvement alternatives are necessary to accommodate the expected future fleet at Port Everglades. Cruise ships do not benefit from channel deepening, they do benefit from the widening components. The proposed alternatives will reduce delays resulting from berthing capacity constraints and traffic restrictions and reduce transportation costs (note: cruise ships and Navy vessels have priority berthing and pilotage because of tight schedules, as such, they do not experience as significant delays as cargo ships). Commercial cargo vessels, regardless of size, experience vessel delays, and therefore could benefit from widening of channels and turning basins or similar improvements that result in improved maneuverability and reduced transit times.

5.3 Incremental Analysis

Navigation benefits are computed in the form of transportation cost savings due to reduced congestion and more efficient use of vessels through deepening. In the initial screening level economic assessment, transportation costs for the without and with project conditions were estimated in one-foot increments to compute the NED benefits associated with the project deepening. The cost savings, the difference between the without and with project costs, represent the benefits of the deepened channel. Cost efficiencies accrue as vessels are able to increase loading and reduce transits. The estimated NED Average Annual Equivalent (AAEQ) benefits and project costs are compared to determine if the improvements are economically justified and to identify the widening footprint and deepening components at which NED net benefits are reasonably maximized. Refer to Section 3.9.2 of the **Engineering Appendix A** for more detailed discussion on the incremental costs.

Initial screening-level incremental benefits were calculated showing by one-foot increments the effective benefit of a deeper and/or wider channel. The combination of deepening and widening in some plans results in a higher benefit than deepening only plans. **Table 21** outlines the discussion of benefits for all the various plans and the corresponding measures of those plans.

Table 21: Plan Alternatives and Discussion of Benefits

Alternatives	Measures	Benefits Discussion
1A, 2A, 5A	OEC, IEC, MTB	No container deepening benefits without SAC measure. Deepening benefits for Tanker access to MTB berths.
1B, 5B	*OEC, IEC, MTB, STB*	*No benefits from added increment of STB. Deepening benefits for Tanker access to MTB berths*
2B	OEC, IEC, MTB, Widener, SAC	Source of Deepening Benefits from Container for widening and access to Southport and Deepening benefits for Tanker access to MTB berths.
2C	OEC, IEC, MTB, Widener, SAC, TN (Turn& Berth)	Source of Deepening Benefits from Container for widening and berthing in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths. This plan has been overcome by events as the port is currently under design to expand the TN, Plan 2E includes the expanded footprint.
2D	OEC, IEC, MTB, Widener, SAC, TN (Turn Only)	Source of Deepening Benefits from Container for widening and turning in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths.
2E	OEC, IEC, MTB, Widener, SAC, S_TN	Source of Deepening Benefits from Container for widening and berthing in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths. This is the only plan under Plan 2 that includes deepening the entire TN footprint (including the portion under design to be deepened by the non-federal sponsor).
3A	*DCC*	*Not benefiting projected fleet.*
4A	*STB*	*Minimal widening benefits from STB.*
5C	OEC, IEC, MTB, STB, Widener, SAC	Source of Deepening Benefits from Container for widening and access to Southport and Deepening benefits for Tanker access to MTB berths. *No benefits from added increment of STB.*
5D	OEC, IEC, MTB, STB, Widener, SAC, TN (Turn& Berth)	Source of Deepening Benefits from Container for widening and berthing in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths. *No benefits from added increment of STB.*
5E	OEC, IEC, MTB, STB, Widener, SAC, TN (Turn& Berth), DCC	Source of Deepening Benefits from Container for widening and berthing in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths. *No benefits from added increment of STB. DCC not benefiting projected fleet*
5F	OEC, IEC, MTB, STB, Widener, SAC, TN (Turn Only)	Source of Deepening Benefits from Container for widening and turning in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths. *No benefits from added increment of STB.*
5G	OEC, IEC, MTB, STB, Widener, SAC, TN (Turn Only), DCC	Source of Deepening Benefits from Container for widening and turning in the TN and access to Southport. Deepening benefits for Tanker access to MTB berths. *No benefits from added increment of STB. DCC not benefiting projected fleet.*
6A	Widener	Source of Widening Benefits from container Vessels for efficient transit into the SAC via the WIDE component.
6B	Widener, OEC,SAC	Source of Widening Benefits from container Vessels for efficient transit into the OEC and down the SAC and WIDE components.
6C	Widener, OEC, SAC, TN (Turn&Berth)	Source of Widening Benefits from container Vessels for efficient transit into the OEC and down the SAC and WIDE components. Turning and berthing benefits from TN expansion.
6D	Widener, OEC, SAC, TN (Turn & Berth), DCC	Source of Widening Benefits from container Vessels for efficient transit into the OEC and down the SAC and WIDE components. Turning and berthing benefits from TN expansion.*DCC not benefiting projected fleet, no additional benefits.*
6E	Widener, OEC, SAC, TN (Turn Only)	Source of Widening Benefits from container Vessels for efficient transit into the OEC and down the SAC and WIDE components. Turning only benefits from TN.
6F	Widener, SAC, TN (Turn Only), DCC	Source of Widening Benefits from container Vessels for efficient transit into the OEC and down the SAC and WIDE components. Turning only benefits from TN. *DCC not benefiting projected fleet, no additional benefits*

5.4 COMPARISON OF ALTERNATIVE PLANS

The widening benefits were combined with the deepening benefits for final plan selection. Improvements (deepen) to the South Turning Basin (STB) would have negligible impacts on transportation costs and as a result alternatives 1B, 4A, 5B, 5C, 5D, 5E, 5F, and 5G would at best have very low net benefits Because the STB is used for cruise vessels which are not depth restricted under the existing conditions. Improvements (deepening and or widening) to the Dania Cuttoff Canal (DCC) have also have negligible impacts on total transportation costs, because the extension of improvements to the DCC would not benefit the fleets projected to call at the proposed new facilities along the DCC, and thus the DCC improvements would simply serve to create new berth capacity for the Port and alleviate some congestion at existing facilities currently used by smaller vessels. Vessels using the DCC are not depth restricted under the exsiting conditions. As a result, Alternatives 3A, 5E, 5G, 6D and 6F would have negligible net benefits and were eliminated.

No significant benefits are derived from alternative 1A, 2A, and 5A because the benefits are predicated on the ability of the containership to transit to Southport, and these plans do not provide the means for that however these alternatives 1A, 2A, and 5A gain benefits from the added tanker access for the benefiting Aframax Vessels, however it is not enough to outweigh the construction costs, and thus the net benefits for these alternatives are negligible. Alternatives 6A, 6B, 6C, and 6E were eliminated as the benefits were not greater than the costs.

Plan 2 provides the most benefits, allowing for larger container and tanker vessels to transit Port Everglades. Plan 2A and 2B were eliminated as they did not include the Turning Notch component. The Turning Notch is necessary for larger post-panamax vessels to transit in the SAC. Ship simulation determined the optimal channel footprint (widening). Plans 2C, 2D, and 2E were compared for optimization. The only difference between these plans was the configuration of the Turning Notch. The alternative that provides the most benefits with the least cost is 2E. Alternative 2E includes deepening with minimal widening of the Turning Notch (including the expanded footprint that will be constructed by the non-federal sponsor) to allow for post-panamax vessels to transit the Southport Access Channel.

The Final plan that is carried forward for determination of the Recommended Plan is to deepening and widen from the Outer Entrance Channel through the Southport Access Channel, including the Turning Notch. This plan, 2E, is an optimization of Plan 2 and provides the most benefits. Harborsym was used to compute the benefits for determining the recommended alternative depth (from 42 to 50 feet) as is discussed in the next section.

5.5 Final Array of Alternatives – HarborSym Analysis

The USACE HarborSym model was used to compute transportation cost savings. HarborSym records and accumulates the total time and cost of vessel transits through the harbor and at sea. Since many variations of events can occur over a total voyage, many iterations of the simulation were run to obtain the average values for time in the harbor, time waiting, and total operating costs of vessels in the harbor and at sea.

Inputs to the model include vessel types, Port structures, commodity types and tonnages, vessel transit rules, and vessel routes (outside of the Port). Once the model was fully set up and calibrated, the with-project and without-project conditions were simulated by loading each project condition with its corresponding fleet of vessel calls and commodity transfers.

The primary output of the model used to determine transportation cost savings (NED benefits) is total transportation costs for each alternative by year. The results were interpolated over the period of analysis and across project depths and then annualized and adjusted to present value (**Table 22**).

Table 22: Cost and Benefits of Alternative Depths

Depth	AAEQ Costs*	AAEQ Benefits	AAEQ Net Benefits	BCR
46ft	$15,000,000	$45,100,000	$30,100,000	3.00
47ft	**$15,900,000**	**$46,900,000**	**$31,000,000**	**2.90**
48ft	**$16,860,000**	**$48,240,000**	**$31,400,000**	**2.90**
49ft	$17,800,000	$48,300,000	$30,500,000	2.70
*Costs include IDC and O&M.				

The National Economic Development (NED) Plan is determined by comparing benefits, based on HarborSym model outputs, to project costs. NED benefits are based on differences in total transportation costs between with the future with-project condition and the future without-project condition. Average annual benefits were compared to average annual costs to determine average annual net benefits. The NED Plan is the plan that reasonably maximizes average annual net benefits. The plan that most reasonably maximizes net benefits is 47 feet. USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c directs that "where two cost-effective plans produce no significantly different levels of net benefits, the less costly plan is to be the NED plan."

The NED plan has been identified to be 47 feet. There is not a significant difference between the 47-foot and 48-foot plans, as the change is only 1.3% in AAEQ net benefits. The non-federal sponsor requested a locally preferred plan (LPP) of 48 feet which was approved by the ASA(CW) on October 16, 2014. There are positive net benefits at this depth. The Recommended Plan is the LPP of 48 feet. In addition to deepening, widening in several channel segments is also recommended. **Figure 35** outlines the Recommended Plan area. **Table 23** shows the total average annual equivalent (AAEQ) benefits for a 47-

foot and 48-foot channel to be estimated at $46.9 million and $48.2 million, respectively. The NED and LPP are shown below at the existing FY15 interest rate of 3.375% and the 7% interest rate. The non-federal sponsor would be responsible for 100% of the incremental costs in addition to their cost shared portion of the 47-foot plan.

Table 23: Total AAEQ Costs and Benefits of the NED and LPP

Depth	Plan	AAEQ Costs	*AAEQ IDC*	AAEQ Benefits	AAEQ Net Benefits	BCR 3.375%	BCR 7%
47ft	NED	$ 15,900,000	*$ 1,200,000*	$46,900,000	$ 31,000,000	2.9	1.5
48ft	LPP	$ 16,860,000	*$ 1,400,000*	$48,240,000	$ 31,400,000	2.9	1.5

Notes: FY15 Price Levels at 3.375%

5.6 Deviation from the NED Plan: Reasons for the LPP

The purpose of the economic analysis for the Port Everglades Feasibility Study is to measure the change in the cost of cargo movement for channel deepening and widening alternatives ranging from 42 feet (widening only) to 50 feet (deepening and widening). The analysis accounts for the fact that larger vessels sail at a range of operational drafts. Past a certain point, each deeper operational draft is associated with a diminishing probability of occurrence. Channel depth alternatives necessary to accommodate deeper vessel sailing drafts come at an increasing cost. The National Economic Development (NED) Plan is that alternative that reasonably maximizes transportation cost savings (benefits) for the lowest cost. From the national perspective, the 47-foot alternative provides the greatest net benefit; it can accommodate the full transition of vessels for the lowest investment cost. Channel depths greater than 47 feet show that benefits continue to increase, but at a slower rate than the alternative costs.

The economic community has discussed in detail the Port Everglades study plan selection and which alternative best meets the criteria to "reasonably maximize" net benefits. The net benefit curve flattens out between 46 feet and 50 feet. The difference in net benefits between 47 and 48 feet is 1.3%. The benefit curve remains flat through depths of 49 and 50 feet indicating that efficiencies are maximized at a 47-foot channel depth where the net benefits are most reasonably maximized and the costs are lower. Approximately 60% of the economic benefits are attributable to petroleum products, 36% are from containers, and 4% are from other savings (e.g. dry bulk and delays). The fleet is expected to have a major shift to Post Panamax Generation 1 and 2 vessels and largest allowable tankers at 44 feet of channel depth or greater, with greater vessel utilization as depths increase. The Port Everglades benefitting fleet is in the active world fleet today (versus in design or expected to be developed). Fleet deployment of larger vessels is expected to occur within the first 5 years following construction. This allows benefits to be achieved in the near term, versus the more standard 15 to 20 years from the base year.

5.6.1 LPP Environmental

The majority of environmental impacts occur with the first increments of widening and deepening. The total impact for seagrasses is at the first foot of depth, while the reef and hardbottom impacts increase at approximately 1 acre of impact per foot of depth dredged. For the NED depth of 47 feet and the LPP depth of 48 feet, the seagrass and mangrove impacts are the same (4.21 acres of seagrass and 1.2 acres of mangroves). For reef and hardbottom habitats, the direct impact acreage is inversely correlated to the below-dredge depth potential impacts: as the channel goes deeper, more of the impact moves from the potential impact below-dredge depth category to the direct impact category. For the 47-foot plan, the direct impact is 14.5 acres and 7.2 acres of potential impacts below dredge depth. At 48 feet, the direct impacts are 15.3 acres and 6.4 acres of potential impacts below dredge depth. As there is only so much reef to impact, the more direct impact to the reef the less potential impacts (i.e. for each additional foot of impact there is less remaining of the reef to impact therefore with an additional foot dredged there is a greater direct impact which leaves less to potentially impact). Upfront mitigation for both depths include the direct impacts, 10% of the below dredge depth impacts, and loss of 2% function as a result of indirect effects of turbidity and sedimentation. The incremental increase in mitigation costs going from 47 feet to 48 feet is approximately $2 million. The incremental increases in cost reflect the mitigation measures high initial fixed cost versus a small incremental cost of adding additional mitigation units.

5.6.2 LPP Engineering

The additional deepening from 47 feet to 48 feet represents an approximate 5.4% increase in cost. There is no significant change in the unit cost of construction or disposal between the 47-foot or 48-foot depth, nor is there a price break-point, between these depths. Using the current criteria for cost development and cost and schedule risk analysis, there is a high level of confidence to execute this project, and that confidence is equal under each alternative. Construction and disposal techniques for each alternative depth are the same. Material will be removed using a cutter head dredge or blasting with cutter head or clam shell removal and placed in ocean disposal. The proposed Ocean Dredged Material Disposal Site (ODMDS) is of sufficient capacity to include material from the 48-foot plan and future O&M, with no impact to long-term disposal capacity.

While vessels have been known to take advantage of tide cycles to transit at a deeper draft, minimizing channel depth requirements, this is not a viable practice at Port Everglades. The tide range at Port Everglades is approximately 2.5 feet to 2.7 feet between mean lower low water and mean high water. Given the magnitude and unpredictable nature of offshore and nearshore currents and the unusual speed (10 to 12 knots) required to maintain vessel control while transiting the entrance channel, the tidal range at Port Everglades is not sufficient to ensure adequate underkeel clearance for vessels with drafts deeper than those for which the channel dimensions are specifically designed. The pilots use the tide to allow some vessels to transit up to and no deeper than the authorized depth, depending on the vessel and channel segment. The risk of

grounding and/or vessel and environmental damage is significant should vessels deeper than the design draft attempt to enter the harbor. Thus use of tide is not a viable option to transit at a deeper depth than authorized.

5.6.3 LPP Operations and Maintenance (O&M)

Port Everglades has a history of low annual shoaling and an infrequent O&M dredging requirement. Because of the minimal shoaling in the project area, the with-project annual O&M is minimally more (~$55,500) than historical cost, and the volume of additional material does not change the frequency of O&M dredging. The increase in annual O&M is primarily due to the increase in channel footprint (widening); therefore there is no projected difference in annual O&M between the 47-foot NED and 48-foot Recommended Plan.

5.6.4 LPP Incremental Costs and Benefits

The average annual equivalent (AAEQ) incremental costs and benefits of the Locally Preferred Plan above the NED plan are displayed in **Table 24**, Costs and Benefits of Project Increments. As shown in this table, the incremental AAEQ benefits for the 48-foot channel are $1.4 million, all of which are transportation savings benefits.

Table 24 shows that the incremental AAEQ net benefits for the LPP (48-foot project depth) are $400,000 with an incremental BCR of 1.40. This is not considered a significant difference between plans, as the change is only 1.3% in AAEQ net benefits between the NED and LPP. The USACE policy guidance in ER 1105-2-100 Exhibit G-1 3.c directs that "when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan." The non-federal sponsor would be responsible for 100% of the incremental costs in addition to their cost shared portion of the 47-foot plan.

Table 24: AAEQ Incremental Costs and Benefits of the Locally Preferred Plan above the NED Plan

Incremental AAEQ Cost	Incremental AAEQ Benefits	Net Incremental AAEQ Benefits	Incremental BCR
$ 960,000	$ 1,340,000	$ 400,000	1.4

Note: FY15 Price Levels at 3.375%

The LPP provides the same type of benefits, transportation cost savings, as the NED plan. The NED and LPP plan will have the same type of mitigation required; however there is an incremental increase in mitigation under the LPP commensurate with the increase in reef and hardbottom impacts due to the deeper depth. The LPP demonstrates similar in-kind outputs and equal to the outputs of the Federal plan while meeting the criteria of environmental acceptability.

5.7 Summary of Accounts

The Federal objective is to determine the project alternative with that reasonably maximizes net benefits while protecting or minimizing impacts to the environment. Both the 47-foot and 48-foot alternatives were reduced during the plan formulation process and optimized to minimize environmental impacts under the EQ account. In particular, the widening was the absolute minimum necessary for safety while avoiding impacting the mangroves as much as possible. Efforts to avoid and minimize environmental impacts will continue in the Preconstruction Engineering and Design (PED) phase. Environmental impacts are more fully described in the EIS.

The Port Everglades area economy, under the RED account, will most likely experience regional economic benefits from the implementation of this project.

The OSE account includes effects on social aspects such as community impacts. The effects of the project on people living and working in the region have been documented; their opinions are noted in the report and included in the EIS, **EIS Sub-Appendices L and M**. In addition the study evaluated environmental justice and determined that the project would have no effect and would not influence any foreseeable future actions that could adversely affect minority and low-income populations.

Table 25: Summary of Accounts

Alternative 2E	Federal Objective			
	NED	EQ	OSE	RED
No Action	X	●	X	X
46'+Widening	●	●	●	●
47'+Widening	●	●	●	●
48'+Widening	●	●	●	●
49'+Widening	●	●	●	●
50'+Widening	●	●	●	●

● - Meets objective
X - Does not meet objective
NED (National Economic Development), EQ (Environmental Quality), OSE (Other Social Effects), RED (Regional Economic Development)

5.8 Recommended Plan

After conducting the economic analysis, Plan 2E at a depth of 47-feet was selected as the National Economic Development Plan. The sponsor requested a Locally Preferred Plan (LPP) of 48 feet and has agreed to pay 100% of the additional cost of the additional foot. The Recommended Plan is the 48-foot LPP.

The Recommended Plan consists of deepening Port Everglades to 48 feet which as shown in **Figure 35**. Through authorization of the recommended plan, the existing limits of the Federal channel will be expanded. The recommended plan includes the following features:

- deepen and widen the Outer Entrance Channel (OEC) from an existing 45-foot project depth over a 500-foot channel width to 55 feet by 800 feet and extend 2,200 feet seaward;
- deepen the Inner Entrance Channel (IEC) from 42 feet to 48 feet;
- deepen the Main Turning Basin (MTB) from 42 feet to 48 feet;
- widen the rectangular shoal region to the southeast of the MTB by about 300 feet and deepen to 48 feet (Widener);
- widen the Southport Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by approximately 250 feet and reconfigure the USCG facility easterly on USCG property;
- shift the existing 400-foot wide SAC about 65 feet to the east (cost is included in the non-federal berthing area dredging costs and is 100% non-federal) from approximately berth 26 to the south end of berth 29 to provide a transition back to the existing Federal channel limits;
- deepen the Southport Access Channel (SAC) from about berth 23 to the south end of berth 32 from 42 feet to 48 feet;
- Environmentally Friendly Bulkheads (EFB) will be placed along portions of the SAC to maintain the existing shoreline. These are used to stabilize the shoreline as the channel is deepened and widened the natural side slopes will fall and to prevent damage to John U Lloyd and the Conservation Easement from side slopes (See Engineering Appendix A Section 4 for more information);
- deepen the Turning Notch (TN), including Sponsor expanded portion, which is currently in the design phase, from 42 feet to 48 feet with an additional 100-foot widening parallel to the channel 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.

To compensate for the unavoidable adverse effects of the action on various significant habitat types, USACE has proposed the following: mitigate for (a) the removal of approximately 7.41 acres of vegetated and unvegetated seagrass habitat (including that within the new channel footprint and resulting side slopes) and (b) the loss of approximately 1.16 acres of mangroves in the project footprint through use of ecosystem benefits from a previously permitted restoration project at West Lake Park (Broward County, FL), which is currently under design. Mitigation for impacts will involve use of approximately 2.4 seagrass functional units and approximately one (1) mangrove functional unit, respectively, from that project, located in a county-operated, state-owned, natural area immediately to the south of the project area. USACE has also proposed the following: mitigate for (c) the direct removal of approximately 14.62 acres of complex, high-profile, linear and spur/groove reef habitat through the creation of approximately 5

acres of artificial reef with the transplantation of 11,502 corals from the impact site to the artificial reef and the outplanting of approximately 103,000 nursery raised corals. Additional mitigation will be provided due to any detectable, incidental, direct impacts of dredging equipment and indirect impacts on hardbottom habitats due to turbidity/sedimentation. These mitigation components were determined to be economic "Best Buys" from among mitigation alternatives.

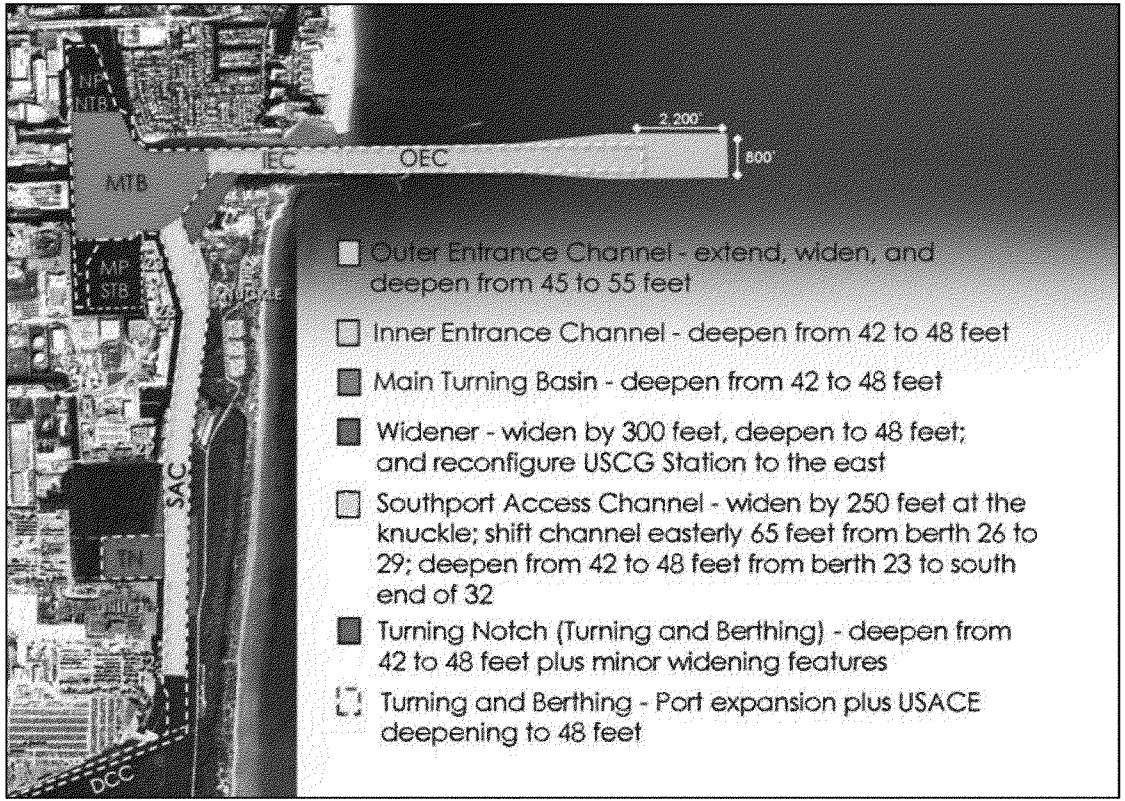

Figure 35: Recommended Plan Components

5.9 Costs and Benefits of the Recommended Plan

Table 26 itemizes the estimated first costs for the Recommended Plan of 48 feet. The detailed cost estimate can be found in the **Cost Estimate Appendix F**. Total project costs, including associated costs and interest during construction, for all of the components, are included and generate a total investment cost of $374,100,000. For the full breakdown of costs and cost sharing tables see **Section 8.0**.

Table 26: 48-Foot Recommended Plan Costs and Benefits at FY15 Price Levels

Port Everglades	RECOMMENDED PLAN
Federal Cost	$189,900,000
Non-federal Costs	$184,200,000
Total Cost Allocation	$374,100,000
Project First Cost	$322,700,000
Total AAEQ Costs	$16,900,000
AAEQ Benefits	$48,200,000
B/C Ratio	2.90

6.0 THE RECOMMENDED PLAN

Tables 27 and **28** summarize Federal and non-federal components, respectively.

Table 27: Federal Elements of the Recommended Plan

Reach	Project Depth[1] (ft MLLW)	Channel Width (ft)	Channel Length (ft)	Additional Federal Elements[2]
Outer Entrance Channel	55	Varies 800max to 400min	Extends 2,200 lf offshore	0.5H:1V (reef/rock) 3H:1V side slope (sand)
Inner Entrance Channel	48	400	Same as Existing	0.5H:1V (reef/rock) 3H:1V side slope (sand)
Main Turning Basin	48	See Fig 38	Same as Existing	0.5H:1V (reef/rock) 3H:1V side slope (sand)
Widener	48	See Fig 38	See Fig 38	0.5H:1V (reef/rock) 3H:1V side slope (sand)
Southport Access Channel	48	See Fig 38	9,385	0.5H:1V (reef/rock) 2H:1V side slope (sand), Environmentally Friendly Bulkheads
Turning Notch	42 to 48	145	1,315 (E-W)	0.5H:1V (reef/rock) 2H:1V side slope (sand)
USCG Basin Reconfiguration[3]	N/A	200	350	Reconfigure basin and adjacent buildings
Mitigation	N/A	N/A	N/A	Seagrass, Mangrove and Reef

[1] An additional depth of 1 foot required and 1 foot allowable will be included in dredging contract
[2] Mitigation for certain project elements will be further discussed in the Recommended Plan Design section
[3] Reconfiguration based on Ship Simulation Study and CGWAVE results

Table 28: Non-federal Elements of the Recommended Plan

Project Component	Impacted Bulkhead (by Berth)	Bulkhead Age		Required Action
		< 40 yrs	> 40 yrs	
OEC	---			---
IEC	---			
MTB	7 - 10		X	Extend depth of pre-project bulkhead
STB	16 - 19		X	Extend depth of pre-project bulkhead
Widener	---			No existing bulkheads impacted
SAC	31 - 32	X		Construct toewall to stabilize bulkhead
TN	30	X		Construct toewall to stabilize bulkhead

6.1 CONSTRUCTION PHASING

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 contractors proposal, construction methodologies, equipment availability, construction window compliance among others. These factors may require multiple contracts.

Table 29: Construction Phasing

Location	Depth	Quantity[1] (cy)	Site	Start Year	Contract No.
ODMDS Selection	---	----	---	Year 1	1
Plans & Specifications	---	----	---	Year 2	1
Outer Entrance Channel	55	1,057,062	ODMDS	Year 3	1
Inner Entrance Channel	48	307,693	ODMDS	Year 4	1
Widener	48	996,245	ODMDS	Year 5	1
Main Turning Basin	48	700,734	ODMDS	Year 5	1
Southport Access Channel	48	1,571,500	ODMDS	Year 6	1
Turning Notch	48	608,528	ODMDS	Year 8	1

[1] Quantities include maintenance material, required and allowable overdepth, and project related berthing areas

The precise number of contracts required will be determined during the Preconstruction Engineering and Design (PED) phase that follows this feasiblity phase. **Table 29** is based on a conservative estimate for funding of the project, on a phased basis.

6.2 USACE CAMPAIGN PLAN

USACE Vision – A great engineering force of highly disciplined people working with USACE partners through disciplined thought and action to deliver innovative and sustainable solutions to the Nation's engineering challenges.

USACE Mission – Provide public engineering services in peace and war to strengthen National security, energize the economy, and reduce risks from disasters.

Commander's Intent – The USACE will be one disciplined team, in thought, word, and action. We will meet USACE commitments, with and through USACE partners, by saying what we will do and doing what we will say. The USACE will, through execution of this Campaign Plan, become a GREAT organization as evidenced by the following in all mission areas; Delivering superior performance, Setting the standard for the profession, Making a positive impact on the Nation and other nations, Being built to last by having a strong "bench" of educated, trained, competent, experienced, and certified professionals.

The Recommended Plan for this project is consistent with these themes. The project team took the latest policy and planning guidance and worked with professionals familiar with the local coastal system to design a project that will work in tandem with adjacent projects to help provide safe, effective, and efficient navigation. Extensive reviews were performed to ensure quality and consistency. The team worked with stakeholders on the state and Federal level as well as local stakeholders.

7.0 RECOMMENDED PLAN DESIGN

Construction methodology for the project will be determined by the contractor selected by the USACE. However, certain assumptions for planning and estimating purposes were made regarding various proposed construction techniques that may be used.

Outer Entrance Channel (OEC)
A 3H:1V angle of repose is expected over time for the side slope. The OEC will have to be extended 2,200 feet offshore to remove two areas that are shallower than the new project depth. The flare located at this region of the channel is required to allow for safer maneuvering of large vessels when a strong cross shore current is experienced. The project depth in the OEC is increased from 45-feet to 55-feet to accommodate ship wave movement and squat associated with the larger design vessel. Additional information on the engineering calculations leading to this depth can be found in **Appendix A, Engineering Appendix – Sub Appendix C**.

Inner Entrance Channel (IEC)
A 3H:1V angle of repose is expected over time for the side slope. Construction of the IEC will include deepening to 48 feet MLLW.

Widener/Main Turning Basin (WIDE and MTB)
The Widener work will facilitate turning and transit between the MTB and the SAC. Based on available data, USACE Geotechnical staff have indicated that it is unlikely blasting will be required for dredging in this area.

Turning Notch (TN)
Construction of the TN (including the expanded portion that will be constructed by the non-federal sponsor and is currently under design) will include deepening to 48-feet MLLW with minor widening along the SAC by approximately 100 feet. Deepening the berthing area (berth 30) on the south side of the TN to 48 feet is included as a non-federal feature.

Southport Access Channel (SAC)
The widened channel is designed to allow the S-Class Post-Panamax vessel to transit the channel with Cruise Vessels at Berths 24-27. USACE Geotechnical staff concluded, based on available data, it is probable that blasting will not be required for dredging in this area. Additional core borings will be done during the design phase for confirmation. The sideslope along John U. Lloyd SRA is expected to be 2H:1V. The channel will be dredged to 48-feet MLLW with one-foot required overdepth and one-foot allowable overdepth. To minimize environmental impacts careful consideration was given to the design of this feature including use of Environmentally Friendly Bulkheads along the eastern shore. This type of bulkhead allows sufficient water to pass through to continue flushing of mangroves and allow juvenile fish access to the mangroves.

U.S. Coast Guard (USCG) Basin
The USCG basin will have to be reconfigured to allow for safe transit of the larger

vessels based on ship simulation study results. Consultations have occurred with the USCG throughout the planning process. The numeric model CGWAVE was analyzed and results verify that the most current design provided acceptable operational wave conditions within the new basin. **Engineering Appendix A** has more documentation on this model analysis. The USCG is in agreement with the plan to reconfigure a majority of their facilities. Coordination amongst the agencies can be found in the **Pertinent Correspondence Appendix**. The USCG facility reconfiguration design can be found as an attachment to the **Engineering Appendix**.

Real Estate Requirements

The deepening of the outer entrance channel, inner entrance channel, middle turning basin, and the turning notch as well as widening of the outer entrance channel, turning notch, and the Southport Access Channel (knuckle) are within the navigable waters of the United States and are available to the United States by navigation servitude. The existing and expanded ODMDS are also available to the United States by navigation servitude.

The land required for the widener at the north end of the Southport Access Channel is federally owned and operated by the U.S. Coast Guard. The U.S. Coast Guard owns a total of 7.8 acres and operates a multi-mission (search, rescue, and drug interdiction) facility on the property. Approximately one acre of uplands will be removed and turned into submerged lands to support the widening of the Southport Access Channel. Use of the U.S. Coast Guard property is necessary to allow deep draft vessels the ability to turn safely. The uplands being submerged will remain Federally-owned and be used for U.S. Coast Guard vessels.

The reconfiguration also requires several U.S. Coast Guard structures, facilities, and utilities to be shifted to the east onto adjacent Federally-owned property. The cost for this reconfiguration is included in the cost-shared project construction costs as a general navigation feature and not as a real estate cost. The U.S. Coast Guard has been involved in the planning of this project and a final plan is still being developed. A permit for use of real property by other federal agencies will be executed between the U.S. Coast Guard and the Department of the Army for construction purposes.

The primary disposal site is an existing disposal site, designated by the U.S. Environmental Protection Agency as an ODMDS. The U.S. Environmental Protection Agency has completed the draft Environmental Assessment on the expansion and has received public comments. The formal designation process including rule making and publication in the Federal Register of the expanded ODMDS is expected to be complete in 2015. No further real estate is needed for the ODMDS. The expansion of this site is required for current operation and maintenance of the channel and no additional costs are included from the ODMDS expansion for this project.

The submerged lands required for relocating excavated hardbottoms to a five acre artificial reef site and transplanting disturbed coral communities are within the navigable waters of the United States and are available by navigation servitude.

In lieu of a real estate fee acquisition for seagrass and mangrove mitigation, mitigation credits are being purchased from Broward County. Broward County is generating mitigation credits to offset impacts of Broward County projects at areas within West Lake Park. Broward County applied for and received permission to construct seagrass and mangrove features through South Florida Water Management District Environmental Resource Permit No. 06-04016-P and Department of the Army Regulatory Permit No. SAJ-2002-0072, as amended. The permits authorize Broward County to complete mitigation activities to offset impacts to tidal, saltwater, and wetland communities and accrue ecological functional value credits for the work within West Lake Park. The area is only available for Broward County projects, specifically port and airport expansion projects. Accrued credits will be purchased by the Federal government and applied to this project prior to construction. An agreement between the United States and Broward County will be executed to guarantee seagrass and mangrove mitigation in perpetuity.

ODMDS Contingency

Should EPA 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), Section 103(b) of MPRSA authorizes USACE, with USEPA concurrence, to select a site for one time disposal of dredged material in ocean waters when the use of a site designated by USEPA is not feasible. This one-time use would be a permit for the entire construction event. After this use, USACE and EPA have the option to permit it beyond that time frame under Section 103. All maintenance material will be placed in the existing ODMDS site, which has more than enough capacity. The cost involved with this contingency plan would be approximately $100,000 (only labor funds for designation).

7.1 Operations and Maintenance Considerations

The Federal channels and basins will be maintained by the USACE, in accordance with WRRDA 2014; O&M is 100% Federal with a project depth under 50 feet.[5] ER 1105-2-100, Appendix E, par E-8.b.(2) states "Where an entrance channel is deeper than interior channels because of the more adverse navigation conditions of the entrance channel, cost sharing is the same as the deepest reach of the more protected interior channels." As such, the Outer Entrance Channel which includes additional underkeel clearance is cost shared at the same rate (100% Federal) for O&M as the 48-foot depth. Port facilities such as berthing areas and port bulkheads will be maintained by the non-federal sponsor. Mitigation constructed as a result of this project will be monitored post-construction by the non-federal sponsor.

The increase in maintenance costs over the existing O&M was determined using FY 15 costs and a 3.375% interest rate over the 50-year period of analysis. The annual O&M costs is expected to increase by approximately $55,500. This increase in cost is based on

[5] **WRRDA 2014 Section 2102(b) OPERATION AND MAINTENANCE.--Section 101(b)(1) of the Water Resources Development Act of 1986 (33 U.S. C. 2211(b)(1)) is amended by striking "45 feet" and inserting "50 feet".**

the increase in material needing to be removed from the channel. The existing project needs approximately 217,000 cubic yards removed every 8 years while the proposed project will need approximately 274,400 cubic yards removed. As the increase in annual O&M is primarily due to the increase in channel footprint (widening); there is no discernible difference in annual O&M between the 47-foot NED and 48-foot Recommended Plan.

7.2 Environmental Requirements and Commitments

Environmental commitments of the project include: (1) the blasting protection protocols to protect marine mammals and sea turtles from blasting activities (2) Use of the standard manatee protection protocols during construction, (3) pre- (baseline), during and post-construction monitoring of coral and hardbottom habitats adjacent to the channel; (4) relocation of hard corals from the 3rd reef entrance channel extension to adjacent habitats.

Seagrass and mangrove mitigation is planned for construction at West Lake Park and hardbottom mitigation is currently planned as artificial reef creation offshore within sand borrow sites used for Broward County beach renourishments. See the EIS for more information.

7.2.1 Seagrass and Mangrove Mitigation

The County has a mitigation project at West Lake Park that is a joint effort to address mitigation needs for the Port expansion project and expansion by the Airport. The entire improvements that extend beyond the Port expansion requirements are intended to address ecosystem-level improvements through a comprehensive plan for the entire West Lake Park area and the region, **EIS Sub-Appendix E**.

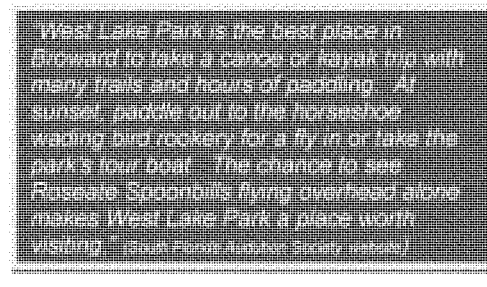

Figure 36: West Lake Park from Florida Audubon Society

The permits for the entire enhancement plan were originally issued by the South Florida Water Management District in April 2004, by the Broward County Environmental Protection Department in August 2004, and the USACE Regulatory Division in March 2006 and have since been extended. The enhancement plan is therefore authorized for use in mitigating impacts under the regulatory jurisdiction of those agencies.

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. Based on Uniform Mitigation Assessment Methodology (UMAM) calculations, the USACE will require use of approximately one (1) functional unit to compensate for the 1.16 acres of mangroves that will be impacted by the navigation improvements at Port Everglades.

Seagrass occurrence within the Port Everglades inlet and channel consists of mixed Submerged Aquatic Vegetation (SAV) with *Halophila decipiens* and *Halodule wrightii*, mixed SAV with *H. decipiens* and *Halophila johnsonii*, monospecific beds of *H. johnsonii*, and *H. decipiens*. *Halophila johnsonii* is a threatened species under the Endangered Species Act (ESA). Mitigation for impacts will involve use of 2.4 seagrass functional units from that project, located in a county-operated, state-owned, natural area immediately to the south of the project area.

One of the principal actions for creating seagrass and mangrove habitat is the removal of exotic vegetation and grading of existing disposal material islands to the appropriate depth. These new habitats will be located along the Intracoastal Waterway. In the event that natural recruitment has not occurred within 12 to 18 months following excavation, methods to plant seagrass donor material will be initiated. It is anticipated that restoration within West Lake Park will occur as a result of enhanced flushing and circulation patterns along the southeastern region of the lagoon. Water quality, clarity, and substrate conditions more suitable for seagrass propogation are expected as a result of the proposed mitigation features.

The project will cost share in purchasing mitigation for the project. The mitigation will be bought from the county, and the county assumes responsibility for providing mitigation. More detailed information can be found in the **Mitigation Plan, Sub-Appendix D of the EIS**.

7.2.2 Hazardous, Toxic and Radioactive Waste (HTRW)

A site assessment for Hazardous Toxic and Radioactive Waste (HTRW) sources was conducted of the area of Port Everglades. The HTRW assessment is required by ER 1165-2-132 and consisted of aerial photo reviews and database reviews of the area. The areas considered for Port deepening do not include any upland disposal sites located adjacent to or near Port Everglades. The evaluation revealed that the Port navigation improvement project is in the vicinity of industrial facilities, ad hoc warehouse or storage

areas, and petroleum storage facilities, and none of these areas are to be directly impacted by the proposed deepening and widening of the Federal channel. The report also provides documentation of small spills which are not unusual for a busy port area. Likely through dilution, actual cleanup remedial actions, and tidal currents all the residual effects have been weathered and eliminated. The material proposed for dredging will be evaluated for its suitability in ocean disposal in the ODMDS constituting the final test for contamination in the material. This testing is known as Section 103 testing and is conducted during the USACE Preconstruction Engineering and Design (PED) phase. The testing may include sediment chemistry as well as bioassays.

Routine testing has been done for placement of material at the ODMDS as the Port routinely collects and examines benthic sediment samples for chemical constituents prior to conducting maintenance dredging. Sediments sampled within the OEC, IEC, NTB, MTB, and STB were tested and were found suitable for ocean disposal. Sample analyses conducted in the project area 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. Again, analyses from these samples did not indicate adverse sediment quality. Operations and Maintenance Dredging (O&M) was completed in FY 2013 for the SAC, MTB, TN, OEC, IEC and the Port's berthing areas. That material also underwent testing under Section 103 of MPRSA and as with previous dredging events at Port Everglades, the material was tested and did not exceed required thresholds and was placed in the ODMDS.

7.2.3 Mitigation Plans (Artificial Reef Sites)

Recommendations to be implemented include the following: mitigate for (c) the direct removal of approximately 14.62 acres of complex, high-profile, linear and spur/groove reef habitat through the creation of approximately creation of 5 acres of artificial reef with the transplantation of 11,502 corals from the impact site to the artificial reef and the outplanting of approximately 103,000 nursery raised corals. The Habitat Equivalency Analysis ("HEA") method was used to calculate mitigation requirements in acres for reef and hardbottom impacts associated with the navigation improvements. Several HEAs were conducted as a result of various habitat types, recovery times, and relief/profiles in the affected areas (for more information refer to **Appendix E of the EIS**).

Mitigation for reef impacts will be done through creation of reef habitat at designated sites north of the Port (**Figure 37**). Currently, reef structures are planned to be created using rock excavated primarily from the OEC, IEC, and MTB areas, or the contractor could choose to purchase native rock instead of using material from the channel. This will be examined and analyzed during the Request for Proposal (RFP) process prior to contract award, where the contractor would present a technical evaluation of how to construct the project and then the USACE, in consultation with the resource agencies, will evaluate the sufficiency of the proposals. The configuration of the artificial reef materials will resemble, in profile and functionality, to the maximum extent practicable those habitats impacted by construction of the project.

The proposed creation of artificial reefs will be designed and placed to mimic the impacted natural habitat of the middle and outer reefs. Two types of mitigation reefs will be constructed: High Relief, High Complexity (HRHC) reefs (exceeding three feet of vertical relief) and Low Relief, Low Complexity (LRLC) reefs (approximately three feet of relief). Monitoring during and post construction of the reef mitigation site(s) will include both physical and biological monitoring. Results of all mitigation reef monitoring efforts will be summarized in annual reports and distributed to all agencies and interested parties. Additional information can be found in the **EIS**.

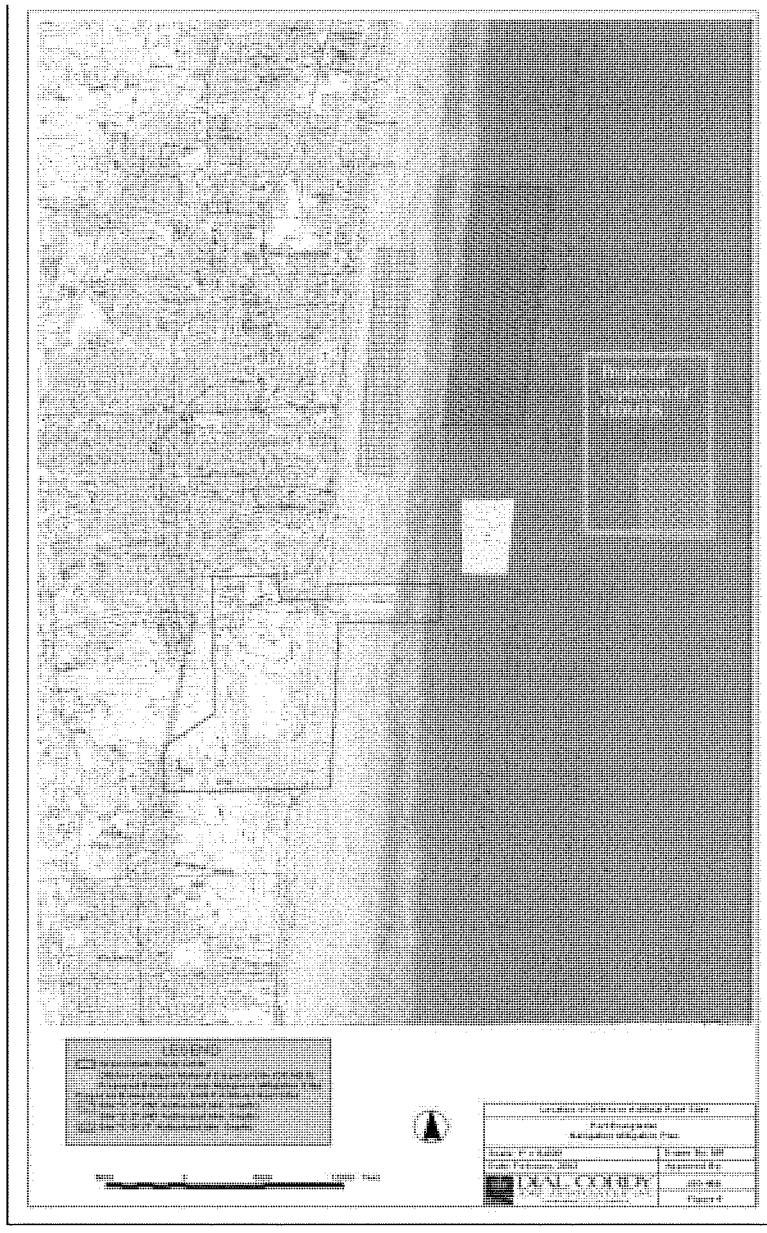

Figure 37: Reef Mitigation Sites

7.2.4 Relative Sea Level Rise Design Considerations

Relative Sea Level Rise (RSLR) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea-level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form of ER 1110-2-8162.

ER 1110-2-8162 provides both a methodology and a procedure for determining a range of sea level rise estimates based on the local historic sea level rise rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a baseline estimate representing the minimum expected sea level change, an intermediate estimate, and a high estimate representing the maximum expected sea level change. Following procedures outlined in USACE 2013 "Incorporating Sea-Level Change in Civil Works Programs," ER 1110-2-8162, the baseline, intermediate, and high sea level rise values were estimated over the life of the project. 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 period of analysis is 50 years. Analysis shows that for three levels of projected future sea level rise over the period of analysis; baseline, intermediate, and high, sea level rise values at the end of the 50-year period of analysis are projected to be 0.39 feet, 0.84 feet, and 2.25 feet, respectively. In general, regional sea level rise (baseline, intermediate, and high) will not affect the functioning of the project alternatives or the overall maneuverability of the vessels. While there is expected to be a small increase in tide range and storm surge penetration for all three scenarios, the structural aspects of the project will be either unaffected or can be easily adapted to accommodate the change.

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 under the high SLR scenario. The mangroves are inside a protected lagoon, with limited water flow and currents. The USACE expects that with a gradual rise in sea level for all three rates, mangrove trees will continue to capture sediments in the mitigation areas, creating land with their prop-root structures and continue to thrive. 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 -3ft MLLW. With an additional 2.25 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 is 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 scenario) 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. Expanded discussion on RSLR can be found in the **Engineering Appendix**, Section 1.1.1 and the **EIS** Section 4.26.3.

8.0 RECOMMENDED PLAN IMPLEMENTATION

8.1 INSTITUTIONAL REQUIREMENTS

All construction material and future maintenance material is planned to be placed in the Port Everglades Ocean Dredged Material Disposal Site (ODMDS), which is undergoing approval for expansion by EPA scheduled for completion in 2015. Berthing area material, subject to Section 103 testing, may be placed offshore or in an upland site such as for use as landfill cap, consistent with previous Port practices. An additional depth of 1 foot required and 1 foot allowable will be included in the dredging contract. The Outer Entrance Channel (OEC) has additional depth requirements for squat and underkeel clearance, 7 feet beyond the required and allowable overdepth.

8.2 VIEWS OF THE NON-FEDERAL SPONSOR

Broward County, the non-federal sponsor, supports the Recommended Plan and fully understands the commitments they must satisfy in order to participate in the project.

8.3 ECONOMIC SUMMARY

Transportion cost savings are the estimated benefits of the project. The detailed economic analysis can be found in the **Economics Appendix B**. Costs and benefits were evaluated at the current FY15 3.375% rate.

Interest during construction takes place at a uniform rate of expenditure starting at the beginning of construction. The Recommended Plan AAEQ benefits are $48,240,000 and AAEQ Costs are $16,860,000, which provide AAEQ Net Benefits of $31,400,000. The benefit to cost ratio is 2.90.

Total costs, including associated costs and interest during construction for all of these components, are included and generate a total investment cost of $374,100,000.

8.4 COST APPORTIONMENT

The Water Resources Development Act of 1986 (Public Law 99-662) as amended, specifies cost apportionment by project purpose for deep draft navigation projects. Federal participation in navigation projects is limited to sharing costs for design and construction of general navigation features (GNF) consisting of breakwaters and jetties, entrance and primary access channels, widened channels, turning basins, anchorage areas, locks, dredged material disposal areas with retaining dikes, and mitigation. Non-federal interests are responsible for and bear all costs for acquistion of necessary lands, easements, rights-of-way and relocations, terminal facilities, as well as dredging berthing areas and interior access channels to those berthing areas.

Title I Section 101 of WRDA 1986 requires the project sponsor to bear a percentage share of harbor construction for project components that are cost shared (general navigation features, mitigation) that varies according to the range of water depths where work is to be done. That variable cost share is paid during construction.

For a commercial navigation project with project depths greater than 20 feet but not in excess of 45 feet, the non-federal share for the construction is 25 percent and for a commercial navigation project with project depths greater than 45 feet, the non-federal share for the construction is 50 percent. Lands, Easements, Rights-of-Way, and Relocations (LERRs) are 100 percent non-Federal costs. Operation and maintenance (O&M) of the general navigation features up to 50 feet in depth with a 100 percent commercial vessel navigation project are a 100 percent Federal responsibility. O&M in excess of 50 feet is cost-shared 50 percent by the non-Federal sponsor. In determining the cost-sharing, the 48-foot depth represents the project depth. Costs for associated wave allowance, squat, allowable and required overdepth are shared at the same rate as the project depth. Preparation of design documentation reports and plans and specifications during the preconstruction, engineering and design phase will be cost shared in accordance with the cost sharing required for project construction. **Table 30** summarizes the cost sharing percentages.

Table 30: General Cost Allocation

Feature	**Federal Cost %**[1]	**Non-Federal Cost %** [1]
General Nav. Features (GNF)	90% from 0' to 20' 75% from 20' to 45' 50% 46'and deeper	10% from 0' to 20' 25% from 20' to 45' 50% >45'
GNF's costs for this project include: mobilization, all dredging costs, all disposal area construction costs, demolition costs for items not on Port property, USCG reconfiguration costs, and mitigation.		
Associated Costs [2]	0%	100%
Associated costs for this project are: dredging of Port berthing areas; Port infrastructure construction including bulkheads, toe walls, etc; lands, easements, and rights of way, and acquisition of disposal sites; all utility relocations except those associated with the USCG facility; costs for features requested by Port in excess of TSP.		
Navigation Aids	100%	0%
Operation and Maintenance		
GNF	100% except cost share 50% costs for maint. > 50 feet	0% except cost share 50% for maint. > 50 feet
Port berths, Port , Infrastruc.	0%	100%
USCG Facilities	100%	0%
Mitigation	0%	100%

[1] The non-Federal Sponsor shall pay an additional 10% of the costs of GNF over a period of 30 years, at an interest rate determined pursuant to section 106 or WRDA 86. The value of LERR shall be credited toward the additional 10% payment.

[2] There are no utility relocations associated with this project.

Cost sharing for the Recommended Plan (48 feet) is as follows: 75/25 at and below 45 feet, 50/50 from 45 feet to 47 feet (the NED plan), and 100% non-federal for 47 feet to 48 feet.

Table 31: Cost Sharing Table NED Plan Summary (October 1, 2014 price levels and FY2015 discount rate)

(October 1, 2014 Price Levels and FY15 discount rate) Cost Summary NED Plan (Deepen to 47 feet)			
	Total Cost	Federal Share	Non-federal Share
	20-45 ft.	75%	25%
General Navigation Features	46-47 ft.	50%	50%
Mobilization	$3,100,000	$2,100,000	$1,000,000
Dredging and Disposal	$132,900,000	$93,000,000	$39,900,000
Environmentally Friendly Bulkhead[6]	$61,000,000	$45,800,000	$15,200,000
Associated General Items[1]	$4,500,000	$3,200,000	$1,300,000
Environmental Mitigation	$50,900,000	$37,100,000	$13,800,000
Mitigation (Mangrove, Seagrass, Art Reef w/Corals)	*$34,600,000*	*$25,400,000*	*$9,200,000*
Monitoring	*$900,000*	*$700,000*	*$200,000*
Coral Propagation	*$15,400,000*	*$11,000,000*	*$4,400,000*
Pre-Construction, Engineering, and Design	$5,600,000	$3,900,000	$1,700,000
Construction Management (S&I)	$8,400,000	$5,900,000	$2,500,000
USCG Reconfiguration	$38,900,000	$29,200,000	$9,700,000
NED Subtotal Construction of GNF	$305,300,000	$220,200,000	$85,100,000
Lands and Damages[2]	-	-	-
NED Total Project First Costs	$305,300,000	$220,200,000	$85,100,000
Non-federal Construction Costs (Local Service Facilities)	$37,800,000	$0	$37,800,000
Non-federal Berthing Area Costs	$12,700,000	$0	$12,700,000
Aids to Navigation[3]	$200,000	$200,000	$0
10% GNF Non-Federal[4]	$0	($30,500,000)	$30,500,000
Total NED Cost Allocation[5]	**$356,000,000**	**$189,900,000**	**$166,100,000**

1. Includes Turbidity Monitoring and Dedicated Marine Animal Observer

2. Real Estate Costs: There are no LERR for this project, there is $12,000 under PED for minimal administrative costs.

3. Navigation Aids - 100% Federal

4. The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment. The value of lands provided for mitigation including the sponsor's incidental cost of acquisition are not creditable against this 10% since that value is cost shared as a GNF.

5. In addition to these costs the AAEQ increases in O&M costs are approximately $55,500. Future O&M costs are due to the channel widening and are 100% Federal.

6. These bulkheads are required to stabilize the shoreline as the channel is deepened and widened the natural side slopes will fall. To prevent damage to John U Lloyd and the Conservation Easement from slide slopes, these bulkheads will be placed along portions of the SAC to maintain the existing shoreline.

The NED plan is cost shared 75/25 up to 45 feet and 50/50 greater than 45 feet as is shown in **Table 31** and the Recommended Plan (48-foot LPP) has an estimated additional cost of $18 million. The additional cost would be a 100% non-federal cost as is outlined in **Table 32**.

Table 32: Cost Sharing Table Recommended Plan/LPP Summary (October 1, 2014 price levels and FY2015 discount rate)

(October 1, 2014 Price Levels and FY15 discount rate) Cost Summary Recommended Plan/Locally Preferred Plan (Deepen to 48 feet)			
	Total Cost	Federal Share	Non-federal Share
	20-45 ft.	75%	25%
	46-47 ft.	50%	50%
General Navigation Features	48 ft.	0%	100%
Mobilization	$3,100,000	$2,100,000	$1,000,000
Dredging and Disposal	$147,800,000	$93,000,000	$54,800,000
Environmentally Friendly Bulkhead[6]	$61,000,000	$45,800,000	$15,200,000
Associated General Items[1]	$5,100,000	$3,200,000	$1,900,000
Environmental Mitigation	$52,800,000	$37,100,000	$15,700,000
Mitigation (Mangrove, Seagrass, Art Reef w/Corals)	*$35,600,000*	*$25,400,000*	*$10,200,000*
Monitoring	*$900,000*	*$700,000*	*$200,000*
Coral Propagation	*$16,300,000*	*$11,000,000*	*$5,300,000*
Pre-Construction, Engineering, and Design	$5,600,000	$3,900,000	$1,700,000
Construction Management (S&I)	$8,400,000	$5,900,000	$2,500,000
USCG Reconfiguration	$38,900,000	$29,200,000	$9,700,000
Subtotal Construction of GNF	$322,700,000	$220,200,000	$102,500,000
Lands and Damages[2]	-	-	-
Total Project First Costs	$322,700,000	$220,200,000	$102,500,000
Non-federal Construction Costs (Local Service Facilities)	$37,800,000	$0	$37,800,000
Non-federal Berthing Area Costs	$13,400,000	$0	$13,400,000
Aids to Navigation[3]	$200,000	$200,000	$0
10% GNF Non-Federal[4]	$0	($30,500,000)	$30,500,000
Total Cost Allocation[5]	$374,100,000	$189,900,000	$184,200,000

1. Includes Turbidity Monitoring and Dedicated Marine Animal Observer
2. Real Estate Costs: There are no LERR for this project, there is $12,000 under PED for minimal administrative costs.
3. Navigation Aids - 100% Federal
4. The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment. The value of lands provided for mitigation including the sponsor's incidental cost of acquisition are not creditable against this 10% since that value is cost shared as a GNF.
5. In addition to these costs the AAEQ increases in O&M costs are approximately $55,500. Future O&M costs are due to the channel widening and are 100% Federal. There is no increase in O&M costs from 47 to 48 feet.
6. These bulkheads are required to stabilize the shoreline as the channel is deepened and widened the natural side slopes will fail. To prevent damage to John U Lloyd and the Conservation Easement from slide slopes, these bulkheads will be placed along portions of the SAC to maintain the existing shoreline.

8.5 Federal Responsibilities

Federal funding is subject to budgetary constraints inherent in the formation of the national civil works budget for a given fiscal year. The USACE will perform the necessary planning, engineering and design needed for the Federal project prior to construction. The USACE will obtain water quality certification and coastal zone management consistency determination for all construction pursued (including associated Port berthing area dredging, toe wall/bulkhead construction and Port infrastructure construction), and abide by the terms and conditions of the Biological Opinion.

8.6 NON-FEDERAL RESPONSIBILITIES

Non-federal construction costs for local service facilities are approximately $37.8 million. These include berthing area costs (Toe Wall, Cathodic Protection, Marine Hardware, etc.) in the Main Turning Basin (Berths 7 and 8), Turning Notch (Berth 30) and the Southport Access Channel (Berths 31 and 32). The cost for non-federal berthing area mechanical dredging in the Main Turning Basin, Southport Access Channel and Turning Notch are approximately $13.4 million. The total estimated non-federal costs for local service facilities and berthing area dredging total $51.2 million. These are 100% non-federal costs.

The non-federal sponsor, after the project has been authorized for construction, enters into a Project Partnership Agreement (PPA) with the United States Government.

8.7 ENVIRONMENTAL CONSIDERATIONS

The National Environmental Policy Act (NEPA) requires Federal agencies to employ an interdisciplinary approach in the decision-making process to ensure that unquantified environmental values are also given appropriate consideration. Section 6 of the **EIS** details compliance with applicable environmental laws. In achieving the goals of providing features to improve navigation and national economic benefits, the impacts to the natural system of South Florida's shorelines, estuaries, benthic communities, fisheries, and associated terrestrial and maritime habitat, including but not limited to, the inshore areas of the Intracoastal waterway and the reefs and hardbottom habitats have been considered in the formulation process.

Extensive plan formulation, plan revision, and plan refinement have avoided impacts to the environment, whenever possible, and minimized impacts to the environment to the greatest extent possible while still meeting the project need and purpose. Efforts have been made to include stakeholders in the planning process to assist the USACE in minimizing environmental impacts. There are several unavoidable environmental impacts of the proposed project to the natural environment.

To compensate for the unavoidable adverse effects of the action on various significant habitat types, USACE has proposed the following: mitigate for (a) the removal of approximately 7.41 acres of vegetated and unvegetated seagrass habitat (including that within the new channel footprint and resulting side slopes) and (b) the loss of approximately 1.16 acres of mangroves in the project footprint through use of ecosystem benefits from a previously permitted Broward County restoration project at West Lake Park (Broward County, FL), which is currently under design. Mitigation for impacts will involve use of approximately 2.4 seagrass functional units and approximately one (1) mangrove functional unit, respectively, from that project, located in a county-operated, state-owned, natural area immediately to the south of the project area. USACE has also

proposed the following: mitigate for (c) the direct removal of approximately 14.62 acres of complex, high-profile, linear and spur/groove reef habitat through the creation of approximately 5 acres of artificial reef with the transplantation of 11,502 corals from the impact site to the artificial reef and the outplanting of approximately 103,000 nursery raised corals. Additional mitigation will be provided due to any detectable, incidental, direct impacts of dredging equipment and indirect impacts on hardbottom habitats due to turbidity/sedimentation. These mitigation components were determined to be economic "Best Buys" from among mitigation alternatives.

8.8 Other Related Laws

As previously mentioned, the proposed action affects seagrass, mangrove and hardbottom/reef communities and other waters of the United States subject to Section 404 of the Clean Water Act (CWA). A Section 404(b)(1) Evaluation Report has been completed and is included in the **EIS** to comply with the CWA. USACE will seek state approval. The state permitting process is used to obtain a coastal zone consistency determination and WQC.

The U.S. Fish and Wildlife Service (USFWS) has provided several recommendations in the Coordination Act Report (CAR).

The USACE has determined that the project "may affect, but is not likely to adversely affect" the Federally endangered species including the West Indian manatee; American crocodile; green, Kemp's ridley, hawksbill and leatherback sea turtles; and smalltooth sawfish; as well as the threatened loggerhead sea turtle, and threatened Johnson's seagrass and Acroporid corals, and has determined that the project is not likely to adversely modify designated critical habitat. NMFS provided a Biological Opinion on March 7, 2014 with a Clarification Letter on May 1, 2014.

In addition, the USACE has determined that the following whale and dolphin species may be affected during blasting activities – bottlenose dolphin, endangered humpback, fin, sei, blue, and sperm whales that are known to occur along the Atlantic coast. The USACE has also determined that designated critical habitat for the West Indian manatee, Johnson's seagrass, and Acroporid corals will not be adversely modified by the proposed action. The USACE has agreed to incorporate the *Standard Manatee Protection Construction Conditions* and implement a blasting plan to minimize possible adverse effects to listed marine species using the standard "Navy Diver" protocol. Consultation with the USFWS, including a biological assessment, was completed and is addressed in the **EIS**. The previously mentioned whale and dolphin species are also protected by the Marine Mammal Protection Act of 1972 (MMPA). Refer to Section 6 of the **EIS** for the complete listing and discussion of all other related laws addressed in this study.

8.9 FLOODPLAIN MANAGEMENT

Executive Order 11988 requires the Federal Government to avoid, to the extent possible, adverse impacts associated with the occupancy and modification of floodplains as well as direct or indirect support of development in those areas where there is a practical alternative. The existing Port facilities at Port Everglades are already in the 100-year floodplain (National Flood Insurance Program). Federal improvement of the existing navigation project will encourage continued use of existing facilities on those lands, as well as those already planned for future growth in commerce.

8.10 COASTAL ZONE MANAGEMENT CONSISTENCY

The Coastal Zone Management (CZM) Act of 1972, as amended (PL92-583) requires Federal activities to be consistent to the maximum extent practicable with federally approved enforceable policies of a state's coastal management plan.The state will review the permit application and project plans and specifications in order to make a final consistency determination prior to project construction. See **Sub-Appendix C of the EIS.**

8.11 COASTAL BARRIER RESOURCES ACT

The proposed new Federal investment decision for the Port Everglades navigation project does not include any recommendations that would result in any new Federal expenditures or financial assistance prohibited by the Coastal Barrier Resources Act (Public Law 97-348); nor were funds obligated in past years for this project for purposes prohibited by this Act.

8.12 SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

The Feasiblity Phase of the study began in 2001 and included a NEPA public scoping meeting on March 28, 2001. Prior to this meeting the Notice of Intent to prepare an **EIS** appeared in the Federal Register, Volume 66, No. 57, on March 23, 2001. As outlined in the EIS, numerous meetings with the resource agencies were held. As is detailed in the **EIS Section 1.6 Table 1**, during the feasibility phase there were 40 agency and/or public meetings held between 2001 and 2014.

8.13 PUBLIC REVIEW

A 45-day comment period for the Draft EIS opened with publication of a Notice of Availability of the EIS in the Federal Register on June 28, 2013. Two public meetings were held during the above mentioned comment period. 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 of the comments received 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. A summary of the public comments is included in the EIS Sub-Appendix L which includes copies of the comments received on the DEIS and the responses to comments.

8.14 ENVIRONMENTAL JUSTICE

The purpose of the proposed action is to provide increased maneuverability, efficiency, and lower costs for navigation while protecting the environment. Existing Port facilities are not easily accessible to some larger vessels, which must await favorable tidal conditions, because of depth limitations in parts of the channel, and other large vessels can only use the channel if they are light-loaded. The proposed activity would not exclude the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies. Meaningful Involvement means that; 1) people have an opportunity to participate in decisions about activities that may affect their environment and/or health; 2) the public's contribution can influence the regulatory agency's decision; 3) their concerns will be considered in the decision making process; and 4) the decision makers seek out and facilitate the involvement of those potentially affected. The proposed project would benefit shipping and the general economy including minority and low income populations.

While there are no identified minority or low income populations that are in the study area or would be affected by the project, the stakeholder involvement approach has been wide reaching and provide a variety of opportunities for all affected communities to comment on the project.

9.0 RECOMMENDATIONS

I concur with the findings presented in this report. The Recommended Plan developed is technically sound, economically justified, and socially and environmentally acceptable.

The work proposed is not within existing authority. I recommend that the plan selected herein for the 48-foot locally preferred deepening alternative be authorized by Congress for implementation. Mitigation is required for seagrasses, mangroves, and reef and hardbottoms affected by the deepening. Mitigation of 2.4 seagrass functional units and one (1) mangrove functional unit will be provided in a county-operated, state-owned, natural area immediately to the south of the project area. Approximately 5 acres of artificial reef will be constructed with the transplantation of 11,502 corals from the impact site to the artificial reef and outplanting of approximately 103,000 nursery raised corals. Additional mitigation will be provided due to any detectable, incidental, direct impacts of dredging equipment and indirect impacts on hardbottom habitats due to turbidity/sedimentation. These mitigation components were determined to be economic "Best Buys" from among mitigation alternatives. Aids to navigation will be provided at 100% Federal cost. Absent sufficient Coast Guard funding, or adequate justification for the navigation aids, non-Federal interests may be required to provide them.[6]

For the purpose of calculating the Section 902 limit, the total estimated project first cost of the project is $322,700,000, October 1, 2014 price level, including an estimated Federal share of $220,000,000 and an estimated non-federal share of $102,500,000. The total estimated project cost includes only GNF costs plus LERR value. The Federal share includes only the Government's percentage share of GNF costs. The estimated non-federal share includes only the non-federal initial percentage share of GNF costs (i.e. not the extra 10% payment amount) plus LERR value. The cost for local service facilities and non-federal berthing areas is approximately $51,200,000 million dollars. These costs are 100% non-federal and are not included in the first total cost of the Recommended Plan.

The Recommended Plan conforms to the essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines on project development. If the project were to receive funds for Federal implementation, it would be implemented subject to the cost sharing, financing, and other applicable requirements for navigation projects. These requirements were established by WRDA 1986, as amended, and would be implemented with such modifications, as the Chief of Engineers deems advisable within his discretionary authority. Federal implementation is contingent upon the non-Federal sponsor agreeing to comply with applicable Federal laws and policies. Prior to implementation, the non-Federal sponsor would enter into a written PPA, to include the following non-Federal responsibilities:

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[6] **Planning Guidance Notebook, ER 1105-2-100, E-8 a.(2)**

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

(1) 25 percent of the cost of design and construction of the GNFs attributable to dredging to a depth in excess of -20 feet MLLW but not in excess of -45 feet MLLW, plus

(2) 50 percent of the cost of design and construction of the GNFs attributable to dredging to a depth in excess of -45 feet MLLW but not in excess of -47 feet MLLW, plus

(3) 100 percent of the costs attributable to dredging to a depth over -47 feet MLLW;

b. Provide all lands, easement, and rights-of-way (LER), including those necessary for the borrowing of material and placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, all as determined by the Government to be necessary for the construction or operation and maintenance of the GNFs;

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of GNFs less the amount of credit afforded by the Government for the value of the LER and relocations, including utility relocations, provided by the non-Federal sponsor for the GNFs. If the amount of credit afforded by the Government for the value of LER, and relocations, including utility relocations, provided by the non-Federal sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LER and relocations, including utility relocations, in excess of 10 percent of the total costs of construction of the GNFs;

d. Provide, operate, and maintain, at no cost to the Government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Government, including but not limited to the following:

e. In the case of project features greater than -50 feet MLLW in depth, provide 50 percent of the excess cost of operation and maintenance of the project over that cost which the Government determines would be incurred for operation and maintenance if the project had a depth of 50 feet;

f. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating and maintaining the GNFs;

g. Provide, at a cost to the Project, prior to construction and for the authorized life of the project, mitigation necessary to offset impacts to seagrasses and mangroves, currently estimated to be 2.4 seagrass functional units and one (1) mangrove functional unit;

h. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

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

j. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

k. Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the project;

l. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

m. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law99-662, as amended, (33 U.S.C. 2211(e)) which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

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

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

p. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation that are in excess of 1 percent of the total amount authorized to be appropriated for the project; and

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

r. Provide and maintain without cost to the United States operation, maintenance, repair, replacement, and rehabilitation of all mitigation areas for the life of the authorized project as described in the Recommended Plan.

The recommendations contained herein reflect the information available at this time and current Department policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before proposals are made for authorization and implementation funding. However, prior to transmittal to the Congress, the non-federal Sponsor, the state, interested Federal agencies, and other parties will be advised of any changes and will be afforded the opportunity to comment further.

Alan M. Dodd
Colonel, U. S. Army
District Commander

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Acronyms/definition of terms

AAEQ	Average Annual Equivalent (economic term)
BCR	Benefit to Cost Ratio
CESAJ	U.S. Army Corps of Engineers – Jacksonville District
CGWAVE	Coastal Gravity WAVE computer program
COE	U.S. Army Corps of Engineers
Corps	U. S. Army Corps of Engineers
CY	Cubic Yards
CZM	Coastal Zone Management Consistency
DEP	Department of Environmental Protection
DCC	Port Everglades Dania Cutoff Canal
DMMP	Dredged Material Management Plan
DOT	Department of Transportation
DWT	Dead Weight Ton
EIS	Environmental Impact Statement
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
EQ	Environmental quality - accounts for non-monetary effects on environmental, cultural, and aesthetic resources
EFB	Environmentally Friendly Bulkhead
ESA	Endangered Species Act of 1973
FEC	Florida East Coast Railway
FCSA	Feasibility Cost Sharing Agreement
FDEP	Florida Department of Environmental Protection
FLO/FLO	Float off – Float Off
FSM	Feasibility Scoping Meeting
FTZ	Foreign Trade Zone
FWC	Florida Fish and Wildlife Conservation Commission
GNF	General Navigation Feature
HCD	Habitat Conservation Division
HTRW	Hazardous, Toxic, and Radioactive Waste
ICTF	Intermodal Container Transfer Facility
IEC	Port Everglades Inner Entrance Channel
INROADS	Proprietary computer program used to calculate volumes
IWW	Intracoastal Waterway
JCP/WQC	Joint Coastal Permit/Water Quality Certification
LERRD	Lands, easements, rights of way, relocations and disposal area
LIDAR	Light Detection and Ranging (survey technology)
LOA	Length overall (vessel)
LO/LO	Load on/Load off
LPP	Locally Preferred Plan
MCACES	Micro Computer Aided Cost Engineering System
MLLW	Mean Lower Low Water
MTB	Port Everglades Main Turning Basin
Navy	U.S. Navy

NED	National Economic Development
NMFS	U.S. National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSU	Nova Southeastern University
NTB	Port Everglades North Turning Basin
ODMDS	Ocean Dredged Material Disposal Site
OEC	Port Everglades Outer Entrance Channel
OSE	Other social effects of a project (safety, quality of life, etc)
Panamax	Vessels that can navigate the Panama Canal
PCA	Project Cooperation Agreement (between Corps and Sponsor)
PED	Pre-construction, engineering and design (design phase of a project)
P&G	Water Resources Principles and Guidelines
Pilots	Port Everglades Pilots Association
Port	Broward County Department of Port Everglades
Post-Panamax	Vessels too large to navigate the Panama Canal before the expansion
PPA	Project Partnership Agreement
RED	Regional economic development - changes in distribution of regional economic activity
R&H Act	Rivers and Harbors Act (Federal legislation)
RFP	Request For Proposal
ROD	Record of Decision - final decision on environmental document
RO/RO	Roll on/Roll off
RP	Recommended Plan
S&A	Supervision and administration of construction work
SAC	Port Everglades Southport Access Channel
SDM	Surface Docking Module
STAR	Simulation Training and Research Center - ship simulation facility
STB	Port Everglades South Turning Basin
TEU	Twenty Foot Equivalent Unit (container size)
TIN	Triangulated Irregular Network (computer 3-D surface)
TN	Port Everglades Turning Notch
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
WAM	Waterways Analysis Model
WRDA	Water Resources Development Act (Federal legislation)

Changes to the Port Everglades EIS in Response to FEIS Comments

1. Date of EIS changed to May 2015
2. Section 1.1 – Update study objectives to exactly match language in feasibility study (remove 2 objectives that were dropped from previous versions of the study that did not get changed in the EIS).
3. Section 1.8 – Added additional clarification on the status of EPA's ODMDS expansion EA and USACE's incorporation of that document.
4. Section 2.1 – Revise study objectives to exactly match language in feasibility study.
5. Section 2.3.3 – Updated to add volume of material to be dredged and Reference to this being the "Least Environmentally Damaging Alternative"
6. Section 4.4.2.2-
    a. Updated the number of in situ SCUBA dives completed at Miami Harbor as of May 2015.
    b. Corrected the distance of the closest monitored coral to channel in 1980-81 dredging from meters. Previously said 1,000 meters (300 m). The 300 meters was an error and has been deleted.
    c. Figure 79 – Corrected location from Miami to Florida Keys.
    d. The statement "US Environmental Protection Agency's" has been shortened to USACE's since this is not the first usage of the acronym for USEPA.
    e. Added reference to Permanent International Association of Navigation Congresses' (PIANC) document "Dredging and Port Construction around Coral Reefs"
7. Section 4.4.2.3 – Revised second sentence to improve readability.
8. Section 5.4 - Added reference to Permanent International Association of Navigation Congresses' (PIANC) document "Dredging and Port Construction around Coral Reefs"
9. Section 8.0 Status of some reviewers updated to add additional reviewers who were left off the reviewers list or reflect current status (retired, no longer with the agency).
10. Literature Cited – added PIANC 2010

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

March 2015 (Rev May 2015)

U.S. Army Corps of Engineers, Jacksonville District

FINAL ENVIRONMENTAL IMPACT STATEMENT
Port Everglades Harbor Navigation Study, Broward County, Florida

March 2015 (Rev May 2015)

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.

For information, contact

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904-232-1817

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 and channel passing restrictions 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 maneuverability and efficiency at the Port for existing vessel use, as well as for larger vessels through the 50-year period of analysis**

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.

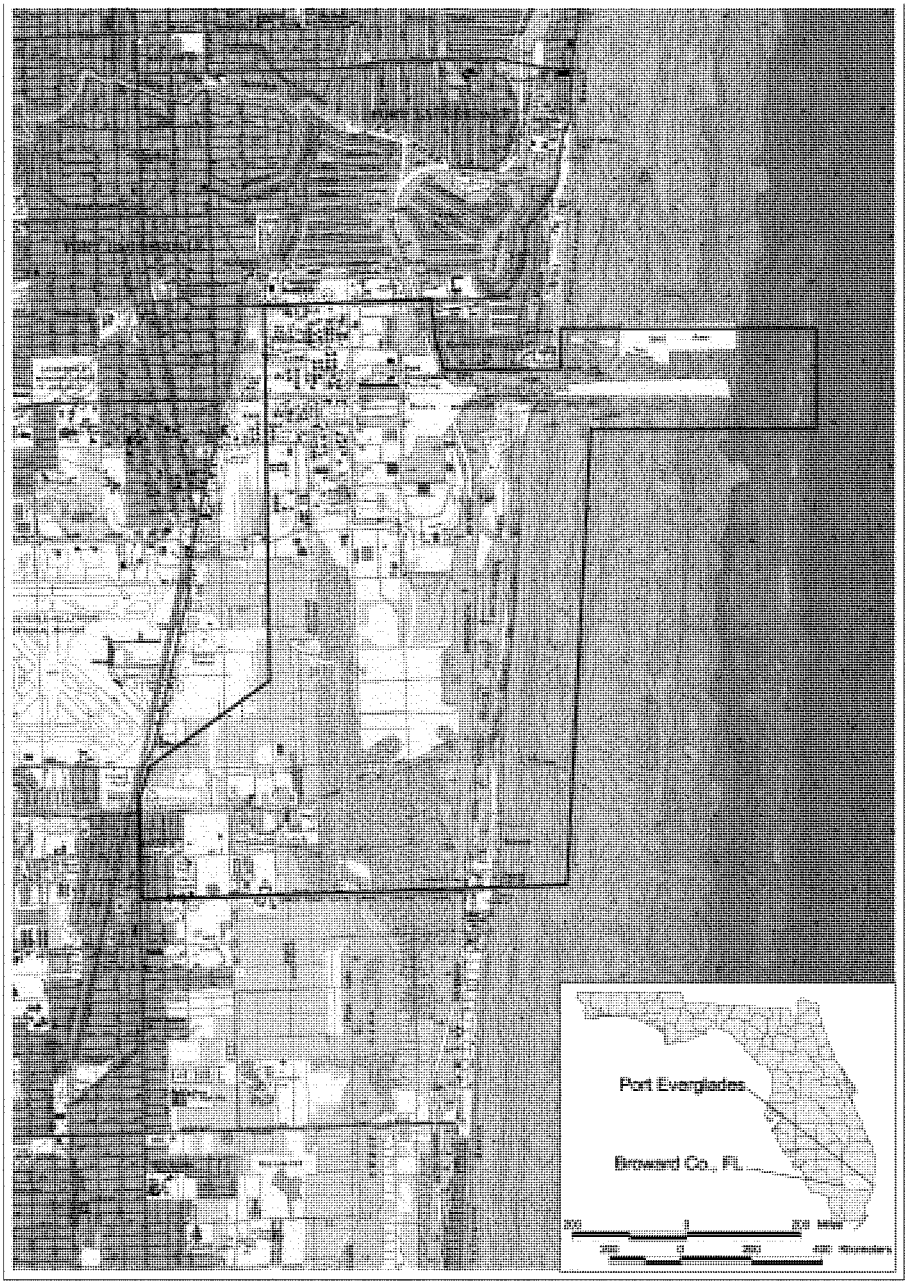
The existing authorized Port Everglades Federal Navigation Project provides for an Outer Entrance Channel (OEC) that is 45 feet deep and 500 feet wide (Figure 2), an Inner Entrance Channel (IEC) that is 450 feet wide and 42 feet deep, a Main Turning Basin (MTB) that is 42 feet deep, a North Turning Basin (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.

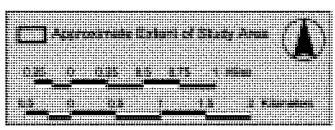
The existing federal channel project depth of 42 feet at Port Everglades does not provide an adequate, safe depth for large tankers and container ships currently visiting the harbor (Section 4.2 of the Port Everglades Feasibility Study). Those ships must be light-loaded or wait on tides to enter the 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.





Port Everglades Location	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
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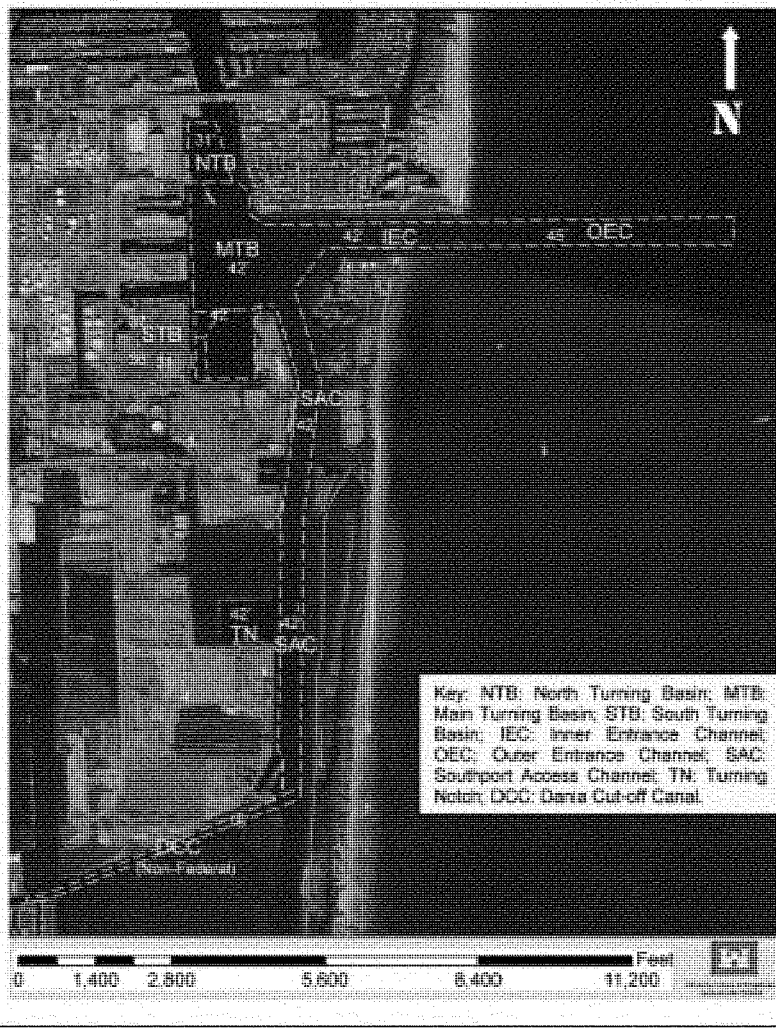
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	2
	Figure



Port Everglades Existing Channel Components and Authorized Depths	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
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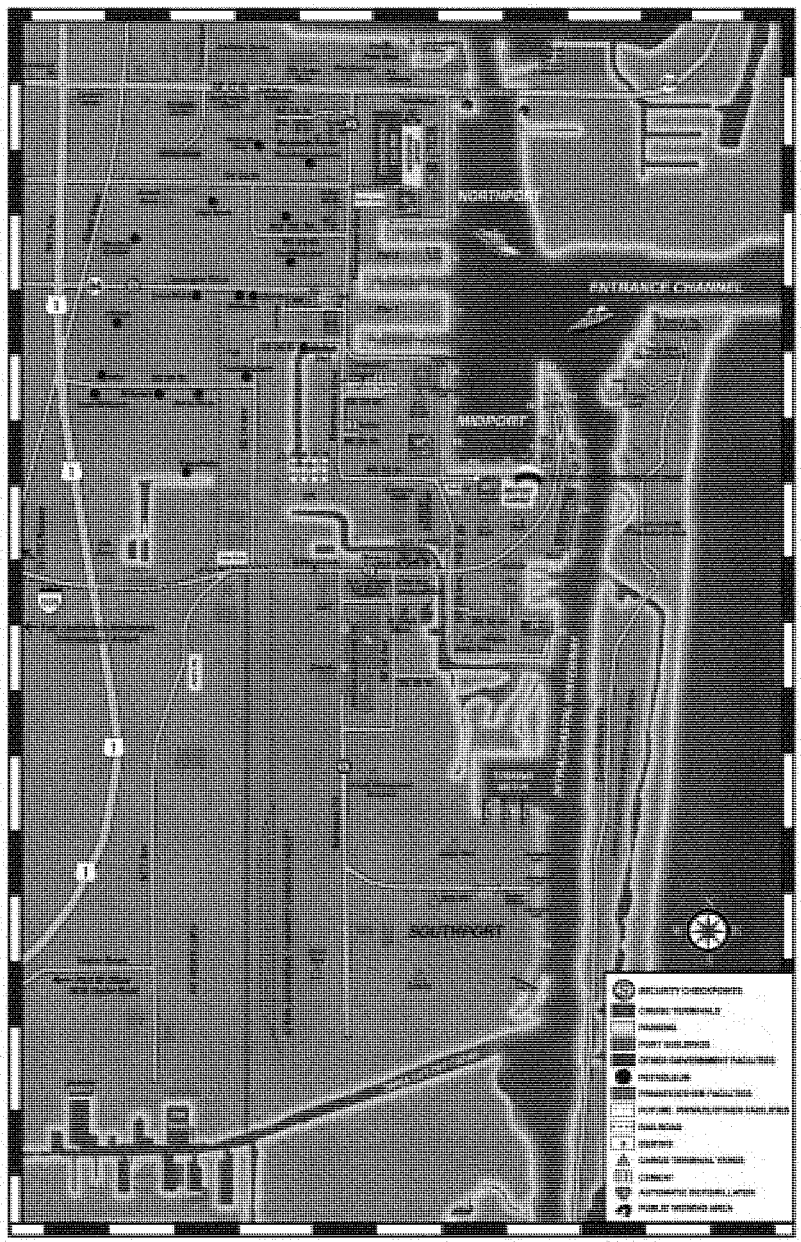
	Figure 2



Source: Port Everglades/Broward County FL, 2009.

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

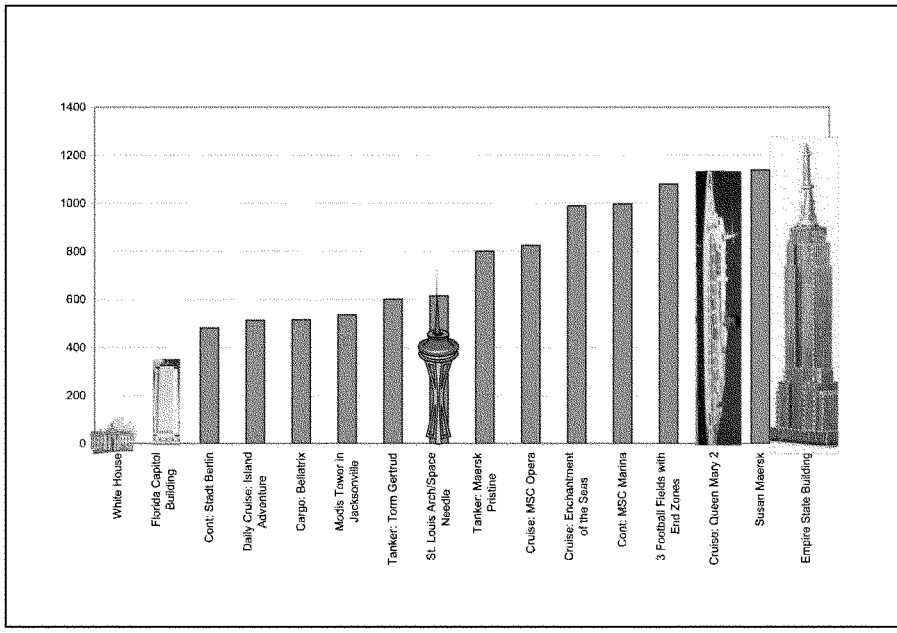


Figure 4 Comparison of Port Everglades Ship Lengths to Notable Structures and Vessels

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. In the event that ODMDS expansion and use is necessary and practicable, USEPA and USACE have initiated NEPA coordination. The Draft Environmental Assessment (EA) for the expansion of the ODMDS was released for public review and comment by USEPA on August 27, 2013 and will be finalized by USEPA through the rulemaking process for the expansion of the Port Everglades ODMDS including the results of site monitoring conducted during September 2014. 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. The results and analysis of the USEPA ODMDS expansion EA are incorporated into this EIS by reference in compliance with 40 CFR §1502.21.

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 recommended for 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 and channel passing restrictions 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 maneuverability and efficiency 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 1.4.11, and Sub-Appendix E "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 incrernental benefits of various project depths for the OEC.

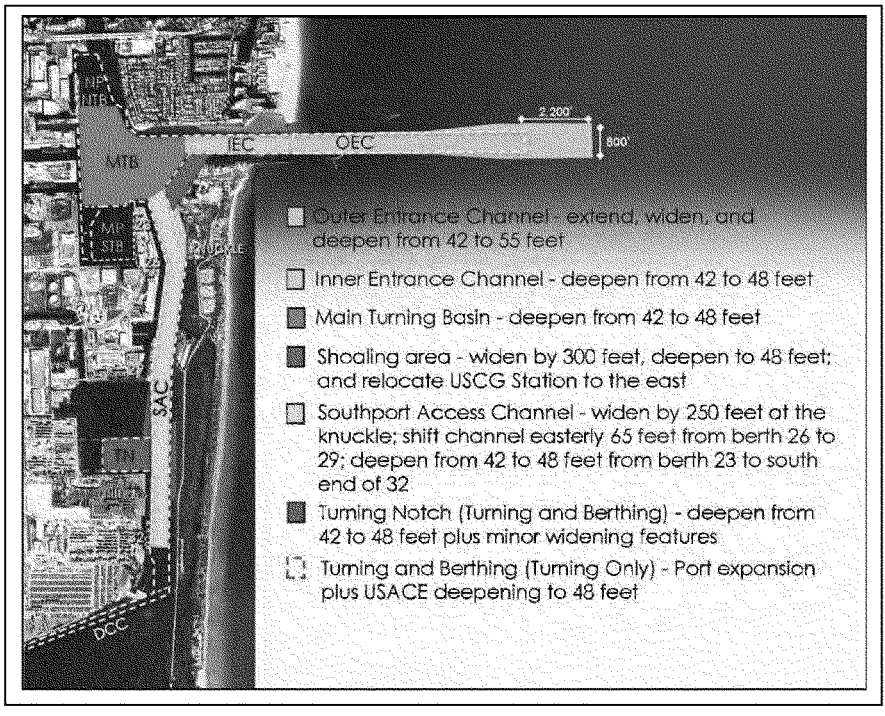


Figure 5 Proposed Components of the Various Plans, Including the Recommended Plan

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, with the removal of 4.85 million cubic yards of material for Alternative 2E. This alternative was evaluated for environmental effects and comparison to the LPP and the No Action Alternative. This alternative was determined to be the least environmentally damaging 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

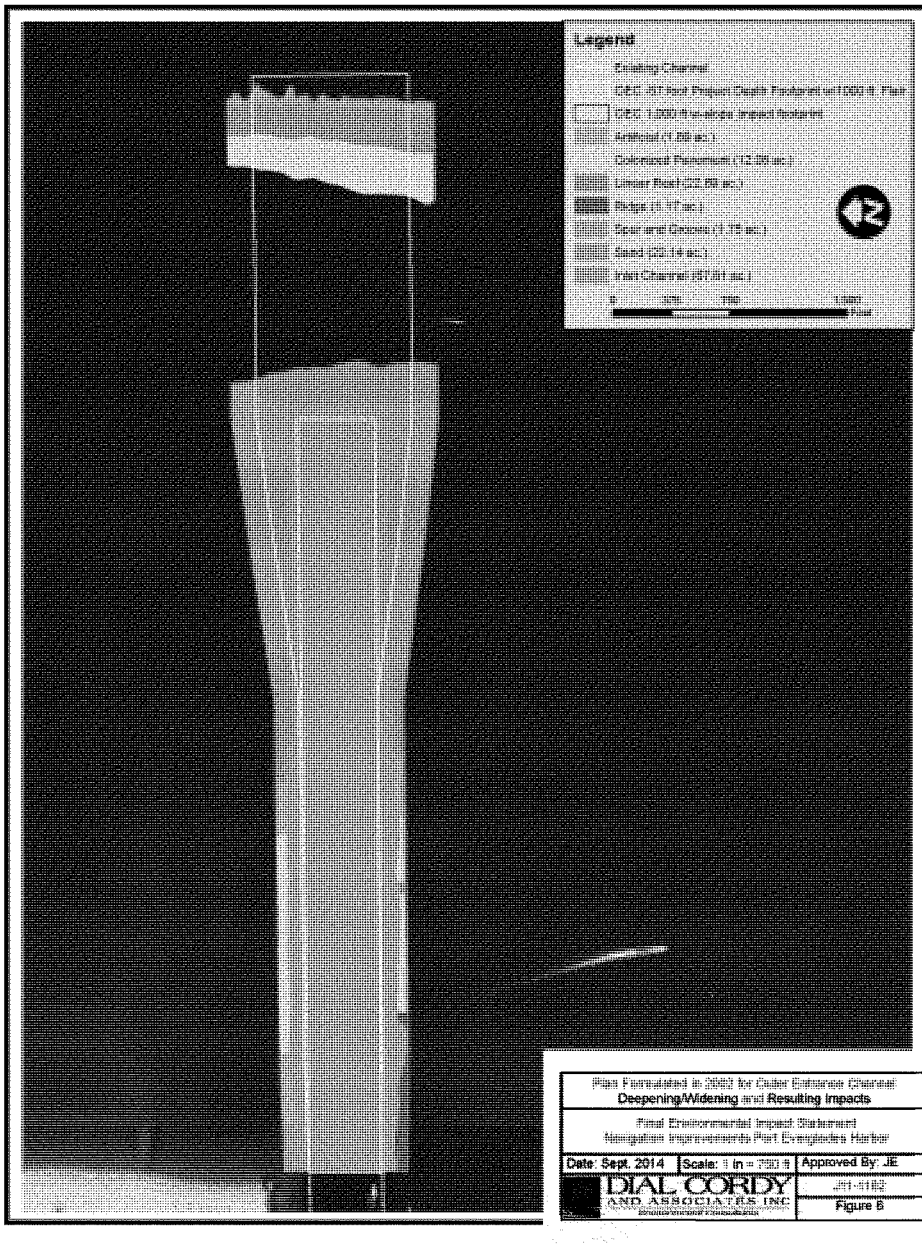
Entrance channel alternatives, typically proposed to reduce reef impacts, were necessarily based on reef position and geometry as well as bottom depths. Therefore, a working knowledge of the county's reef system, including relevant nomenclature, is necessary to understand descriptions of each option.

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.

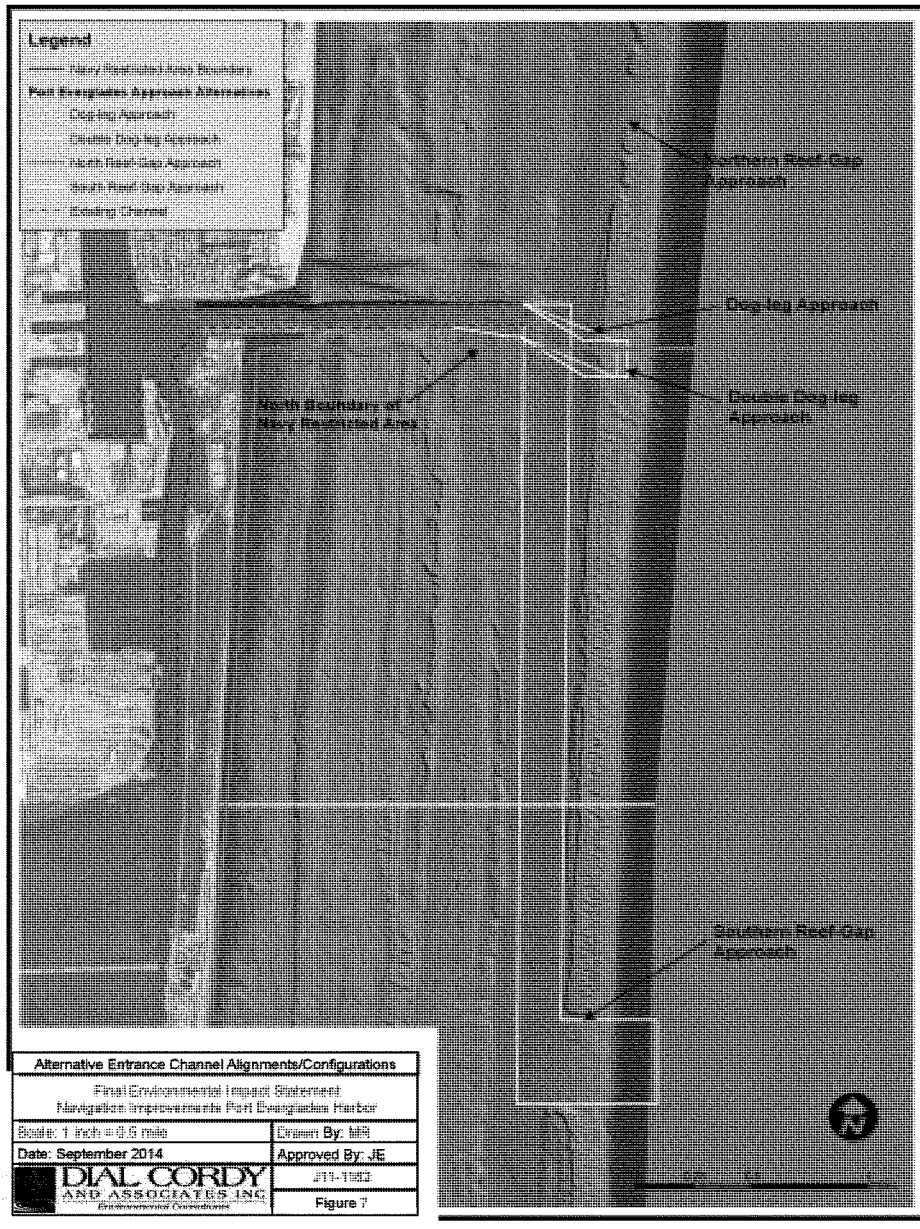
1,000-Foot-Wide OEC Flare with 3:1 Side Slopes. In 2000, during meetings with the Port Everglades Pilots Association regarding the need for a safe channel, analyses indicated that a channel with a 1,000-wide flare on the seaward (i.e., eastern) end was a required project component due to a need to simplify 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.


Legend
Existing Channel
Artificial (1.89 ac.)
Colonized Pleistocene (12.09 ac.)
Linear Reef (22.89 ac.)
Ridge (1.17 ac.)
Spur and Groove (1.75 ac.)
Sand (22.14 ac.)
Inlet Channel (67.81 ac.)
0
500
1,000
Feet
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 = 700 ft
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
Figure 6

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).

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.

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	J11-1503
	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:* as 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

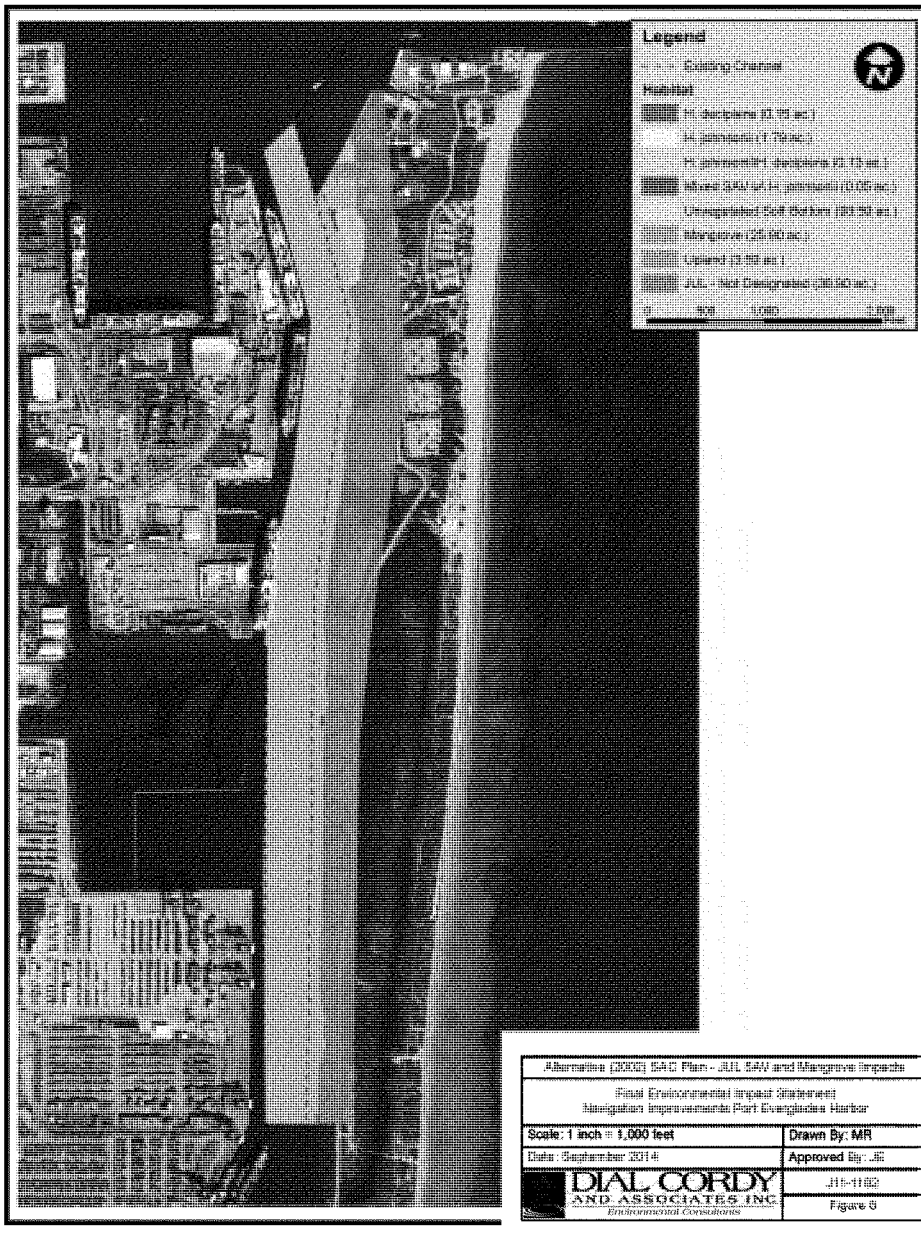
Alternative	Addresses Objective 1	Addresses Objective 2	Addresses Objective 3
Deepen/Widen	X	X	X
NOAA			
Offshore			Partially (petroleum)
Lightering			Partially (petroleum)
Truck		X	
Rail			Partially (cargo)

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.


Legend
Existing Channel
Habitat
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
Figure 5

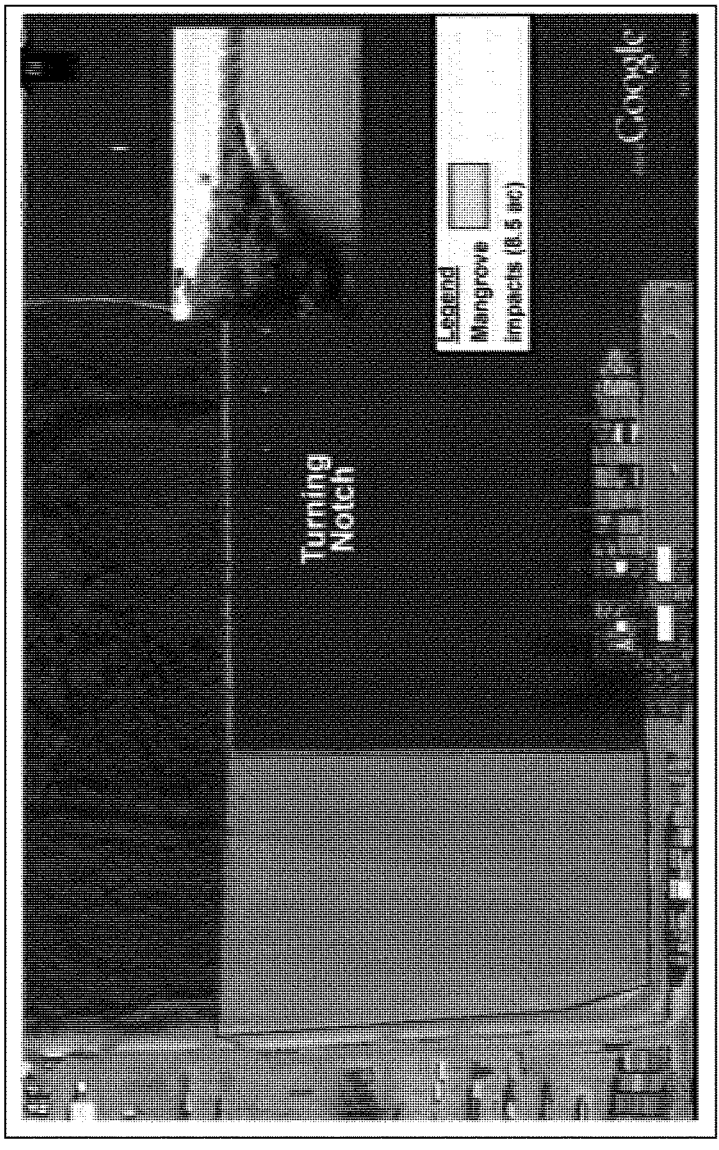


Figure 9 Plan Formulated in 2002 for Turning Notch Deepening/Widening and Resulting Impacts

Legend
Existing Channel
Habitat
H. decipiens (2.40 ac.)
H. johnsonii (0.51 ac.)
H. johnsonii/H. decipiens (0.04 ac.)
Unvegetated Soft Bottom (40.77 ac.)
Mangrove (1.54 ac.)
0
380
600
1,200
Feet
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
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.

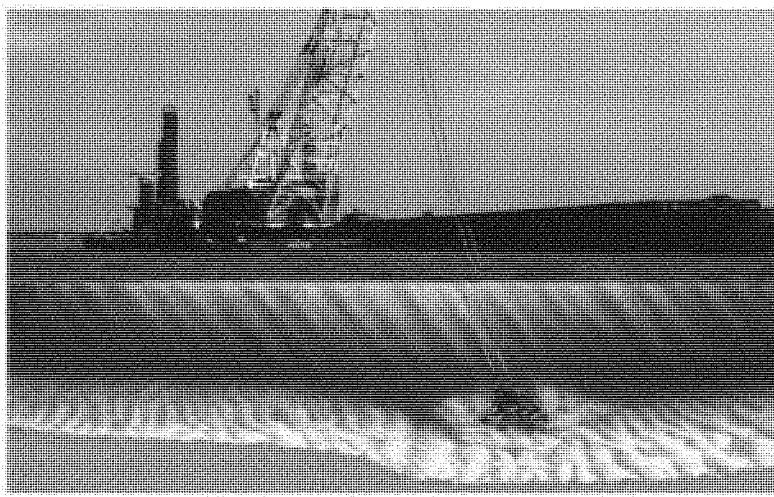
2.9.2.1 Mechanical Dredging

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

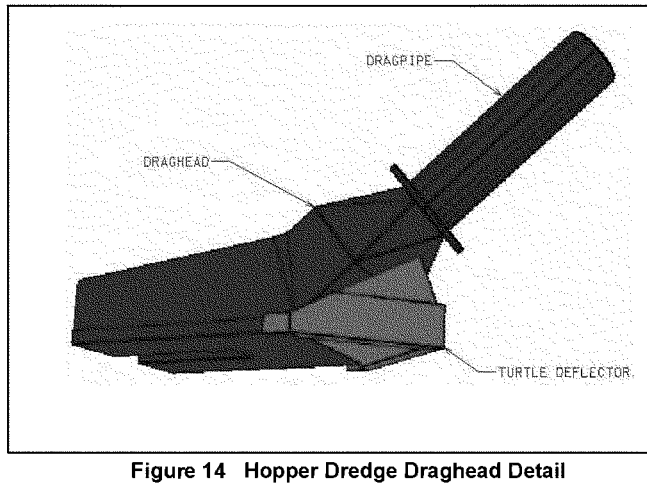


Figure 14 Hopper Dredge Draghead Detail

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.

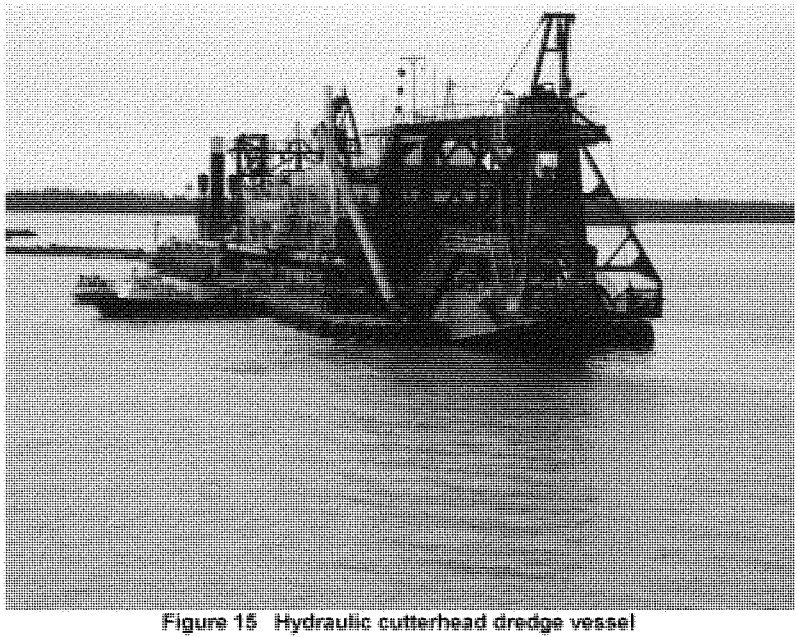


Figure 15 Hydraulic cutterhead dredge vessel

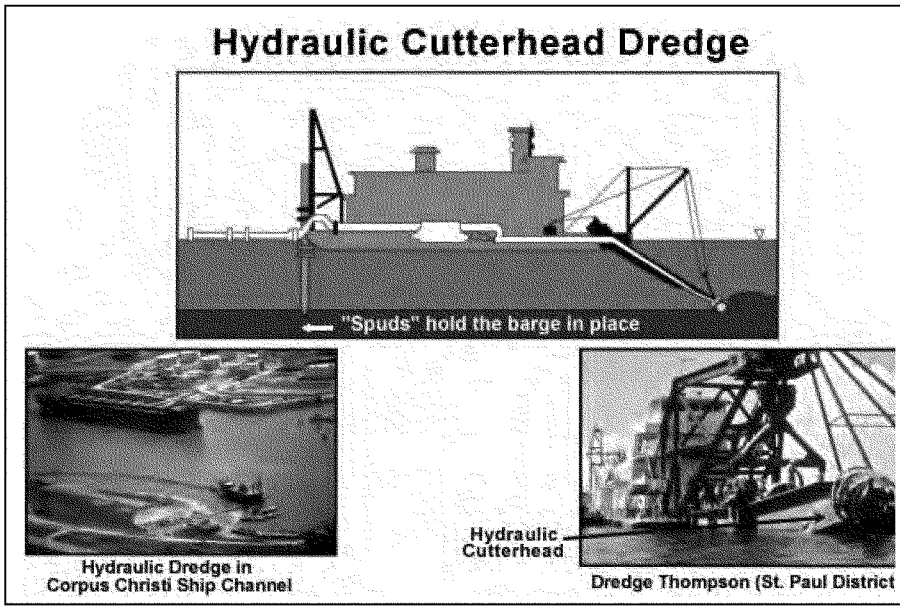


Figure 16 Cutterhead Dredge Configuration

Photo/drawing: Engineer Research and Development Center 2007

Figure 17 Cutterhead Dredge Contacting Substrate

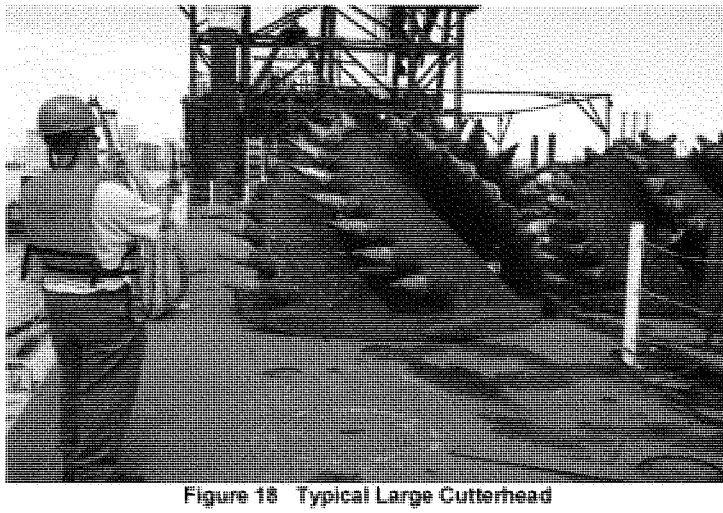


Figure 18 Typical Large Cutterhead

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

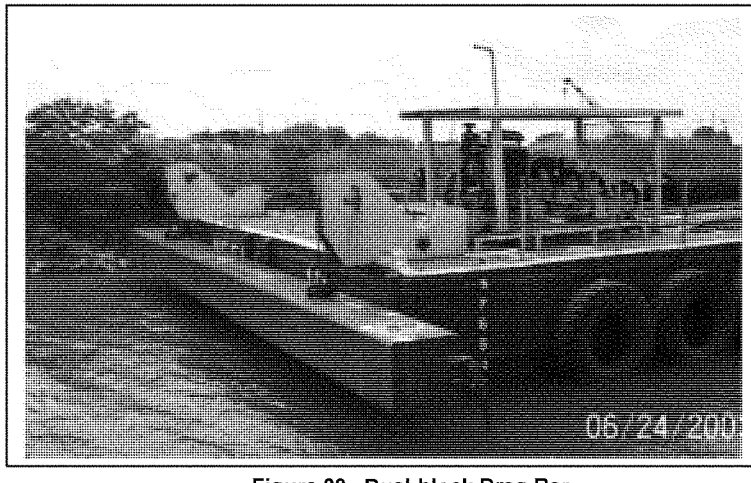
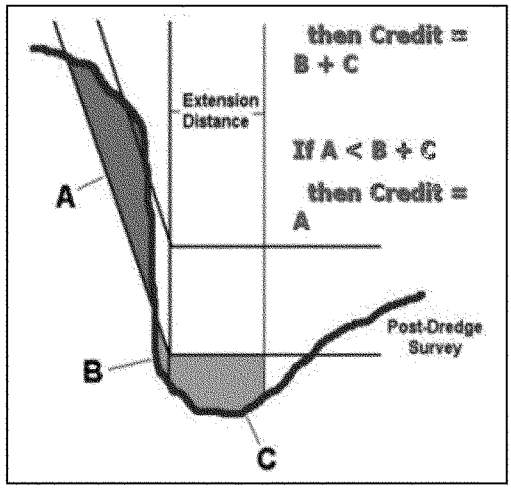


Figure 20 Dual-block Drag Bar

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.



Overcut along the sides (=**B+C**)

Material from side above (**A**) would slough down to more or less fill the overcut

Figure 21 Diagram of Overcut in Dredged Channel Cross-Section

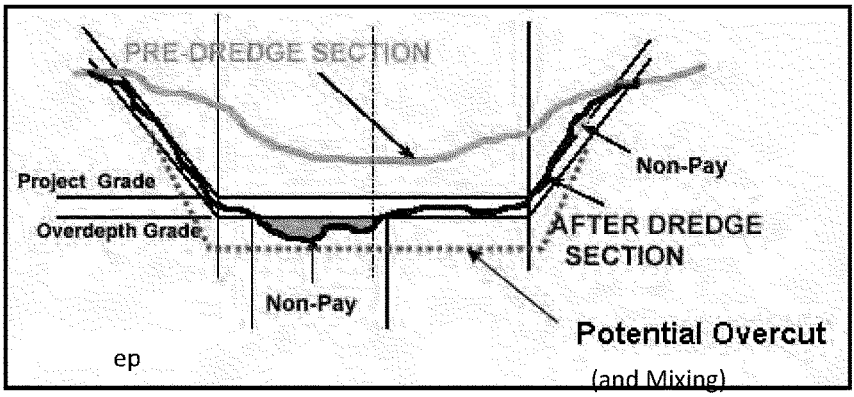


Figure 22 Typical Cross-Section Showing Project Grade Relative to Overdepth Grade

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.

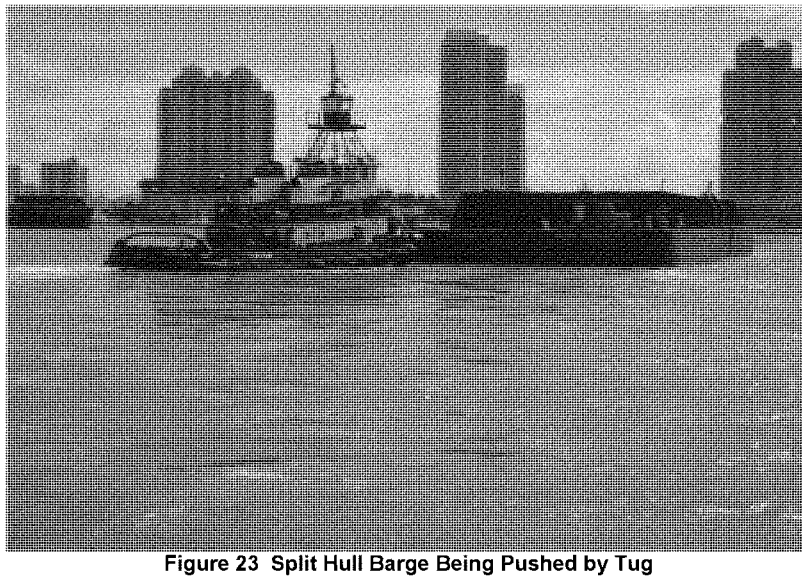


Figure 23 Split Hull Barge Being Pushed by Tug

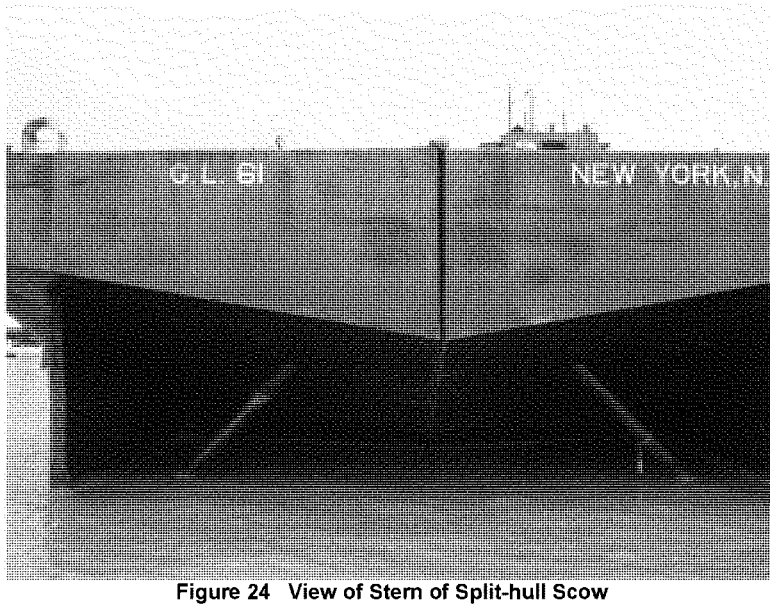


Figure 24 View of Stern of Split-hull Scow

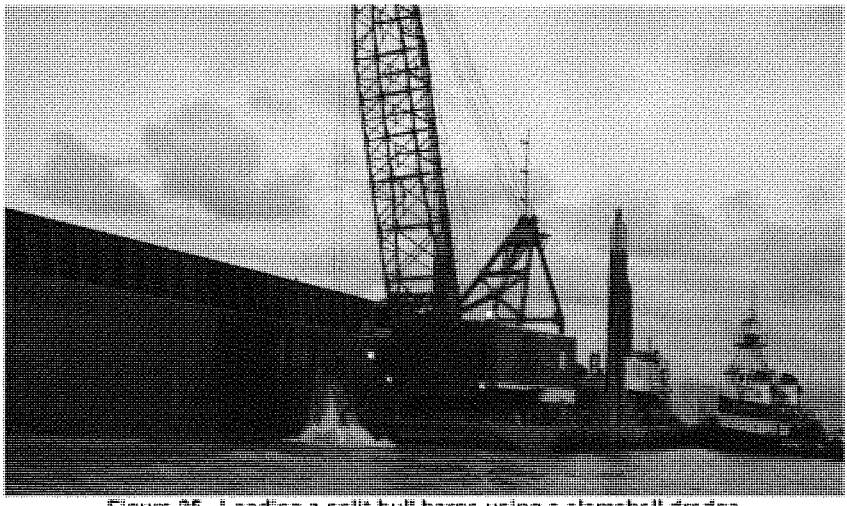


Figure 25 Loading a split-hull barge using a clamshell dredge

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).

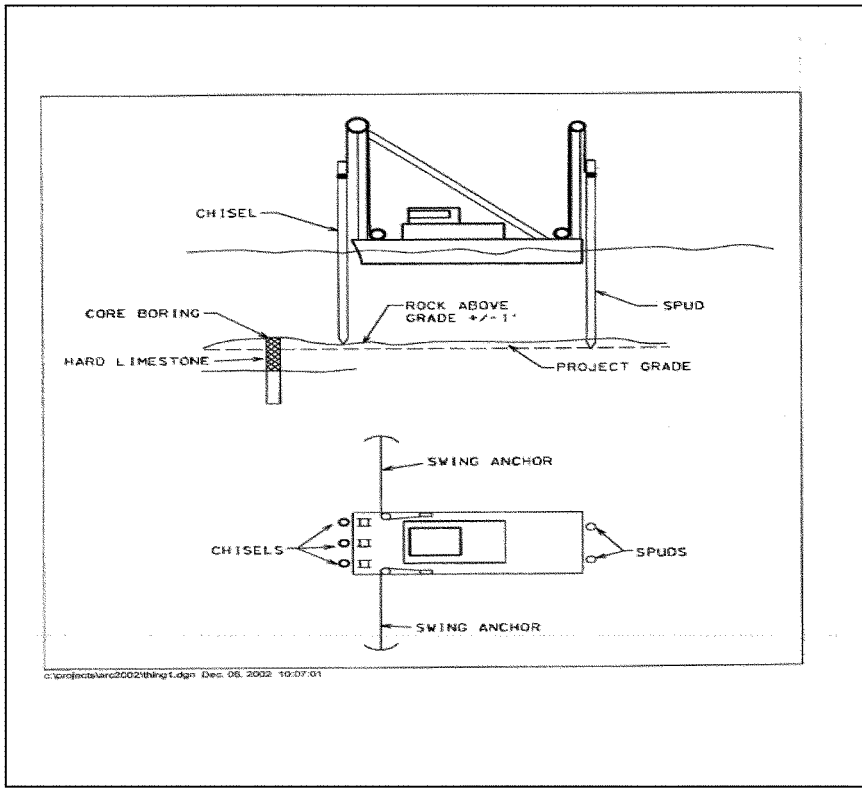


Figure 27 Drawing of a Typical Punch Barge Configuration

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).

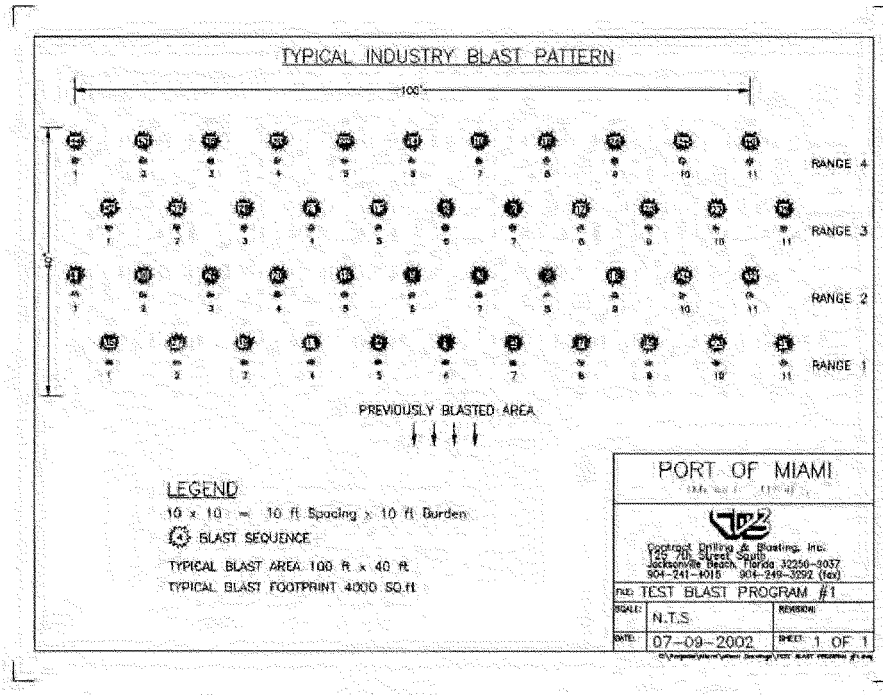


Figure 28 Typical Blast Array Planview

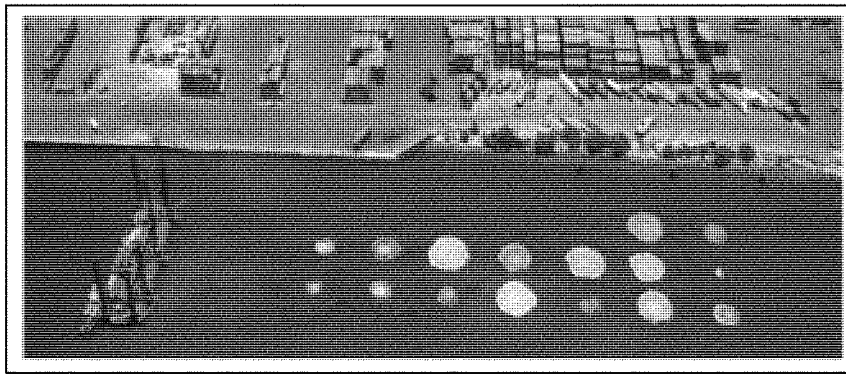


Figure 29 Typical rectangular blast array- water surface signature

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.

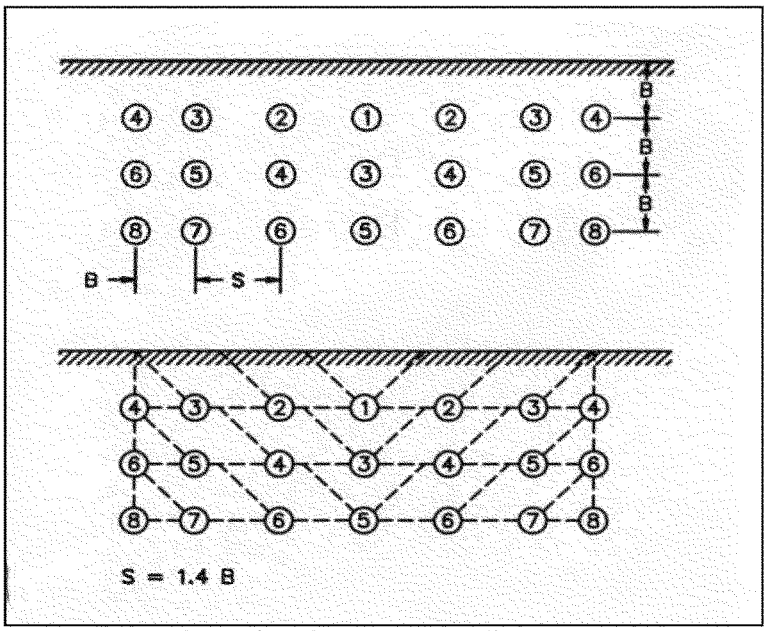


Figure 31 - Delay Pattern for a Blast Array

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.

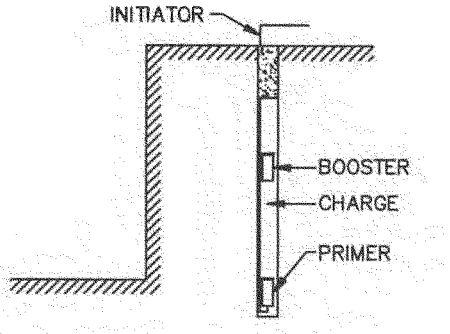


Figure 32 Typical Stemmed Hole for Loading Charges

Figure 33 Stemming Material

Figure 34 Unconfined Blast of Seven Pounds of Explosives

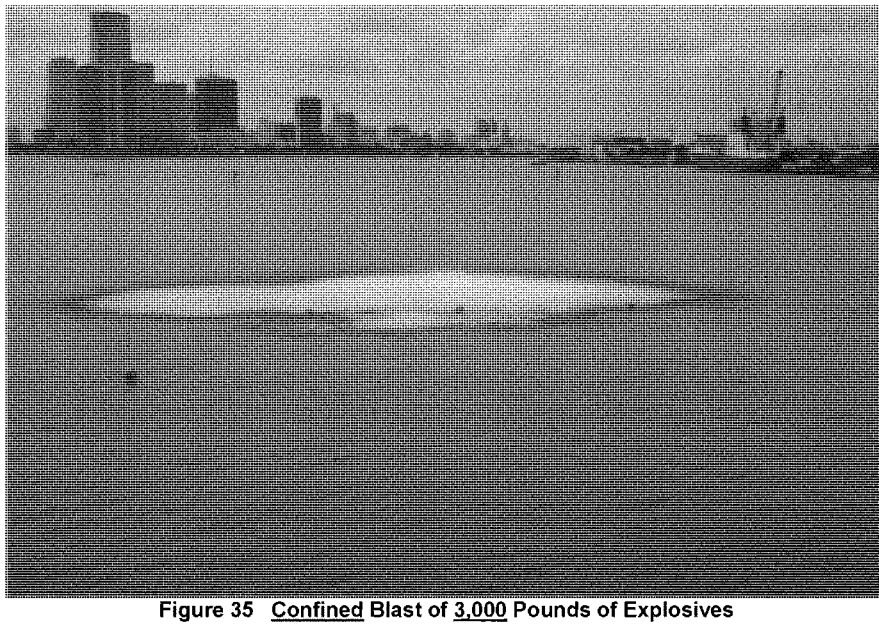


Figure 35 Confined Blast of 3,000 Pounds of Explosives

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).

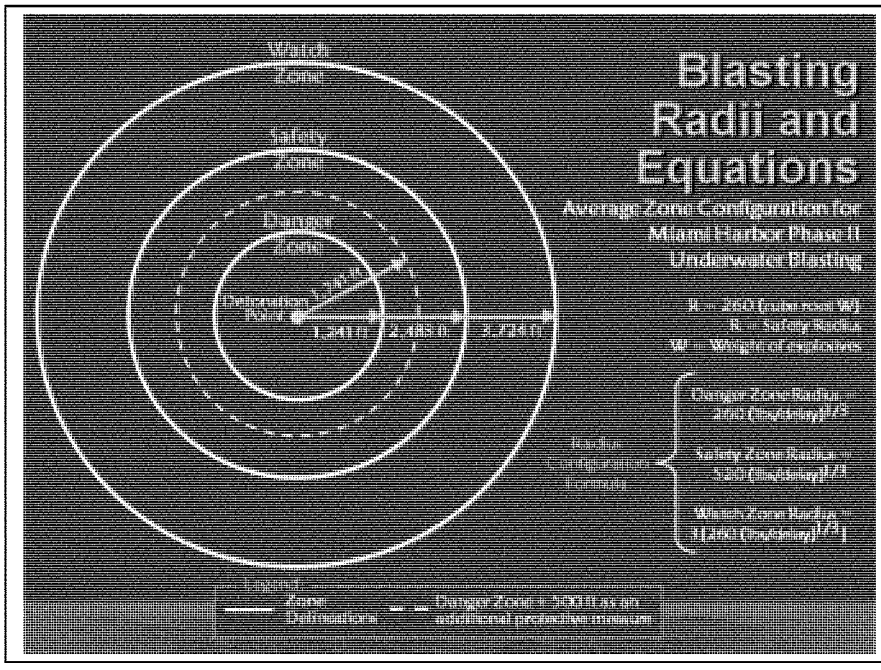


Figure 36 Confined Underwater Blast Zone Radii and Equations from Miami Harbor Expansion Project

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.

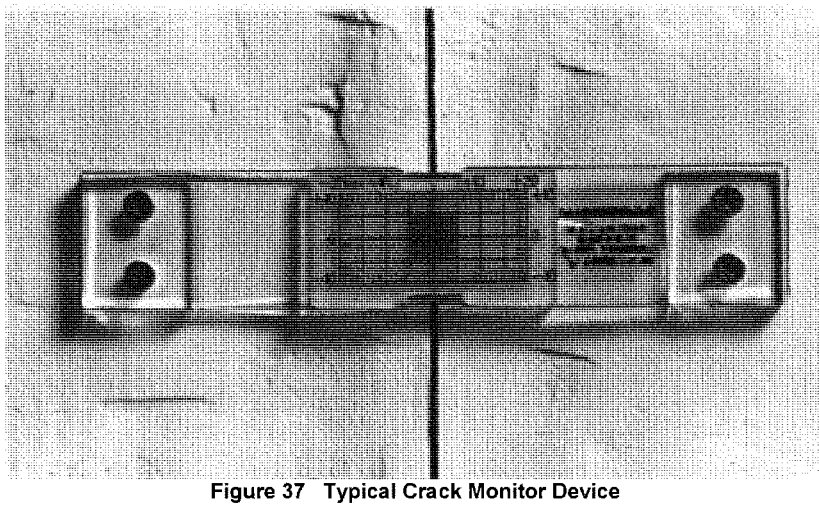


Figure 37 Typical Crack Monitor Device

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

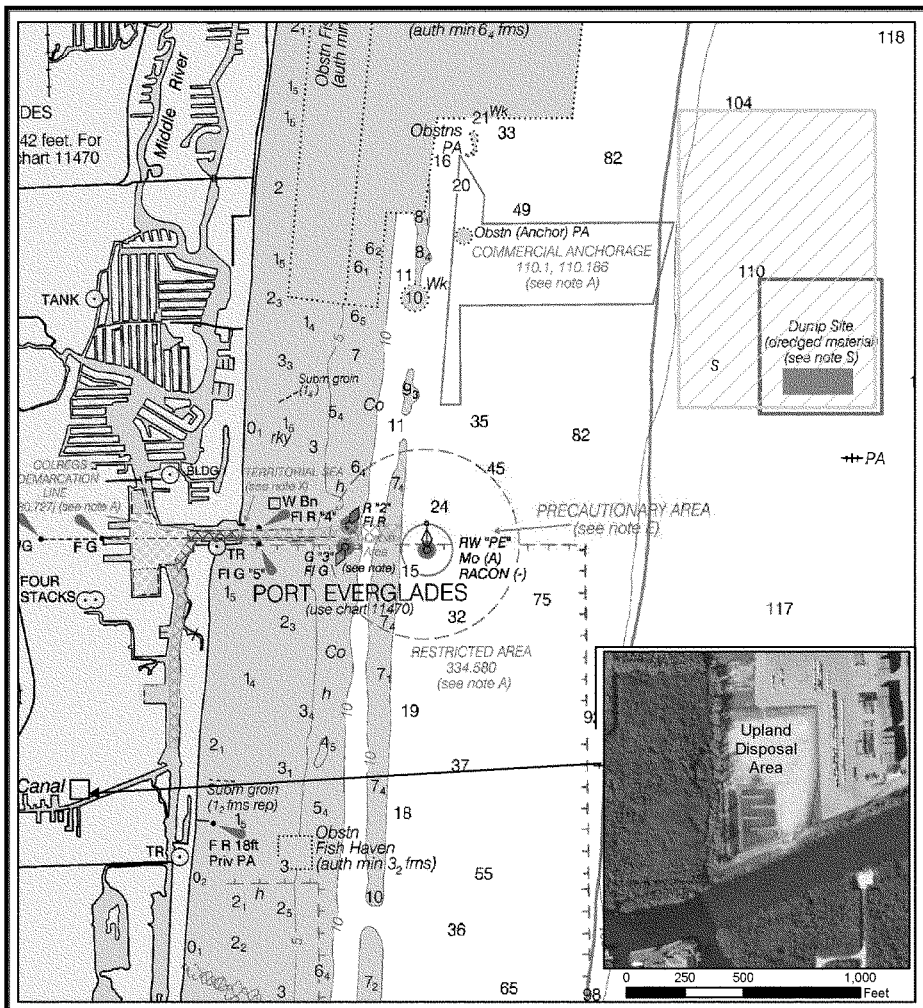
USACE has concluded that confined blasting is the *least* environmentally impactful method for pre-treatment of hard, consolidated rock in the Port. Each blast will last no longer than 15 seconds in duration, and may even be as short as two seconds. Additionally, the blasts are confined in the rock substrate 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).

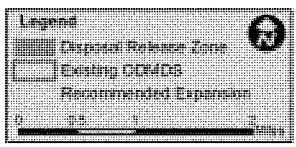
2.9.4 Disposal of Removed Materials

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.





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).

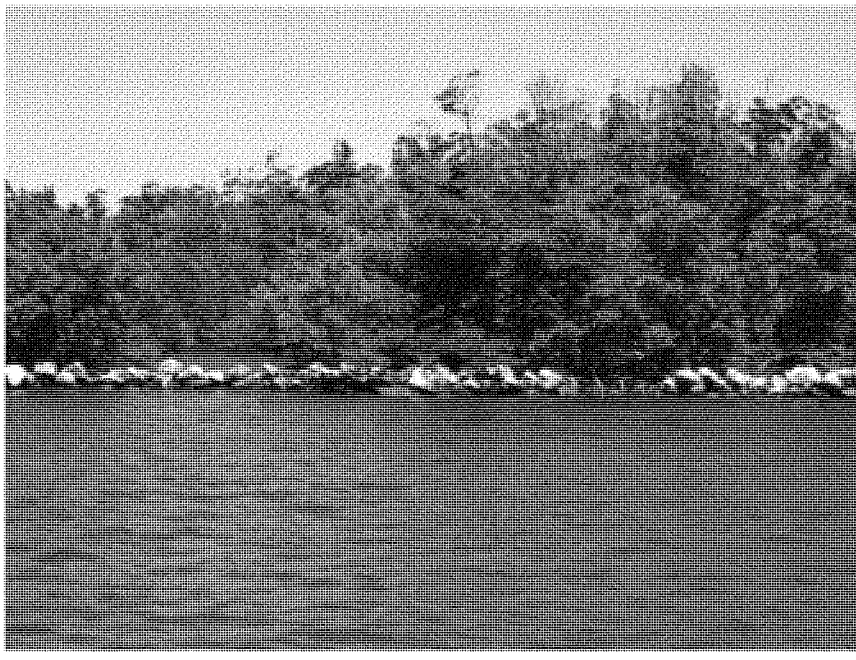


Figure 39 Existing Rip Rap Bulkhead Along John U Lloyd State Park

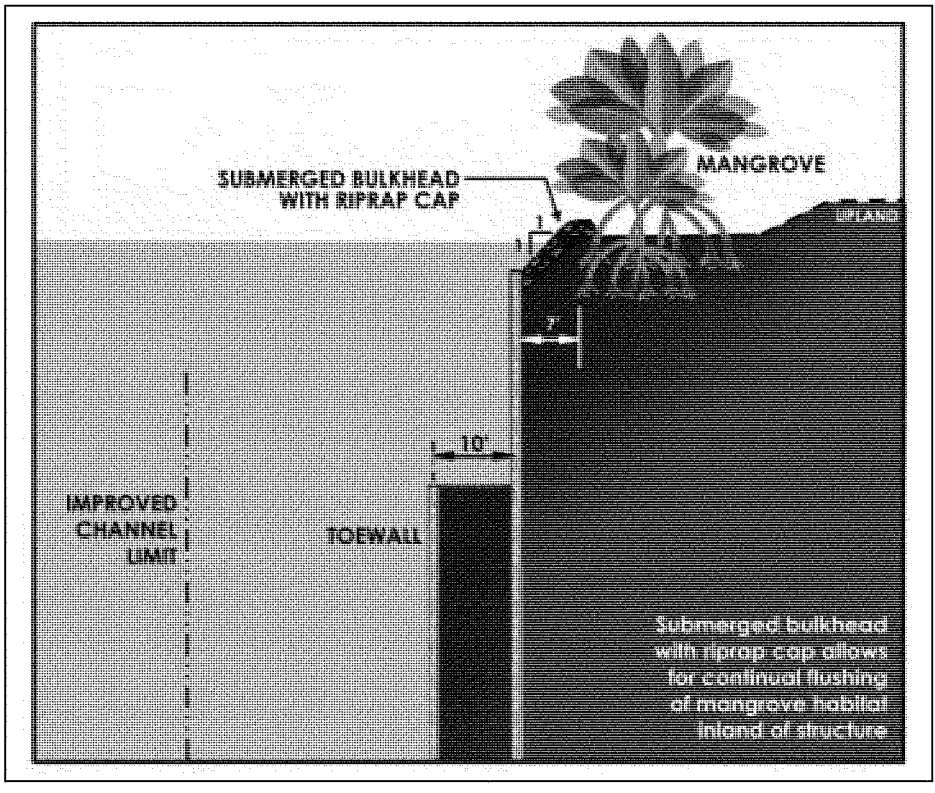


Figure 40 Typical cross section of an environmentally friendly bulkhead on the Southport Access Channel

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.

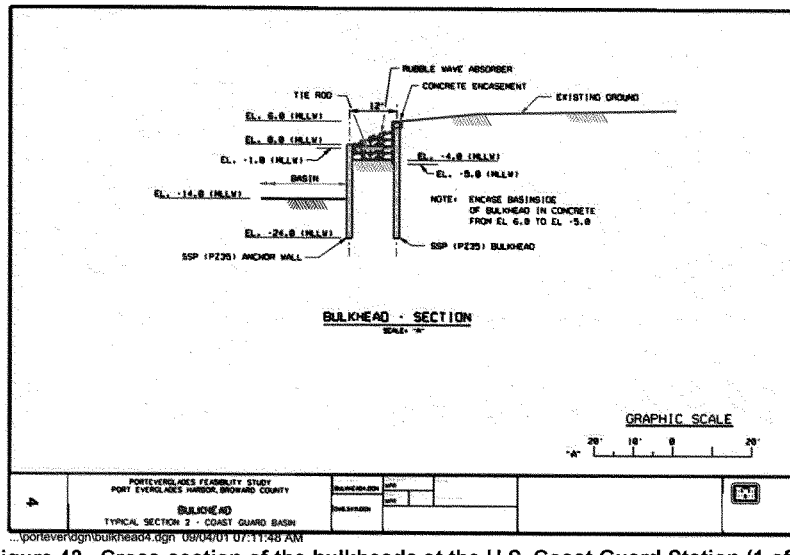


Figure 42 Cross-section of the bulkheads at the U.S. Coast Guard Station (1 of 2)

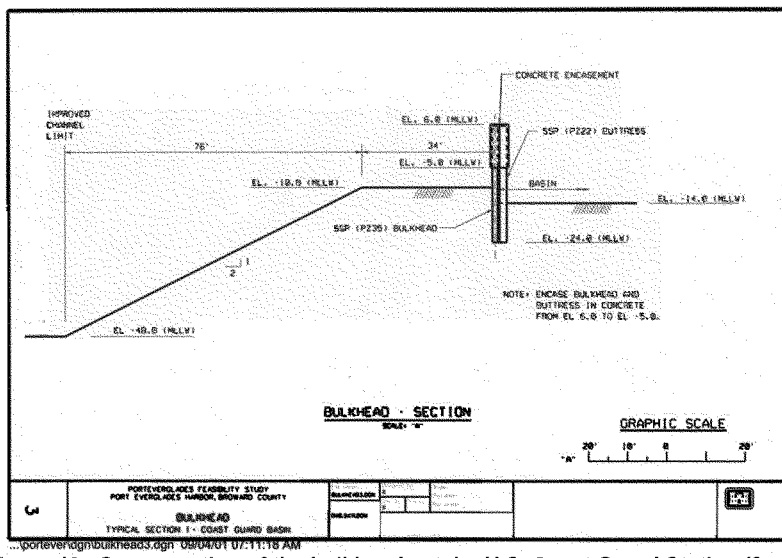


Figure 43 Cross-section of the bulkheads at the U.S. Coast Guard Station (2 of 2)

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).

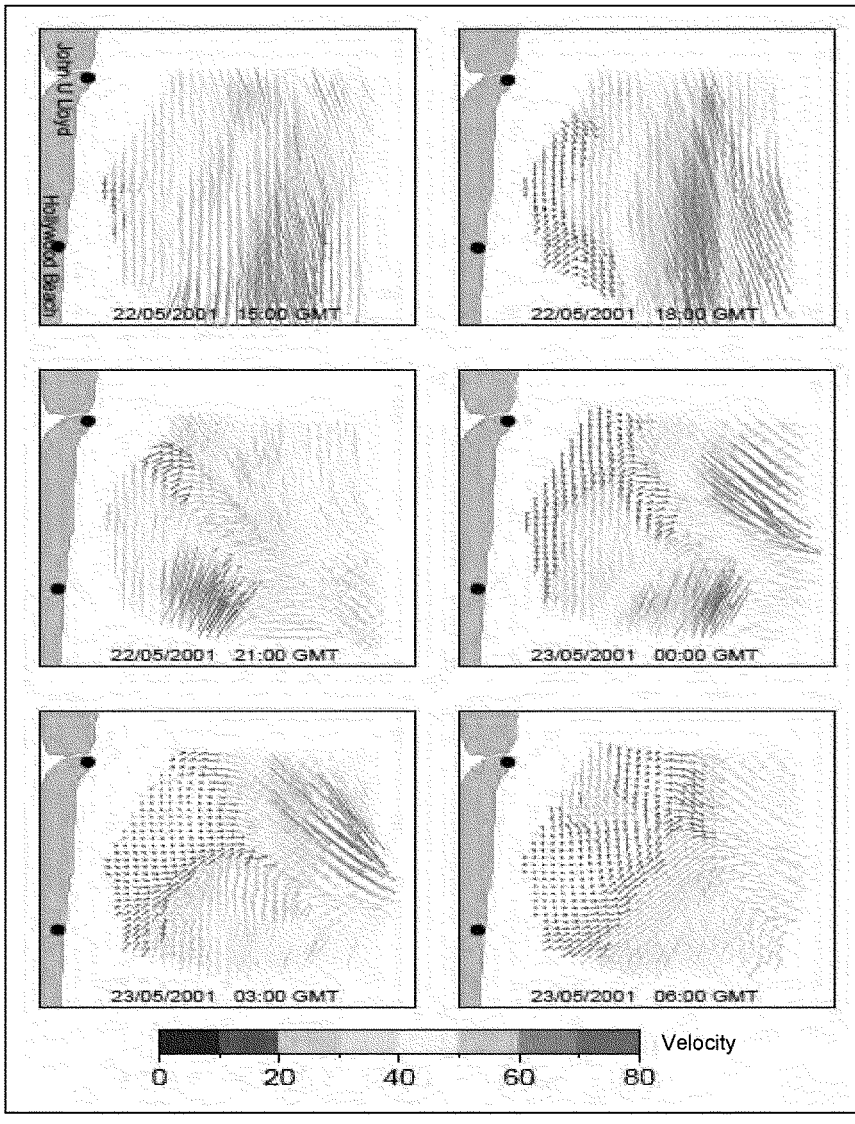


Figure 44 Current Direction and Intensity Changes in 24-hour Period Offshore of Port Everglades (Martinez-Pedraja *et al.* 2004)

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.

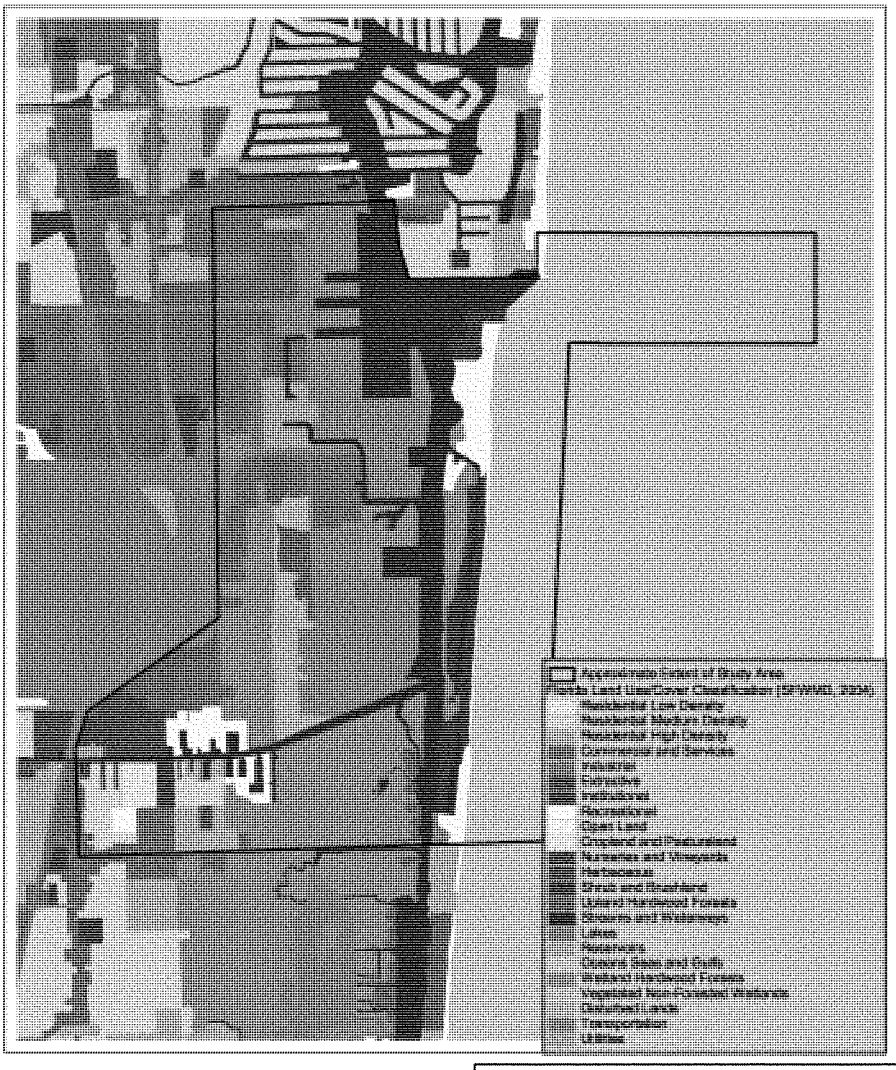
All MPRSA-required testing and analysis of material proposed for disposal at the ODMDS will be completed during the PED phase of the project. Some of the material may meet exclusionary criteria under MPRSA and may not require testing (e.g., sand or rock) while other areas may require additional testing. 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

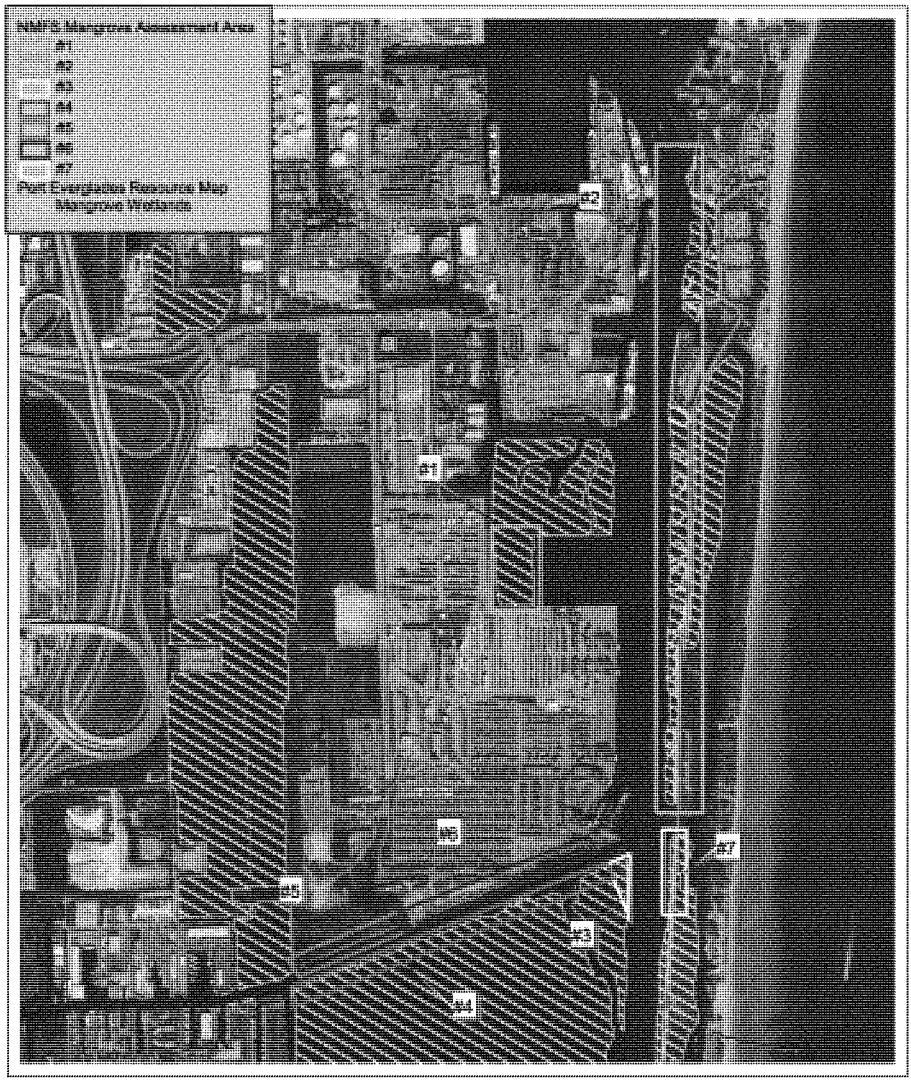
Land Use and Ecological Communities	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: 1 inch = 1 kilometer	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	Figure 45

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."

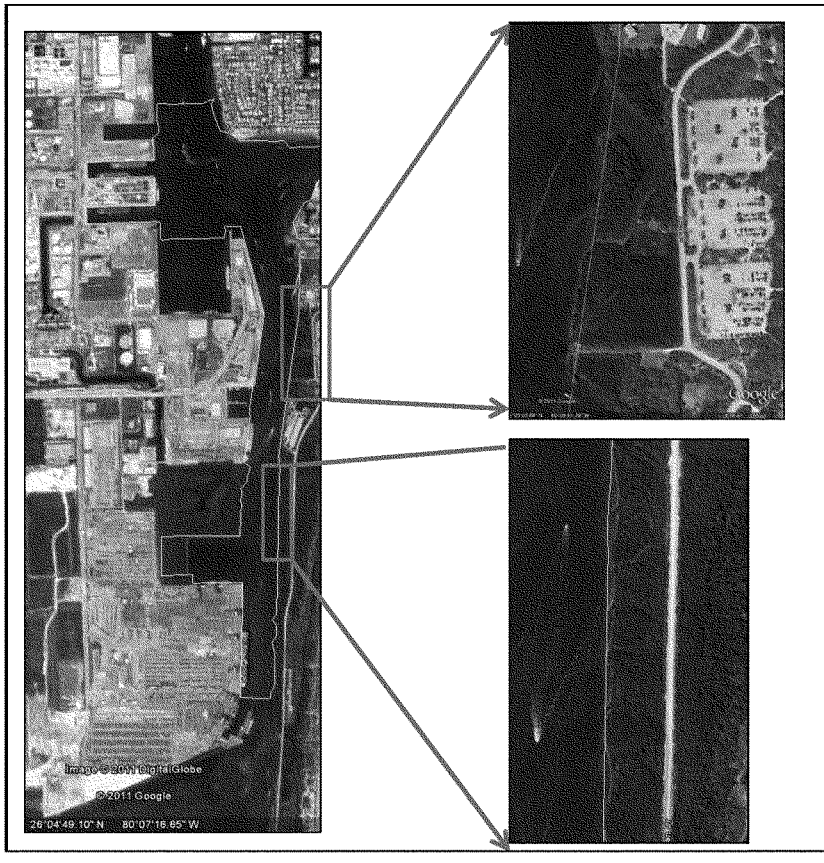
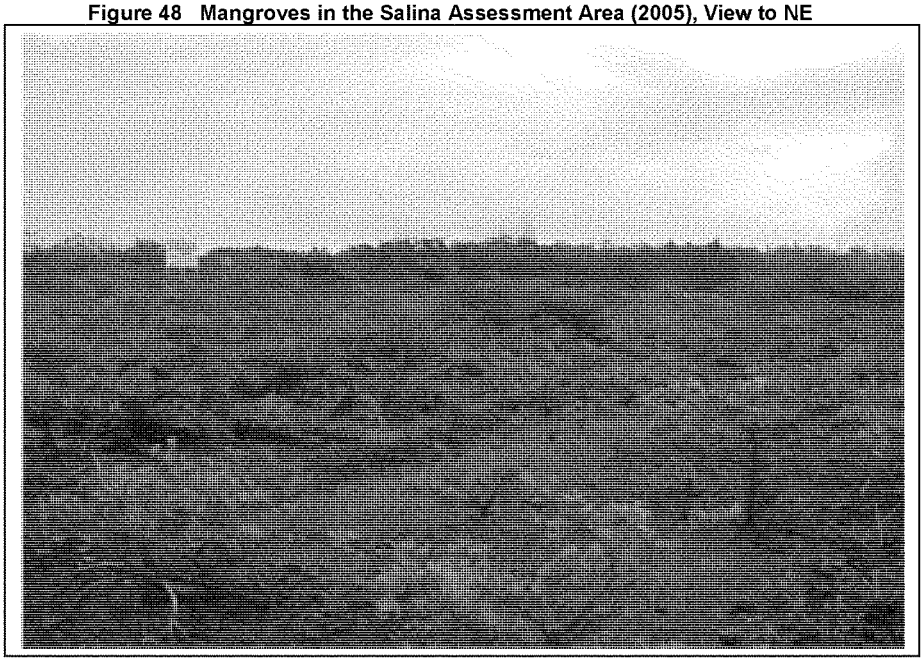


Figure 47 Mangrove Resources Detail along SAC (NMFS 2011)

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

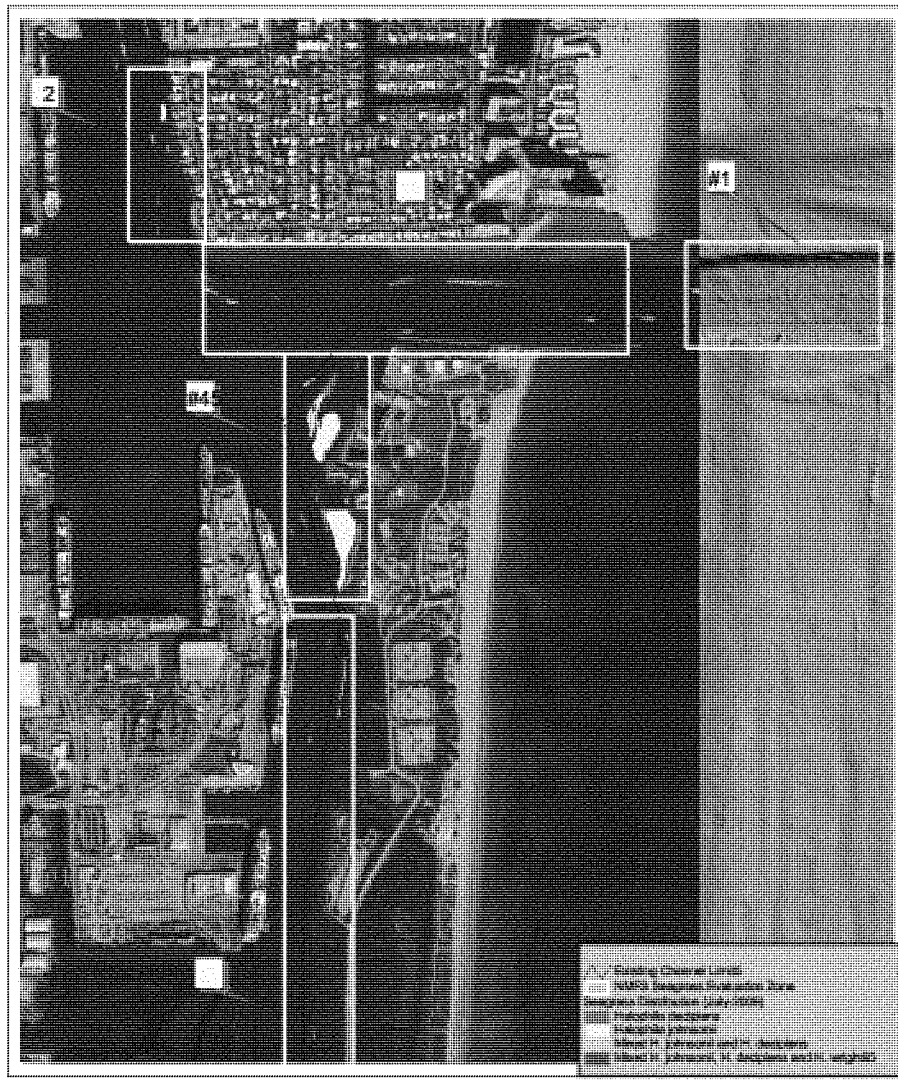
3.6.1 Seagrass Communities

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).

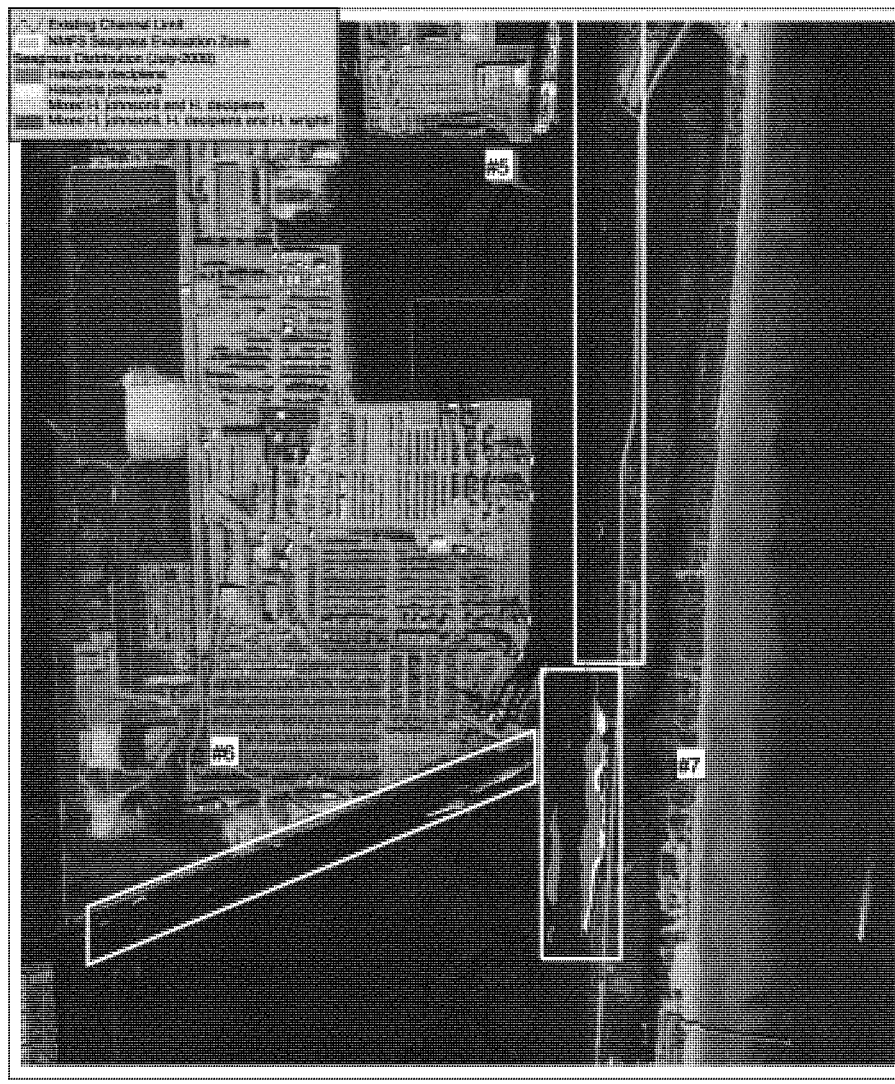
Several other seagrass surveys and anecdotal observations have occurred in the project area, including a Broward County seagrass survey in 2001, and a Broward County/FDEP QA/QC assessment for a previously conducted seagrass survey near the USN facility (the south side of the IEC) for a proposed Navy 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).



10005 05 10005 2000 Feet5

Seagrass Distribution (2009) - Northern Portion of Study Area5	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor5	
Scale: 1 inch = 1000 feet5	Drawn By: MR
Date: September 20145	Approved By: JE5
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-11825
	Figure 495



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

Geomorphology.

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).

Fishes associated with offshore hardbottom and reef habitats.
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).

Fishes and benthic organisms associated with adjacent nearshore hardbottom habitats.
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

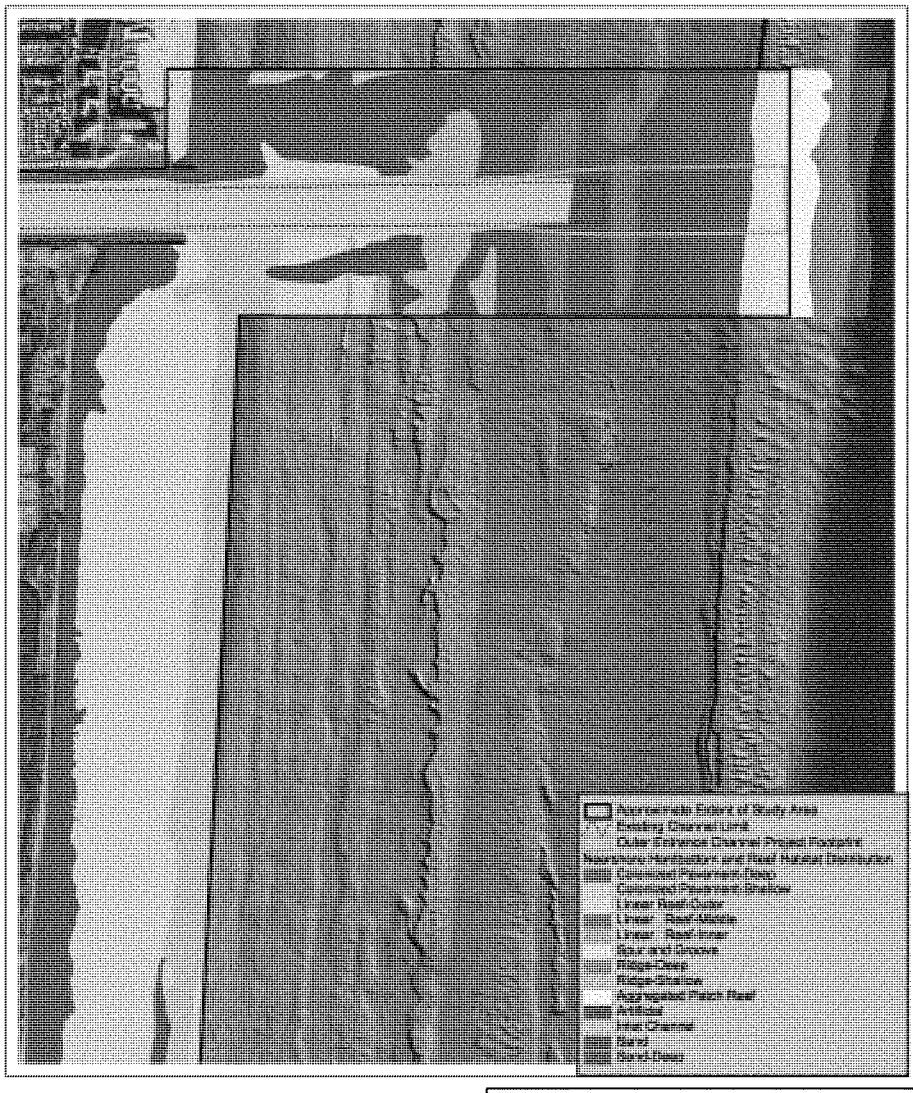
Port Everglades channel habitat.

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.

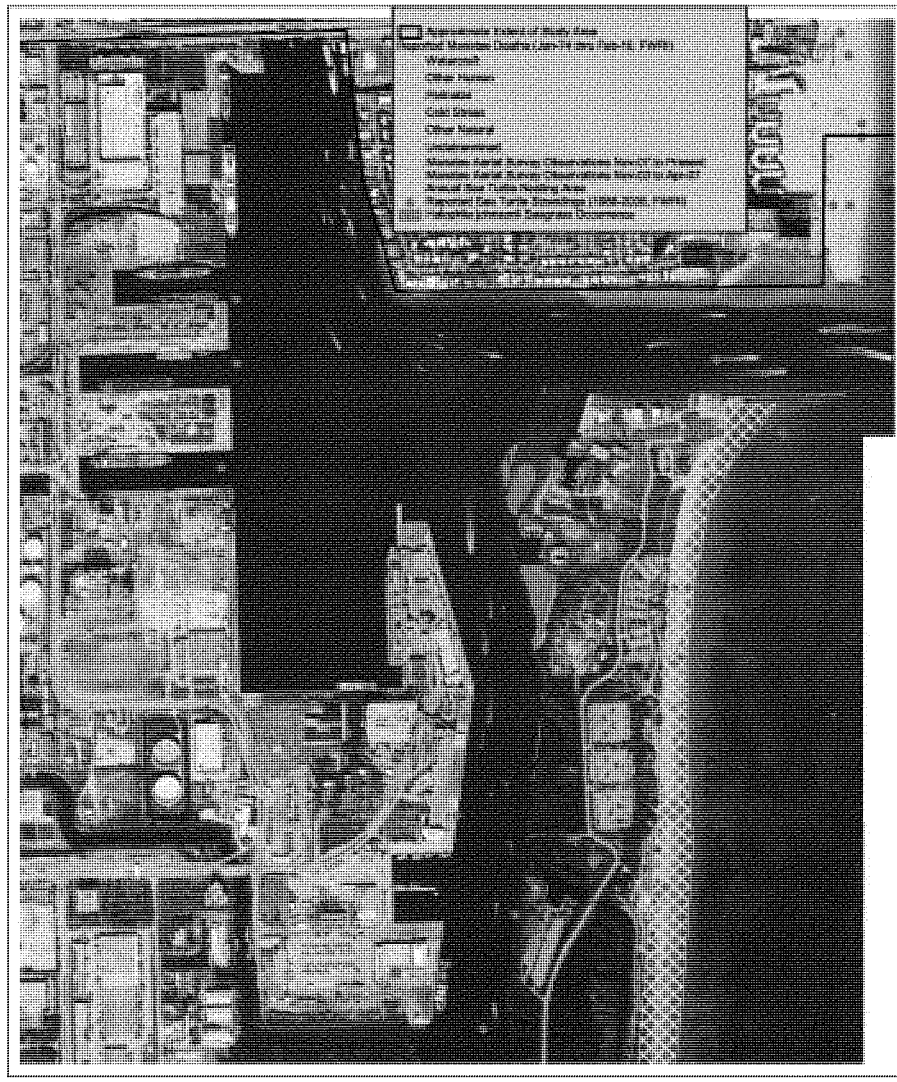
The piping plover (*Charadrius melodus*), a migratory shorebird known from Broward County, is protected as a threatened species under the ESA and the State of Florida, and is also protected under the Migratory Bird Treaty Act. The species breeds in the northern Great Plains of the U.S. and along beaches 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

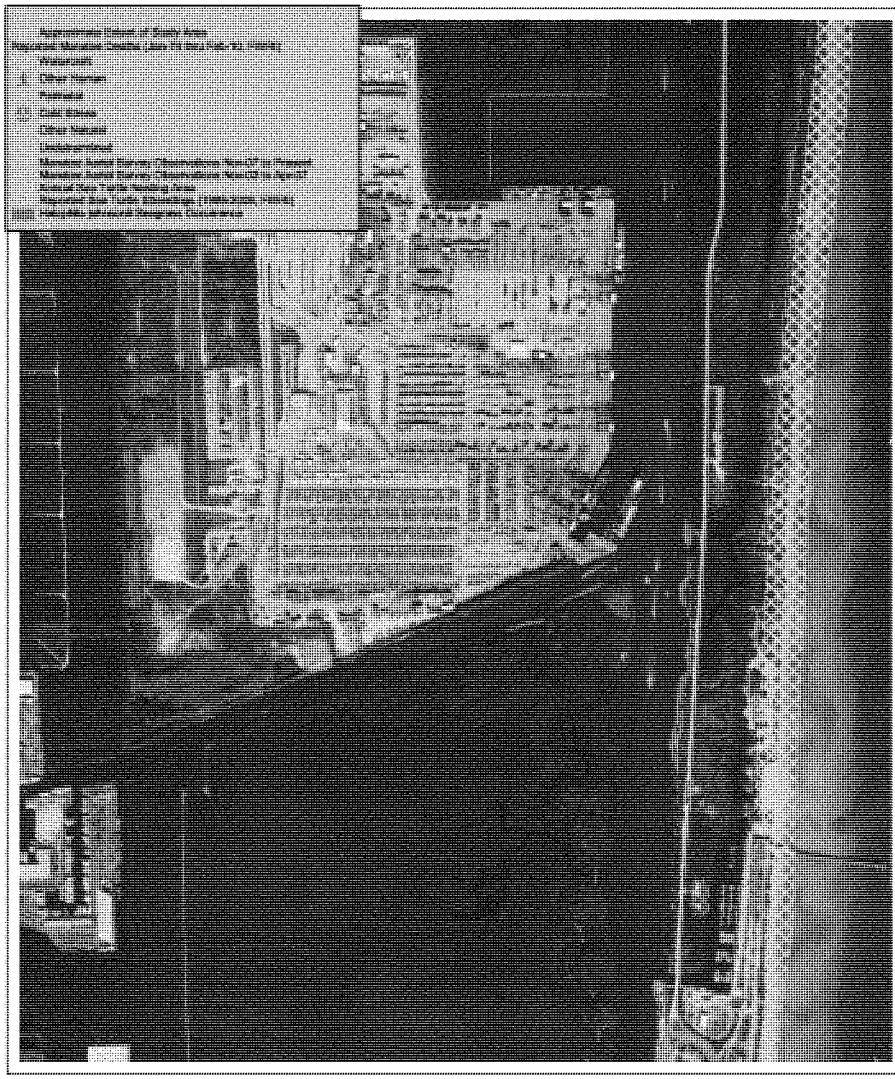
3.7.2.1 Johnson's Seagrass

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; Vimstein 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.



1000 0 1000 2000 Feet

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).

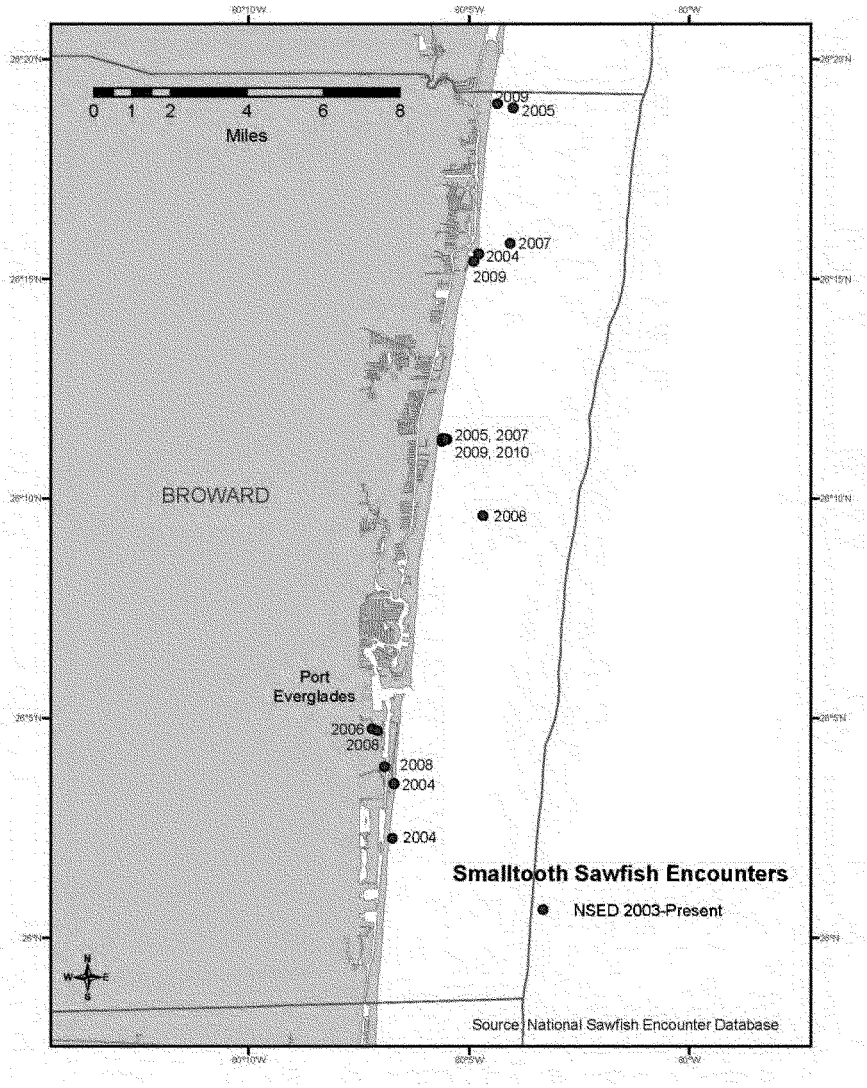
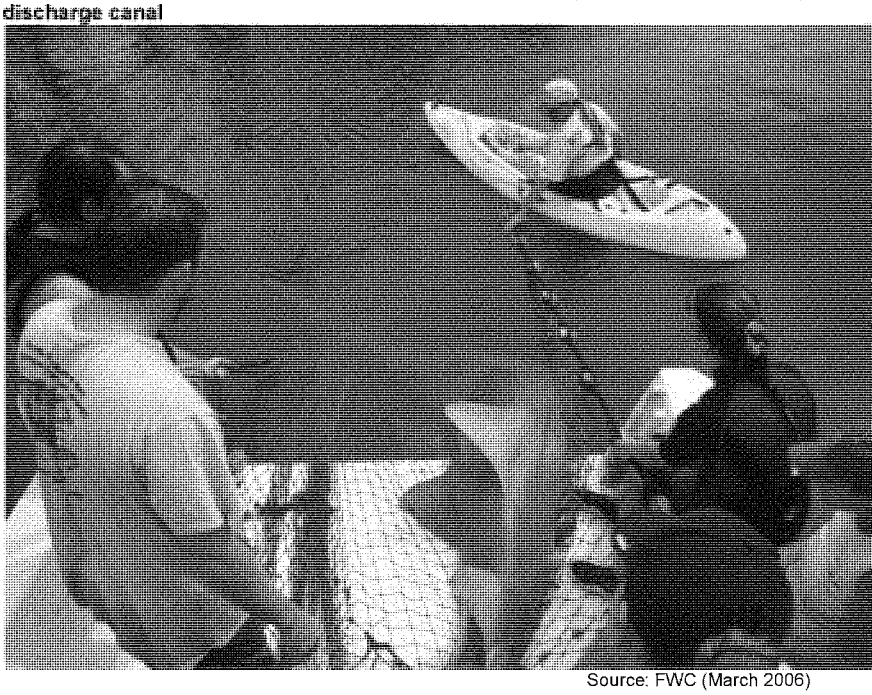


Figure 54 Smalltooth sawfish observations, Broward County, Florida (2003-2011)

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 2006

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).

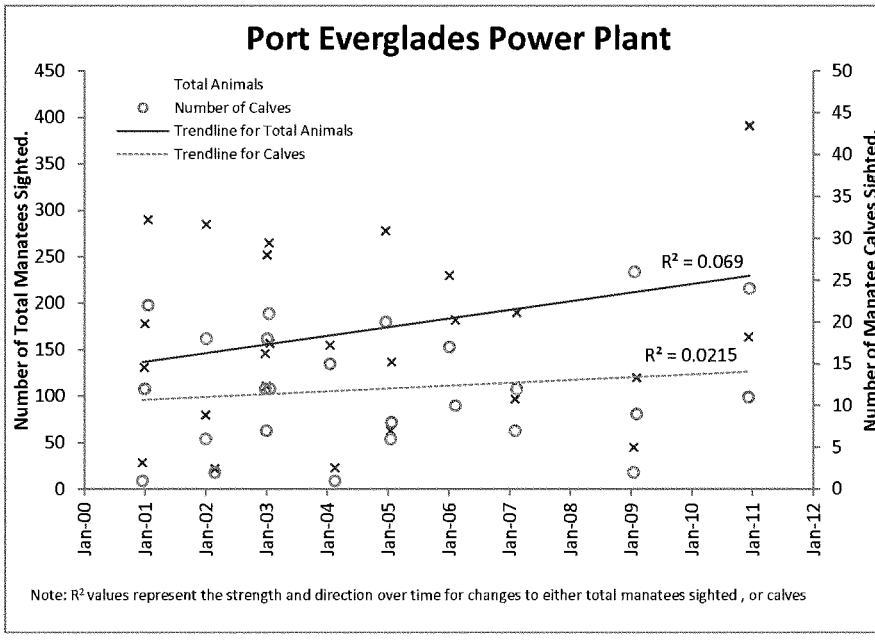


Figure 57 Aerial Sightings of Manatees at Port Everglades Power Plant (2000-2011)

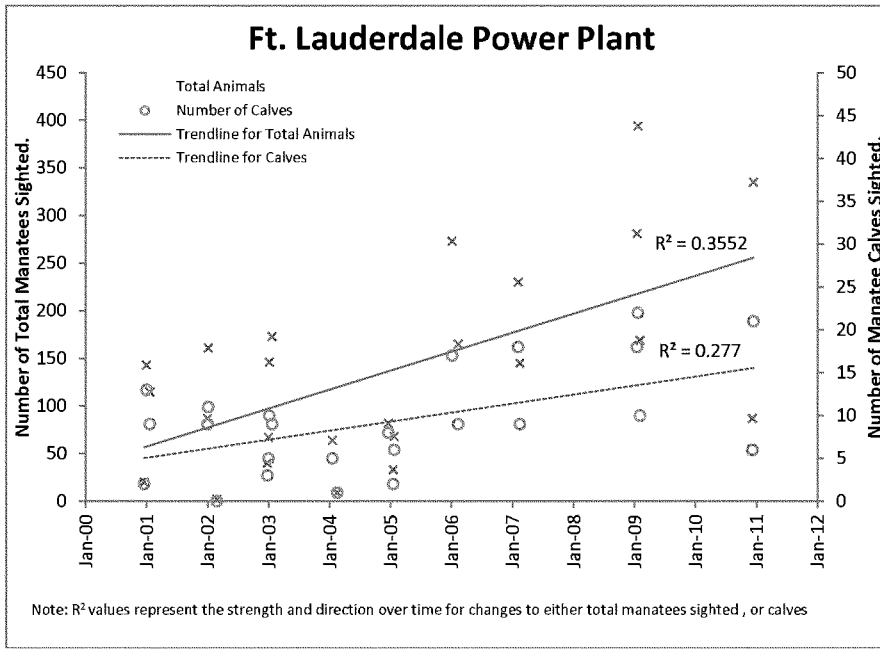


Figure 58 Aerial Sightings of Manatees at Fort Lauderdale Power Plant (2000-2011)

FP&L has temporarily ceased operations at the current Port Everglades location. Demolition the current plant was completed in 2013 and construction of the new plant is expected betwee 2014-2016 with the plant online and operational in 2016 (based on information provided on th FP&L website: http://www.fpl.com/environment/plant/port_everglades.shtml, accesse 3/13/2013). FP&L has been preparing, with USFWS and FWC, an environmental monitoring pla and a biological monitoring plan. During construction, FP&L will maintain an "Interim Wam Water Refuge" (IWWR), using the current warm-water discharge system, during the wint months beginning with the discontinuation of operations at the existing Port Everglades plant ar continuing until the new units are operational (Golder Associates 2012). The implementation the IWWR should result in continued manatee use of the Port Everglades plant and potentially r decrease in protection measures associated with the Port Everglades expansion project (i. standard manatee protection measures and cessation of confined underwater rock blastir during manatee congregation periods).

3.7.2.6 Bottlenose Dolphin

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

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

3.7.2.7 North Atlantic Right Whale

The North Atlantic right whale (*Eubalaena glacialis*) (NARW) is a federally listed endangere species and is also listed as a depleted stock under the MMPA. The minimum estimate population within the north Atlantic Region is 346 animals (NARWC 2012). This estimate is base solely on the whales cataloged as alive in 2011 in the New England Aquarium's (NEA) right wha identification catalog. The conservative middle estimate of population is 509 individual whale This is based on the 2011 survey data which is the sum of the 476 cataloged whales presume alive in 2011, the 13 "intermatch" whales that were likely to be added to the catalog, and the 2 calves from 2010 to 2011 that were also likely to be added to the catalog. The high estimate the current population of north Atlantic right whales is 672 individuals. This is a sum, based c 2011 survey data, of the 627 cataloged whales, minus known dead individuals; 22 acti

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 Deepening Feasibility Study
Port Environmental Impact Statement
Navigation Improvements, Port Everglades Harbor
Scale: 1 inch = 1,000 feet
Date: September 2014
Drawn By: MH
Reviewed By: JS
DIAL CORDY
JN 1109
Figure 29
Legend
Dredged Material Placement Area
Dredged Material Placement Area
Dredged Material Placement Area

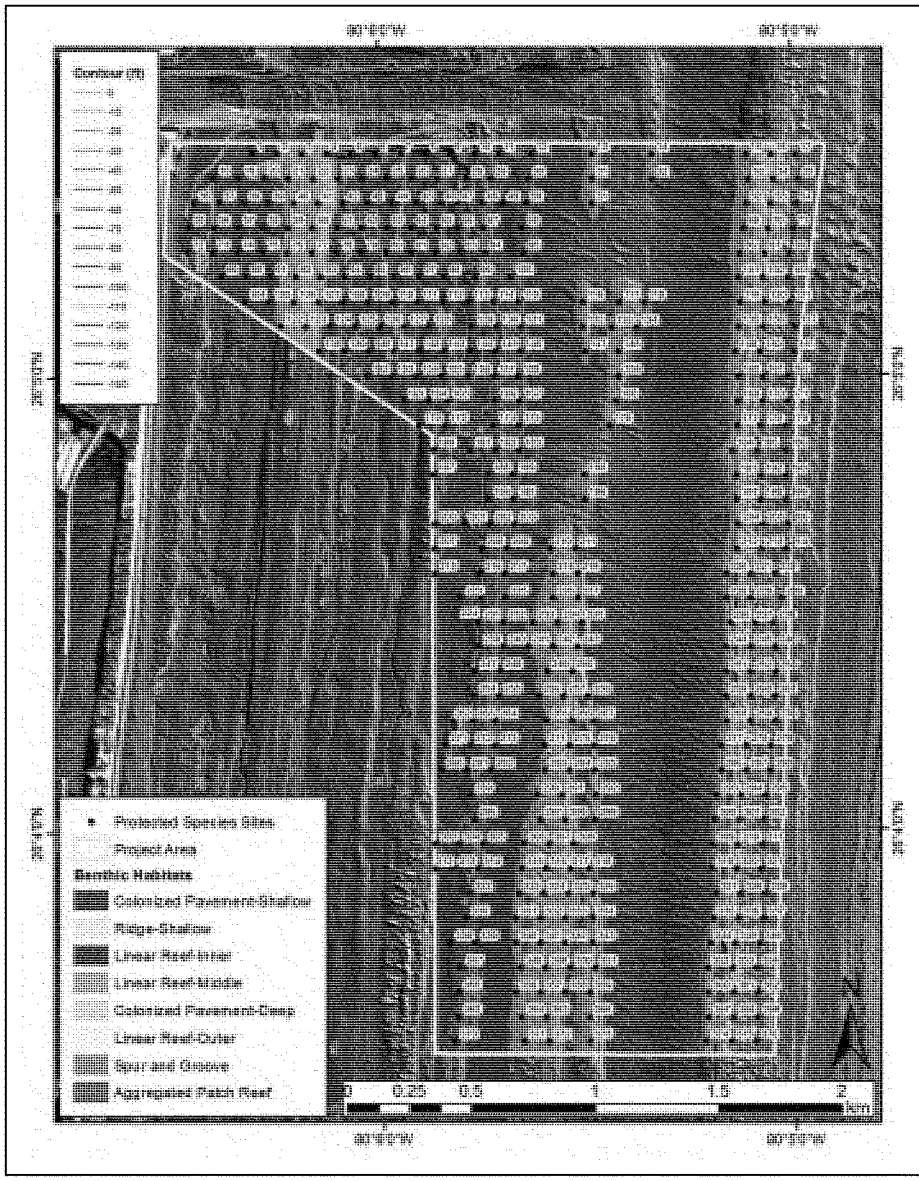
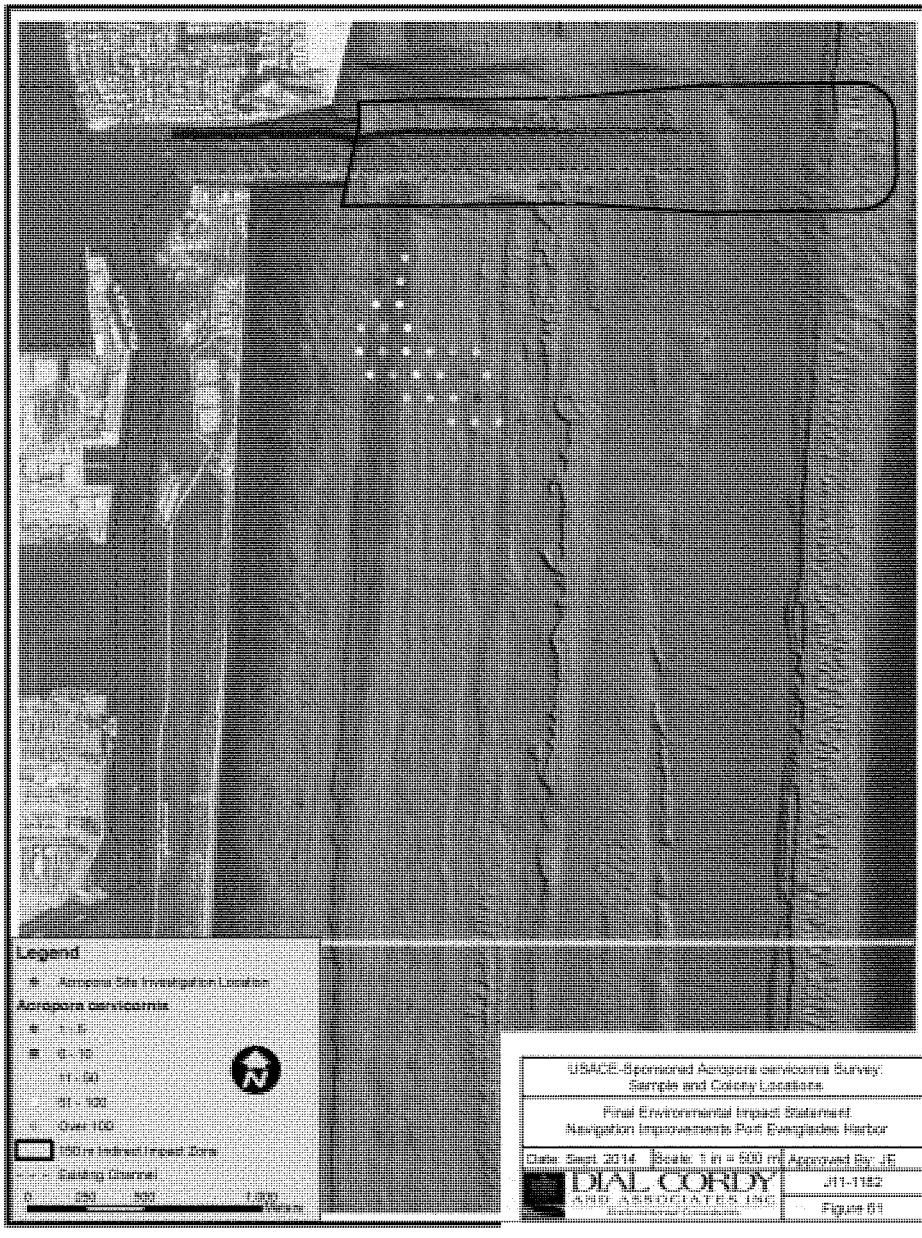


Figure 60 Locations of 376 coral survey locations used for NSUOC (2011)


Legend
Acropora Site Investigation Location
Acropora cervicornis
1 - 5
6 - 10
11 - 50
51 - 100
Over 100
100m Indirect Impact Zone
Existing Channel
0
250
500
1,000
Meters
N
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
DAL CORDY
AND ASSOCIATES INC
J11-192
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 franksi), 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).

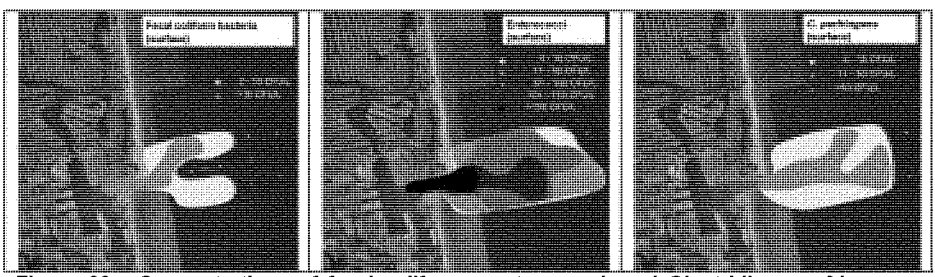


Figure 62 Concentrations of fecal coliforms, enterococci, and *Clostridium perfringens* from samples collected at Port Everglades in 2007-2008

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.

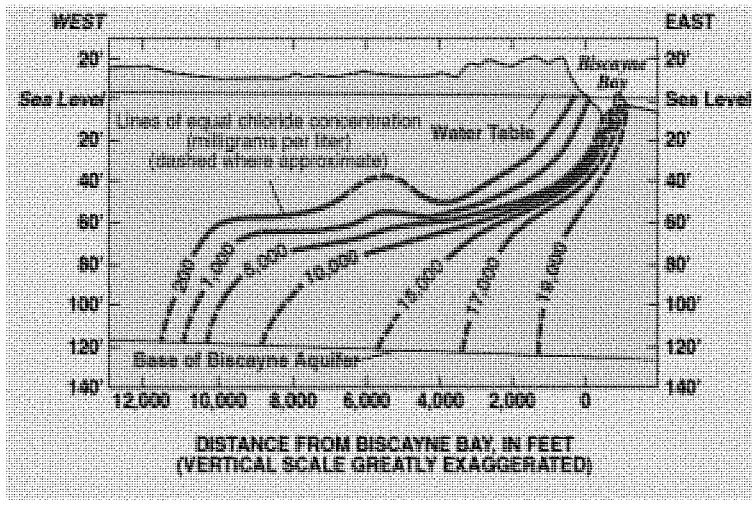


Figure 63 Relationship Between Freshwater and Saline Water Zones in Biscayne Aquifer

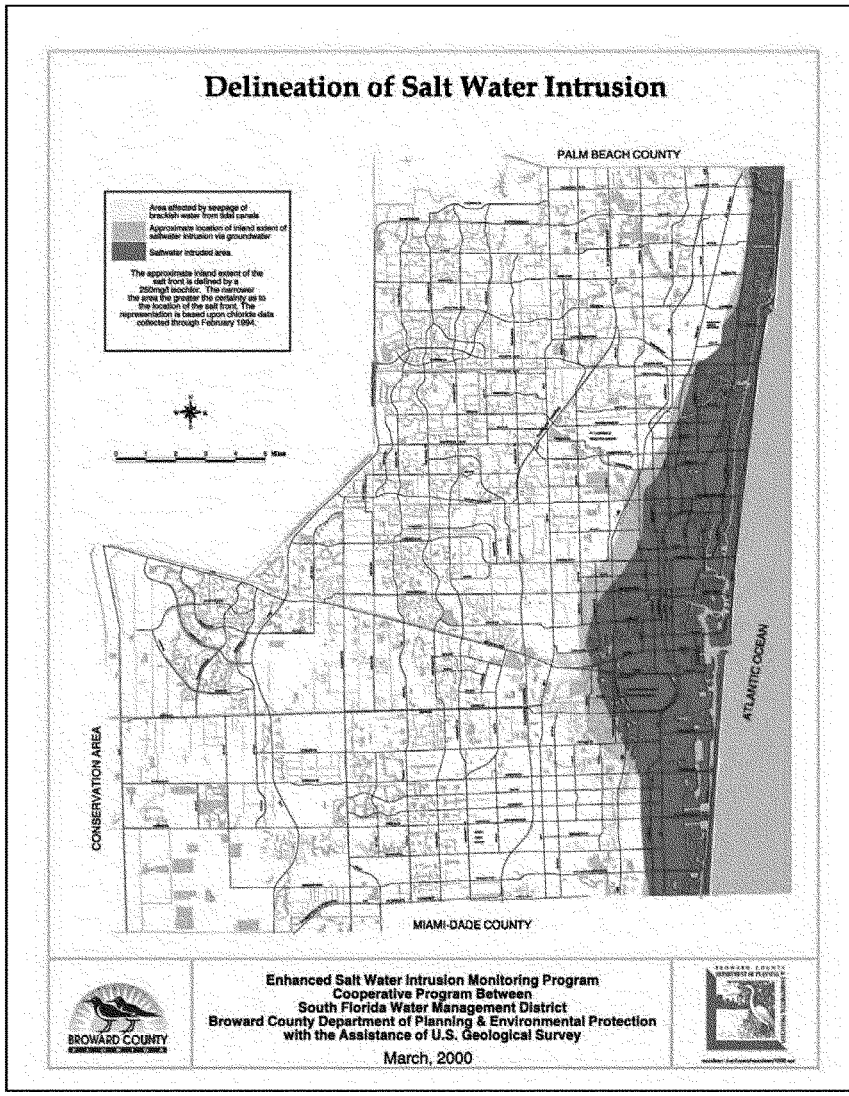


Figure 64 Broward County Saltwater Intrusion

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

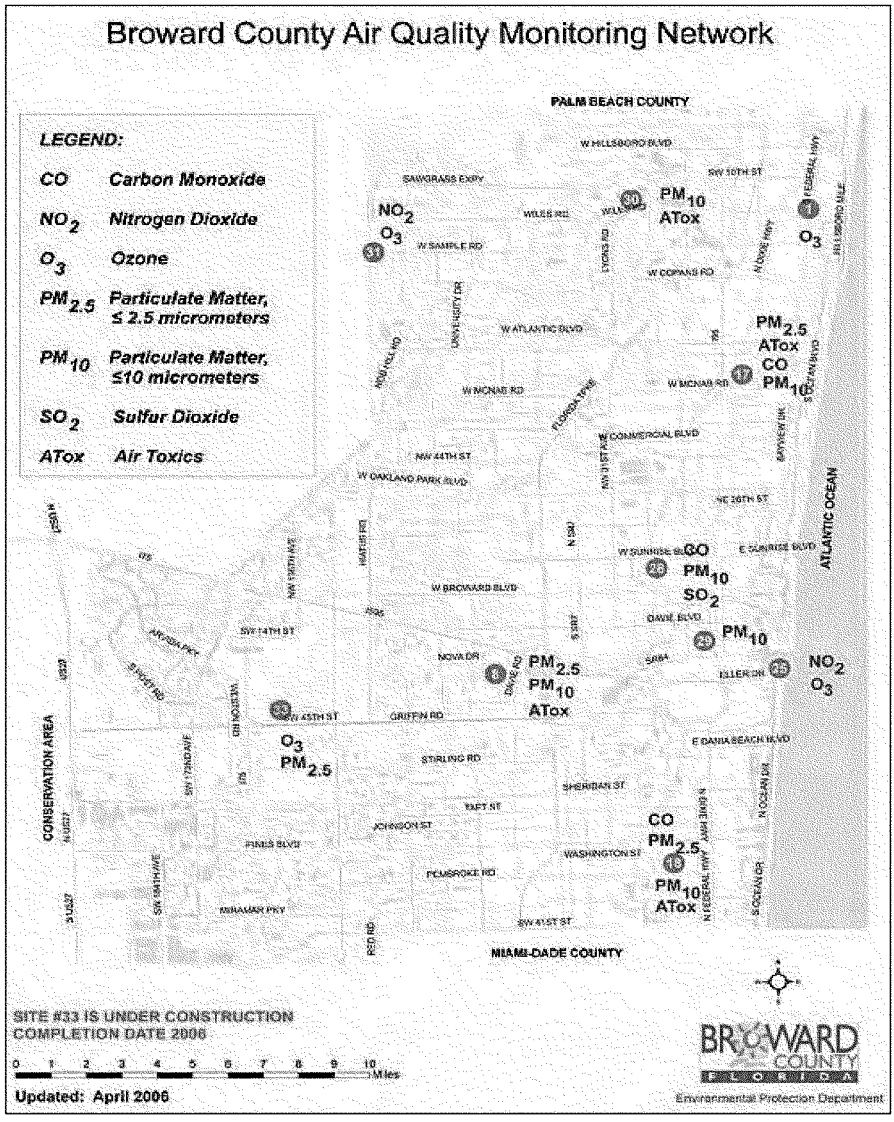


Figure 65 Broward County Air Quality Monitoring Stations

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.

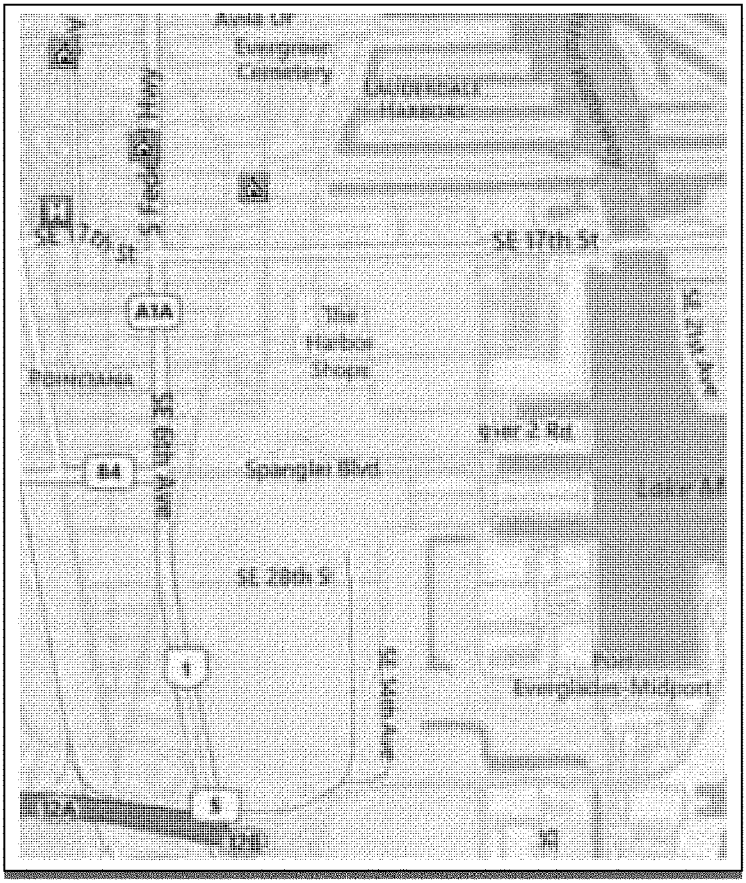


Figure 66 Sensitive Air Quality Receptors Near Project Area

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 modem 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 modem 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.

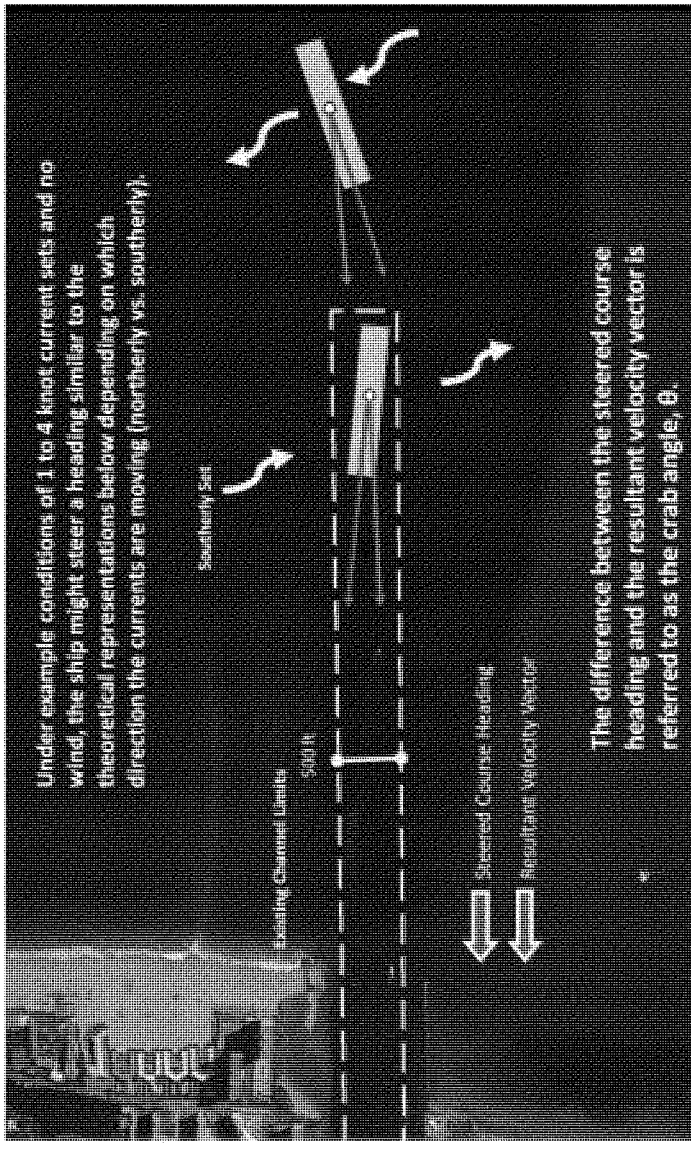


Figure 70 Cross-currents at eastern terminus of the Outer Entrance Channel

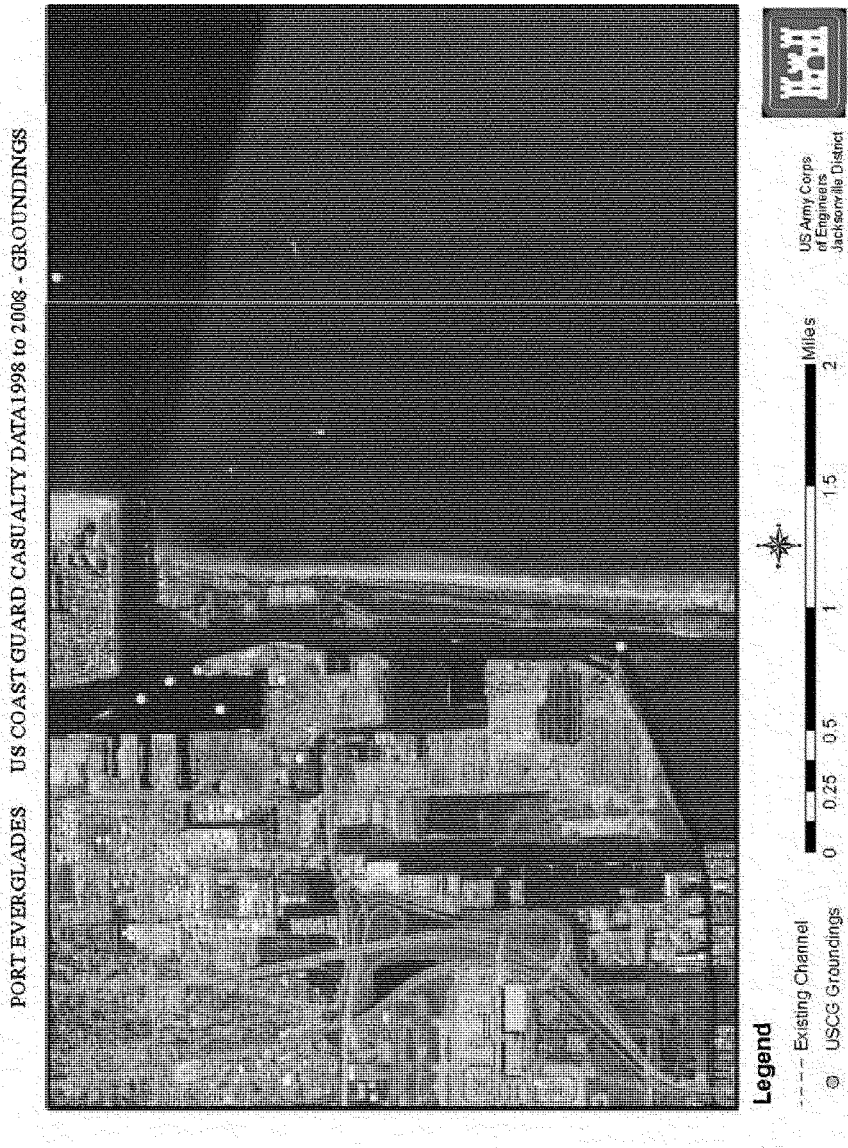


Figure 71 Groundings (U.S. Coast Guard data, 1998-2008)

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.

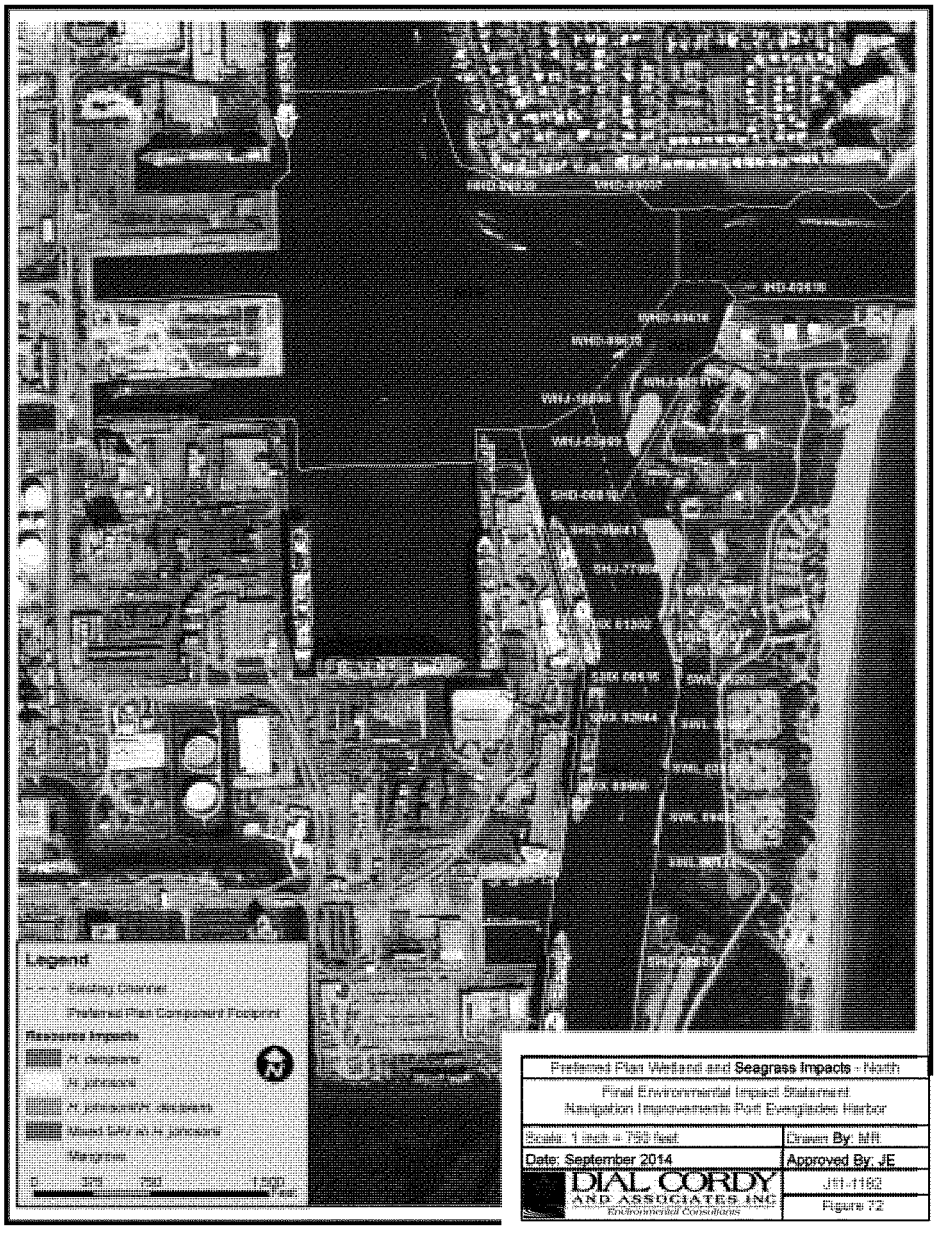
4.3.2 No-Action Alternative

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.



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
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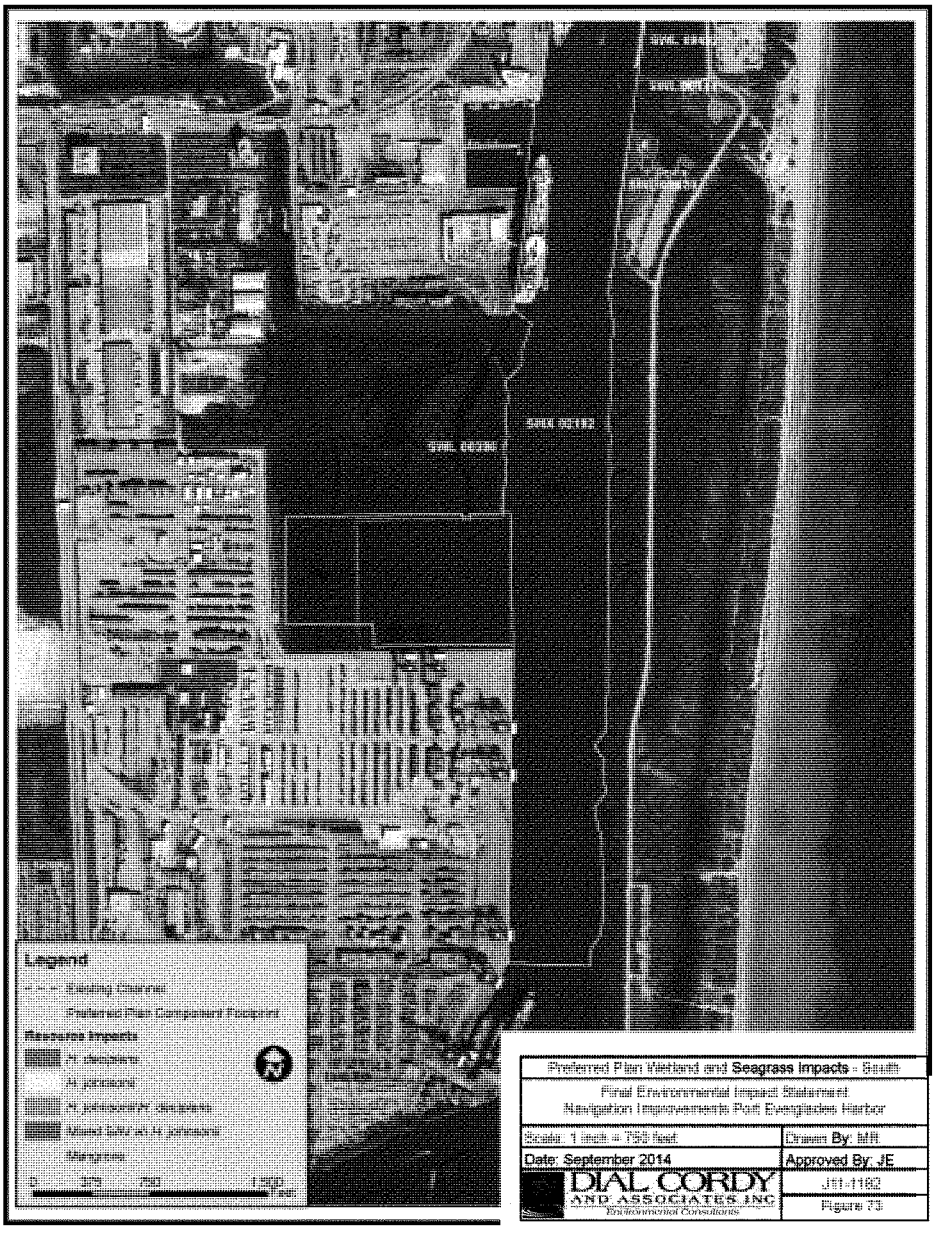
	Figure 72



Preferred Plan Vieland 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).

Inlet Channel
Legend
Existing Channel
SAV within OEC Footprint (0.20 ac.)
Halophila decipiens Area of Occurrence (1.03 ac.)
LPP Component Footprint (48+1+1+7)
Broward County Marine Resource Delineation*
Coral Reef and Colonized Hardbottom
Artificial
Unconsolidated Sediments
Inlet Channel
* Broward County Marine Habitat Classification (Walker et al. 2008)
0 50 100 200 300 400
Meters
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
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J11-1182
Figure 7-8

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.

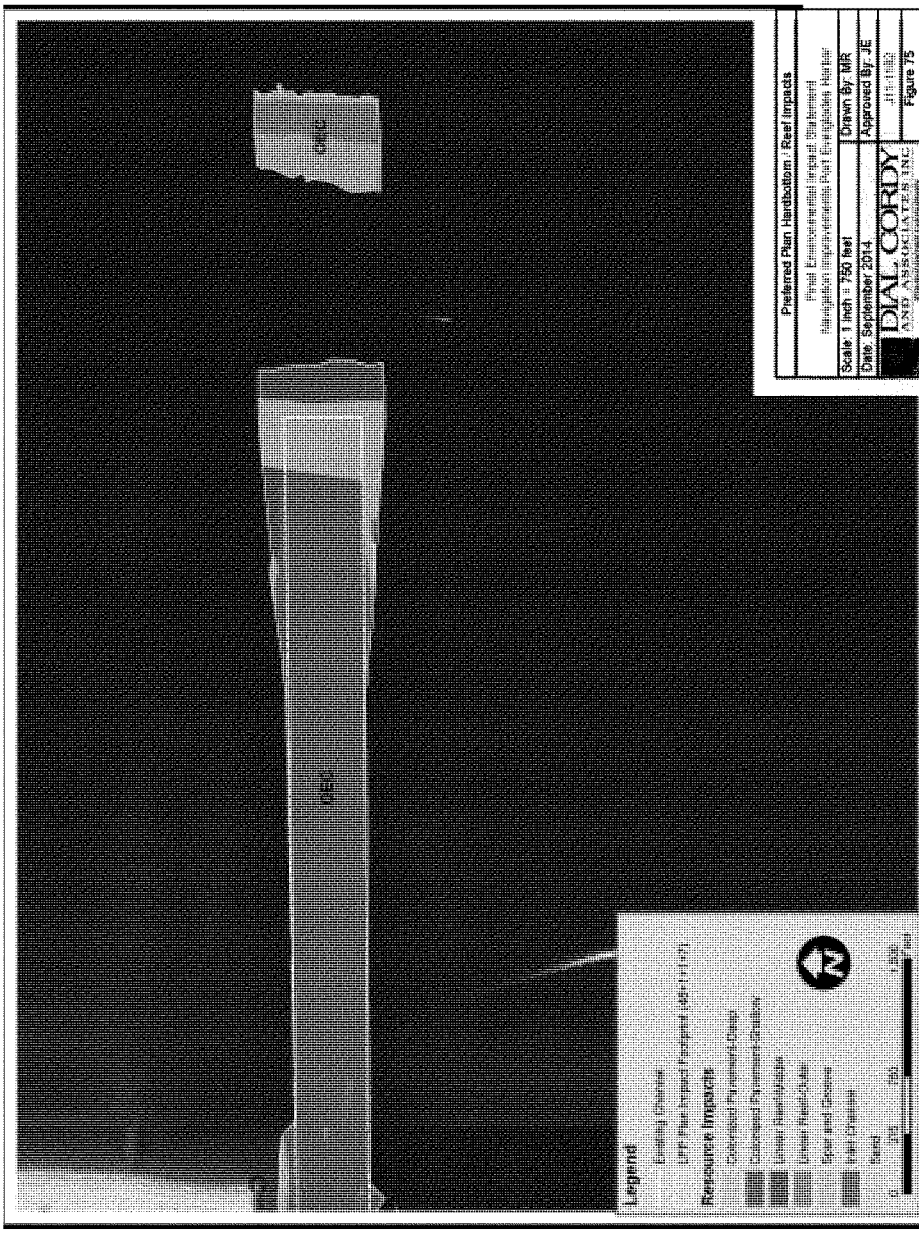
Impacts from the implementation of the Recommended Plan include removal of approximately five acres of the Middle Reef, in addition to existing channel wall habitat (0.36 acres) in that area. Also, approximately 0.2 acres of habitat below the proposed dredge depth within the Middle Reef complex is anticipated 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

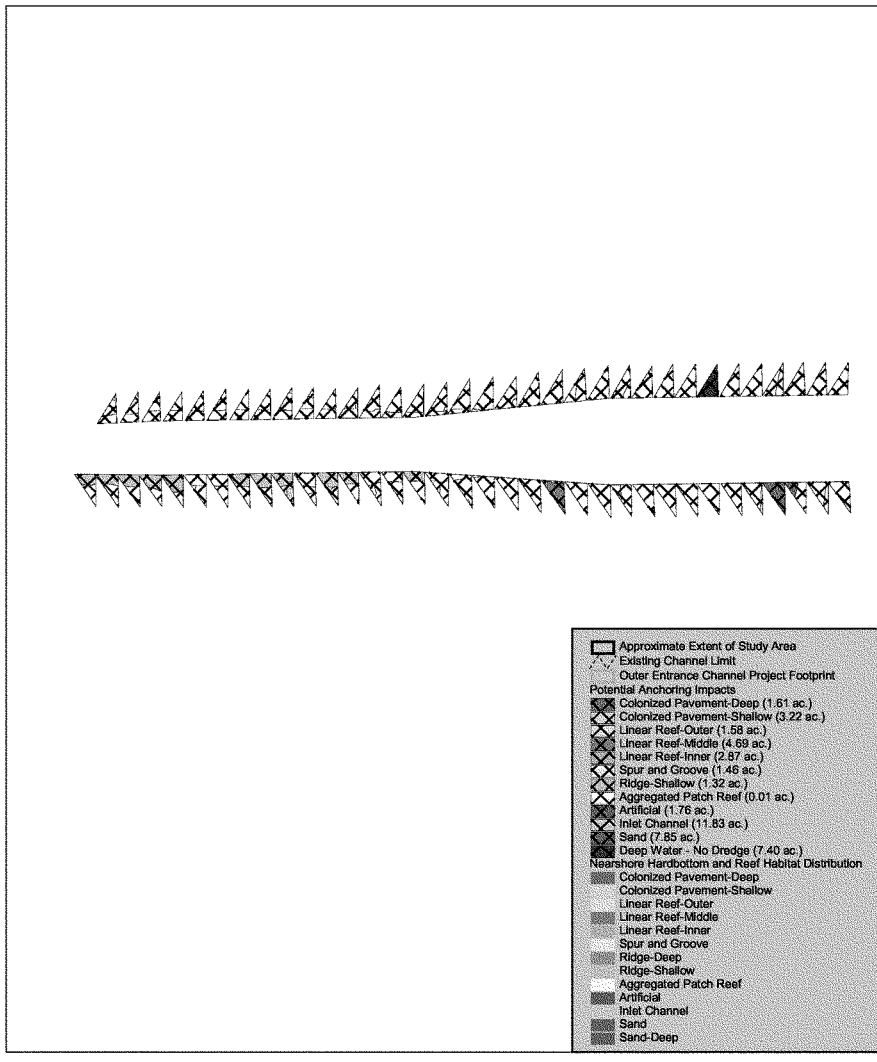
*Impacts do not include channel wall impacts, incidental impacts due to dredge equipment, below-dredge-depth incidental impacts, or indirect impacts to hardbottoms due to water quality.


Preferred Plan Hardbottom / Reef Impacts
Scale: 1 inch = 750 feet
Drawn By: MR
Date: September 2014
Approved By: JE
DIAL CORDY
AND ASSOCIATES INC
Figure 75
Legend
Resource Impacts

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
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	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.

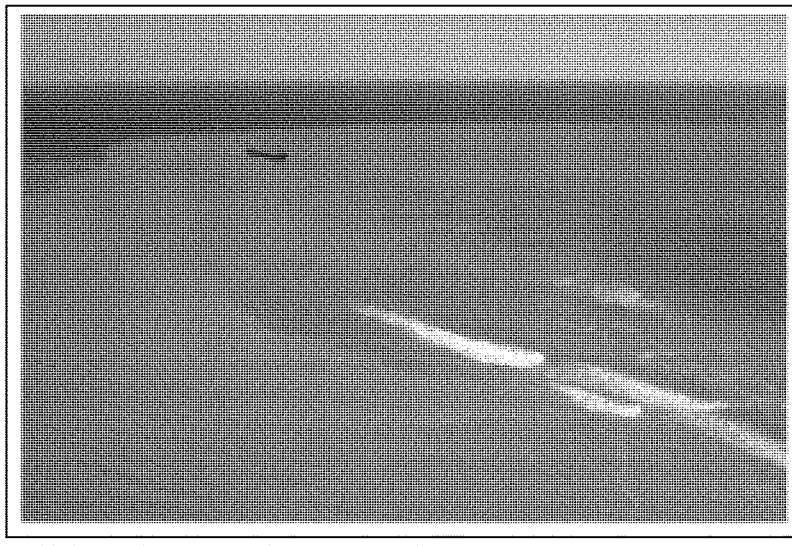


Figure 77 Natural sedimentation and turbidity associated with the passage of Hurricane Sandy (October 2012, view seaward from beach toward outer reef)

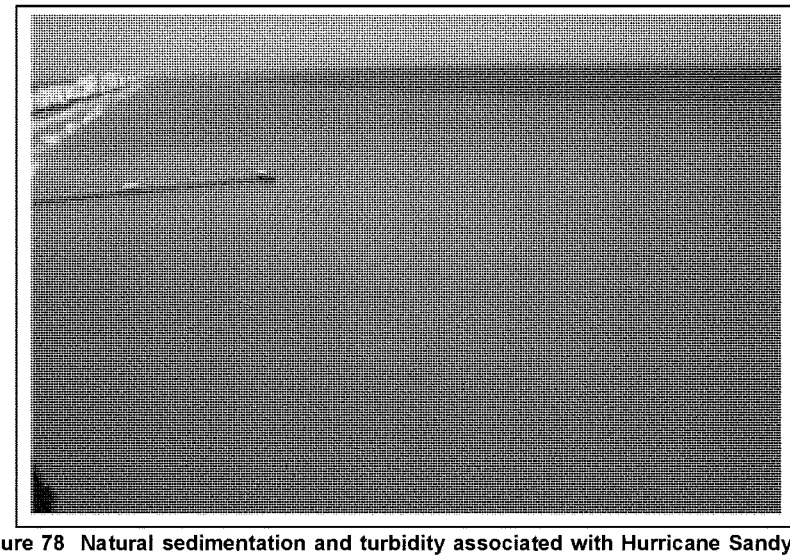


Figure 78 Natural sedimentation and turbidity associated with Hurricane Sandy (October 2012, view north toward Commercial Street Pier)

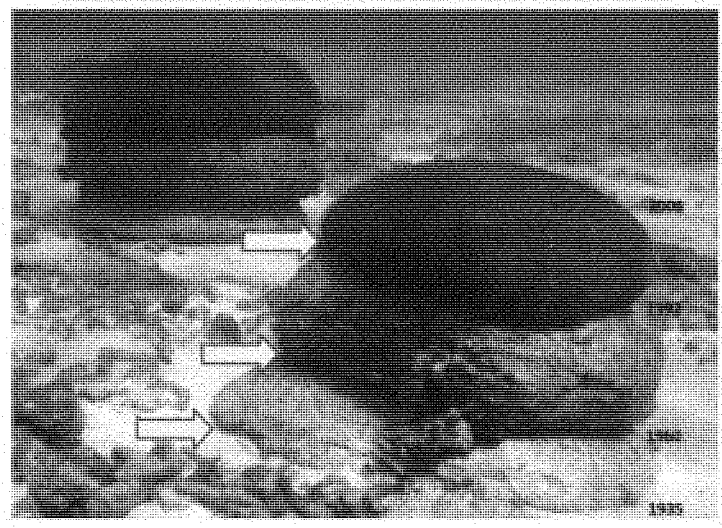
Partial burial of coral colonies by sediment, particularly fine, silty clay-like material is not uncommon in SE Florida reef ecosystems, mainly in response to large storms and hurricanes. This was demonstrated in Miami-Dade County after the passage of Hurricane Andrew in 1992. Regarding that, Blair et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

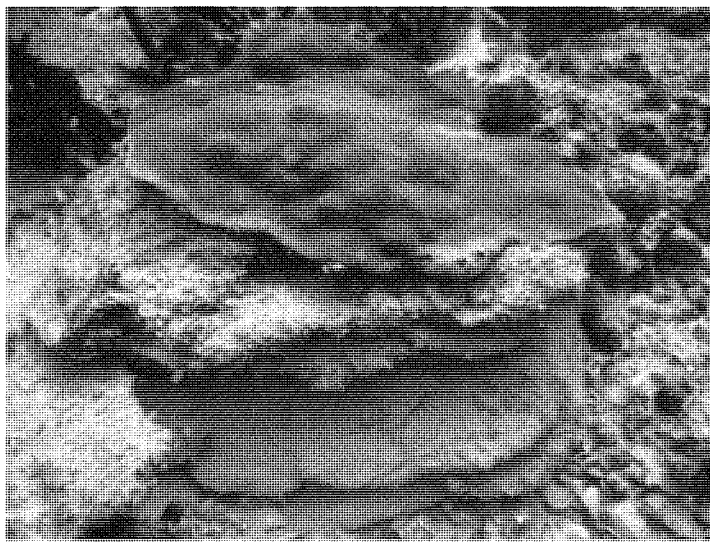
Additionally, Precht and Precht (2015) found large corals showing upward "pillow-like" growth (Figure 79) in response to large influxes of sediments due to hurricanes in 1935, 1960 and 1992. Specifically, Precht and Precht observed the following:

> "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.



Florida Keys, 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).

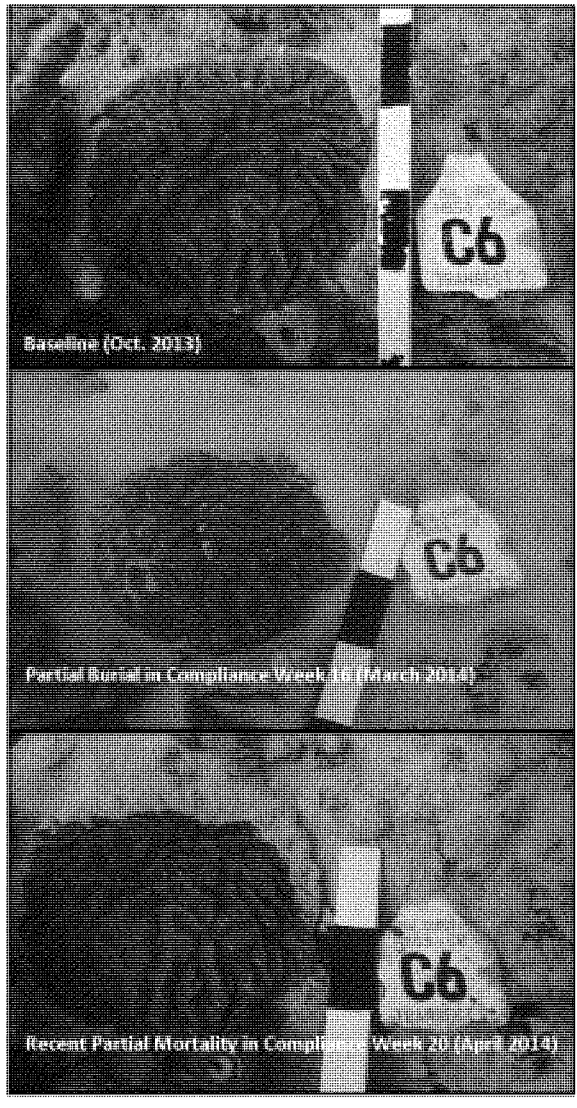


Figure 80 Monitored corals documenting effects of sedimentation at channel-side monitoring sites (Miami Harbor 2014)

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 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 7,000 *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 USEPA's 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; and "Dredging and Port Construction around Coral Reefs," (PIANC 2010). 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)

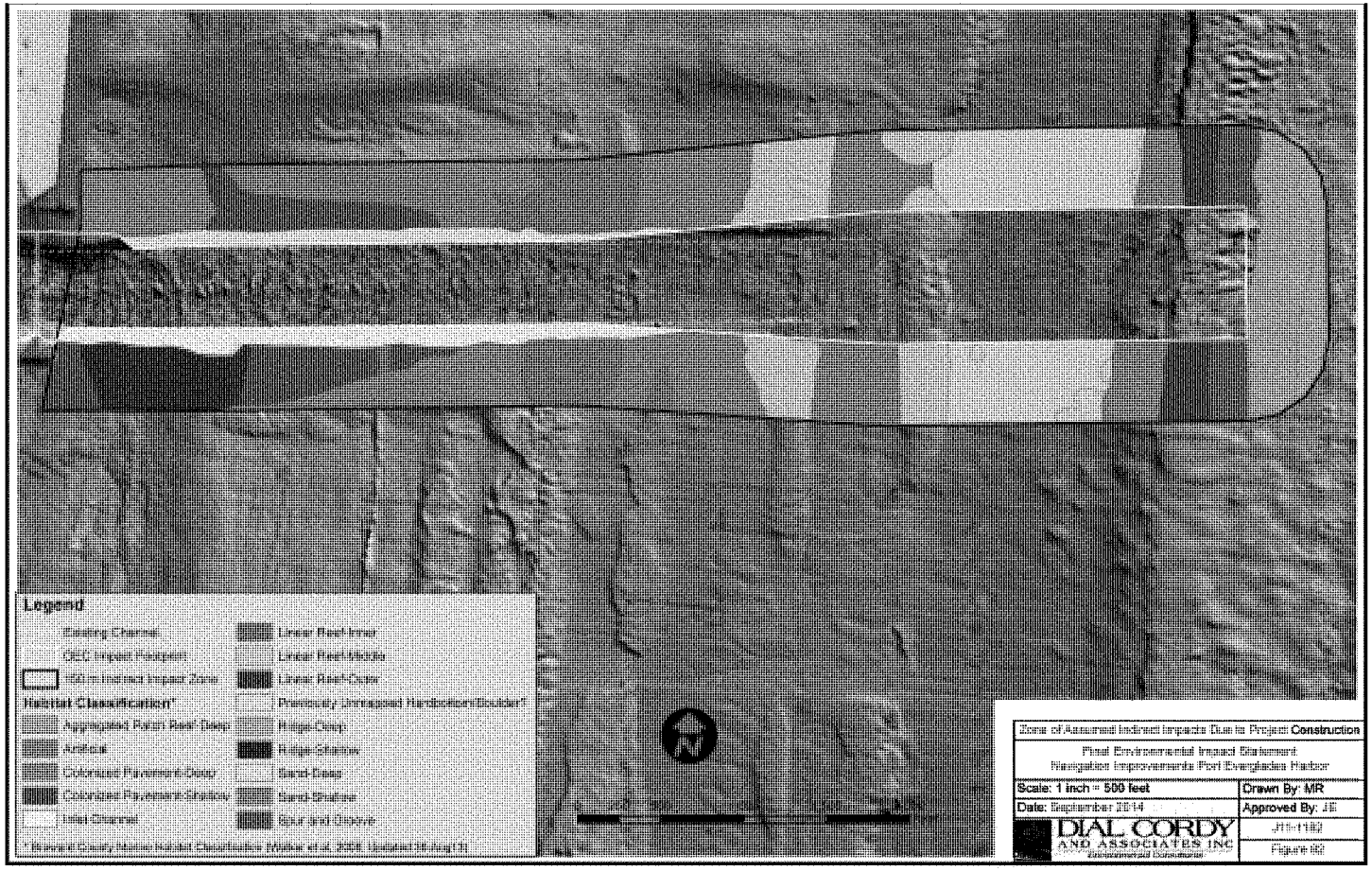
In conclusion, USACE acknowledges that the possibility of temporary, uncontrolled, incidental resuspension of material during dredging operations. In that event, the effects of this turbidity/sedimentation should be temporary (less than two years), but could include a temporary loss of photosynthetic 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. The direct impacts (dredging footprint) of the NED Plan 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.


Legend
Existing Channel
DEIS Impact Footprint
Indirect Impact Zone
Habitat Classification*
Aggregated Patch Reef Deep
Artificial
Colonized Pavement Deep
Colonized Pavement Shallow
Inlet Channel
Linear Reef Inner
Linear Reef Middle
Linear Reef Outer
Previously Damaged Hardbottom Habitat
Ridge Deep
Ridge Shallow
Sand Deep
Sand Shallow
Scour and Groove
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

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 Athemidae), 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.

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.

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.

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.

Dredged Material Disposal Impacts. 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

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.

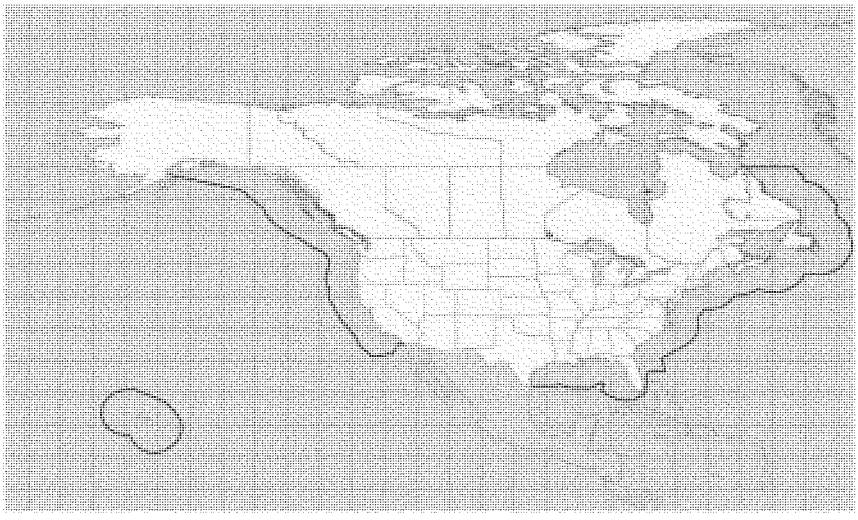


Figure 83 IMO US and Canadian ECA Boundary

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.

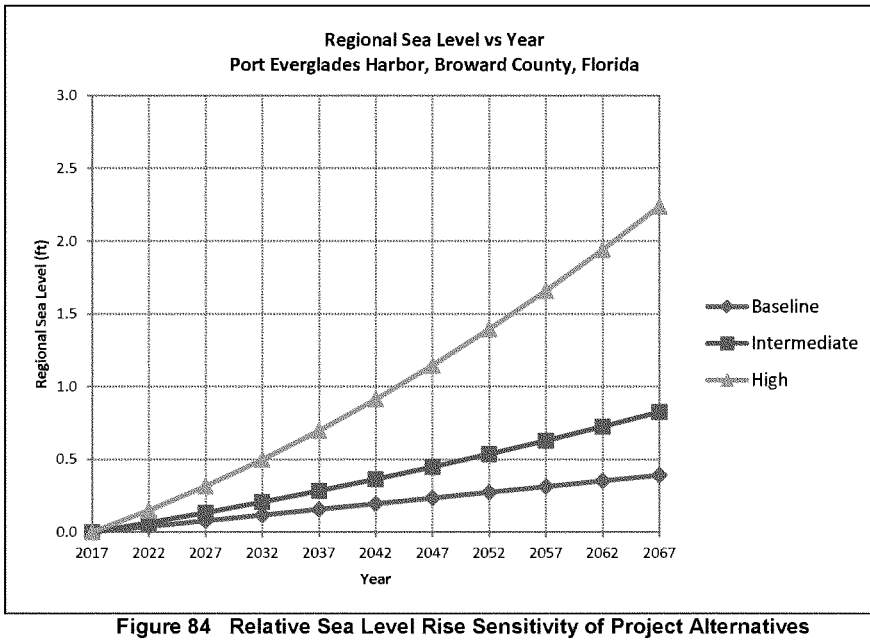


Figure 84 Relative Sea Level Rise Sensitivity of Project Alternatives

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 species). 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 analysis.

- *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 are 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.

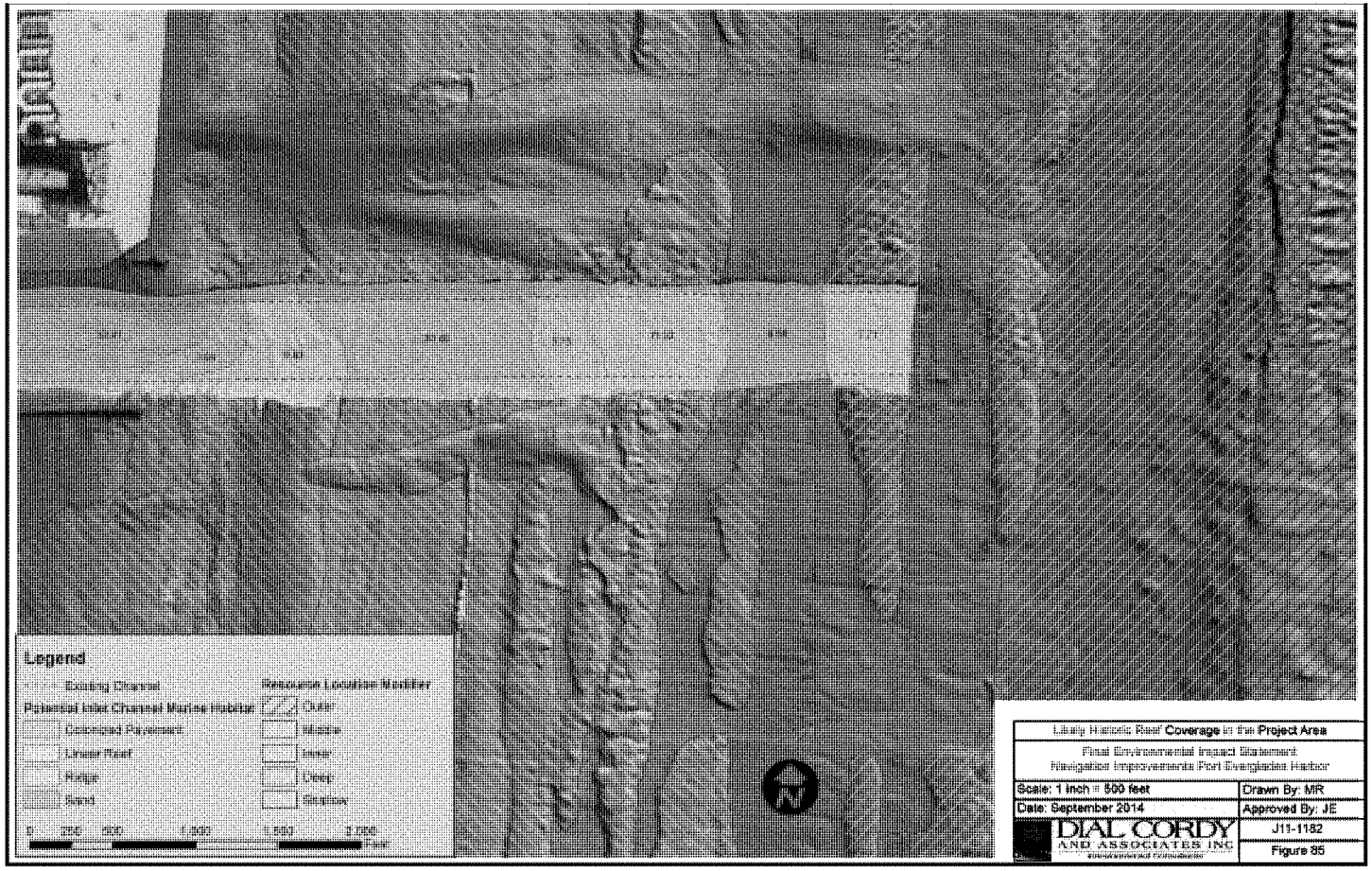
If permitted and constructed, the proposed Port Everglades Inlet Sand Bypass Project would impact additional 1.46 acres of shoal crest; 11.97 acres of rubble/sand; 7.69 acres of rubble/colonized pavement; 8.04 acres of colonized pavement; and 0.39 acres of channelized wall (Broward County 2008). The 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. .


Legend
Existing Channel
Potential Inlet Channel Marine Habitat
Concrete Revetment
Linear Reef
Ridge
Sand
Resource Location Modifier
Outer
Middle
Inner
Deep
Shallow
0 250 500 1,000 1,500 2,000
Feet
Library Hermatic Reef Coverage in the Project Area
Final Environmental Impact Statement
Navigation Improvements Port Everglades Harbor
Scale: 1 inch = 500 feet
Date: September 2014
DIAL CORDY AND ASSOCIATES INC
Environmental Consultants
Drawn By: MR
Approved By: JE
J11-1182
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.

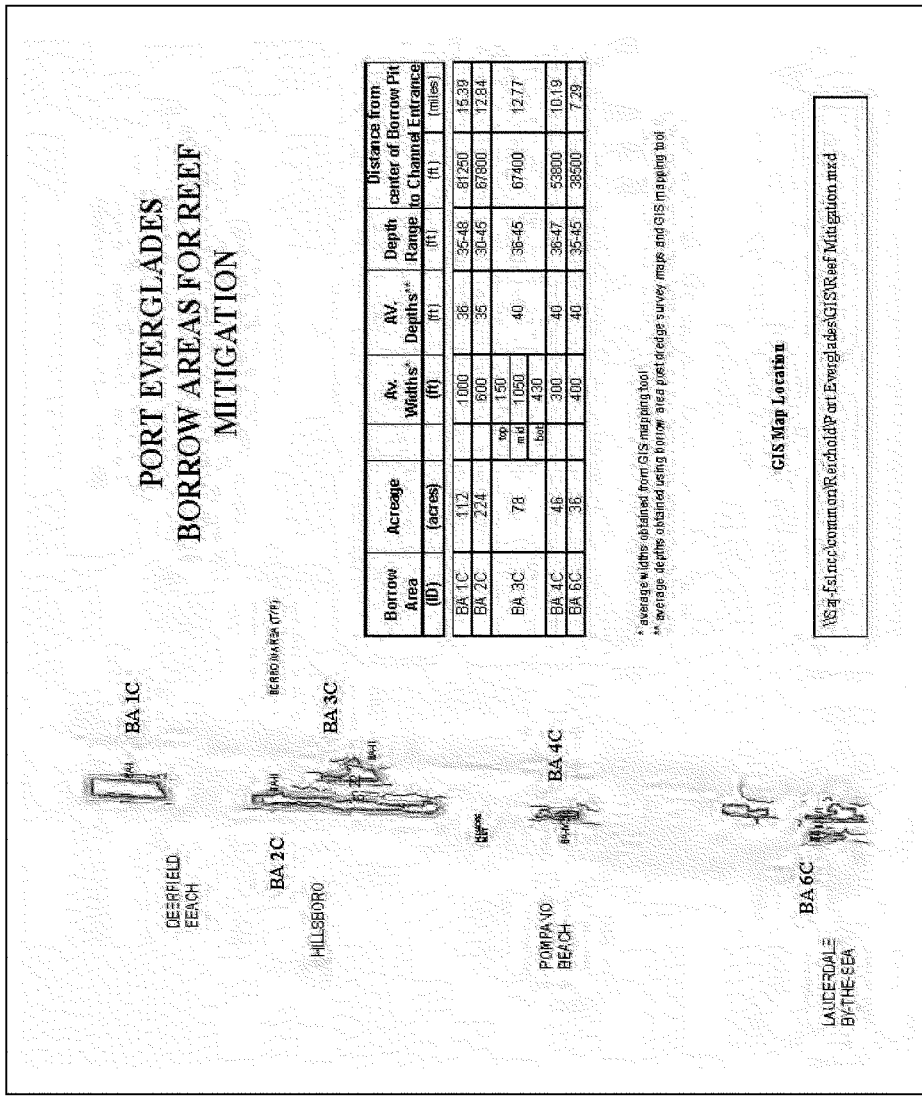
5.2.2 Recommended Reef Mitigation Plan

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/m^2). 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 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.



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

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.

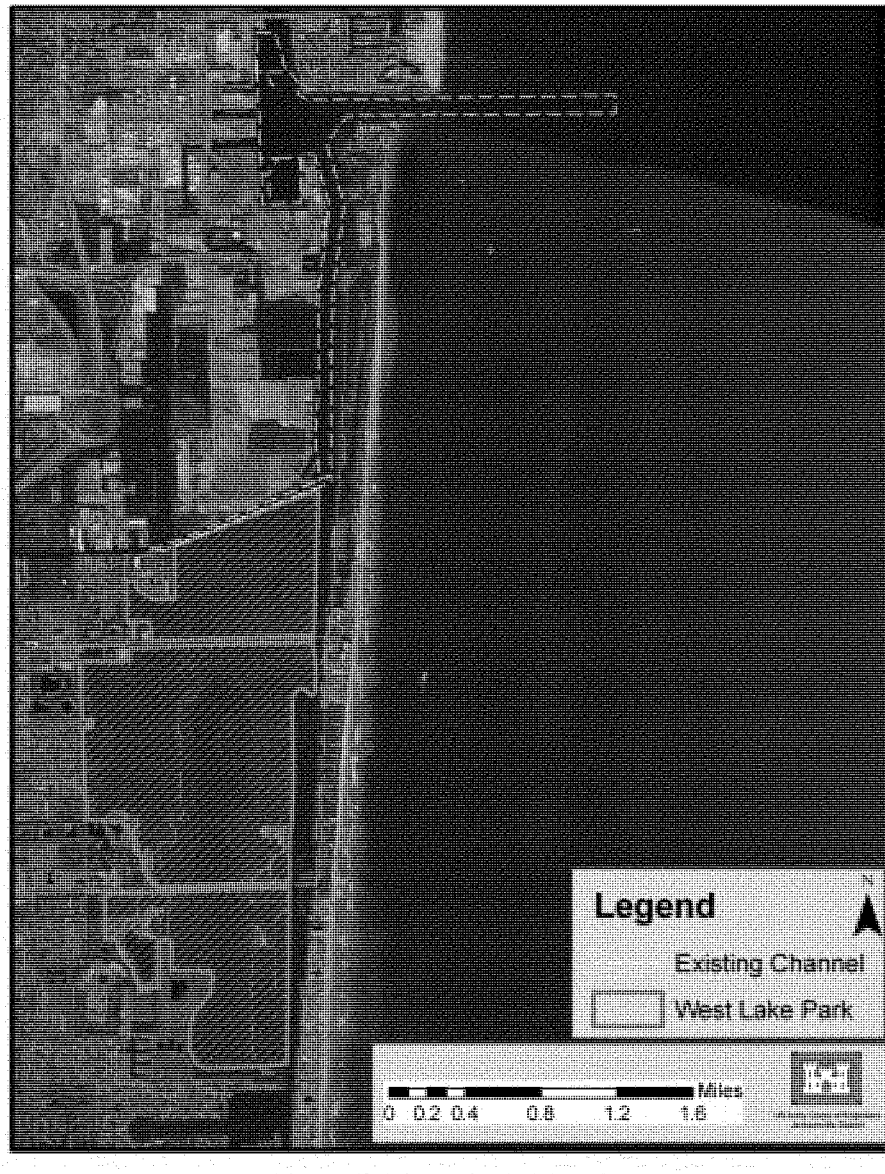
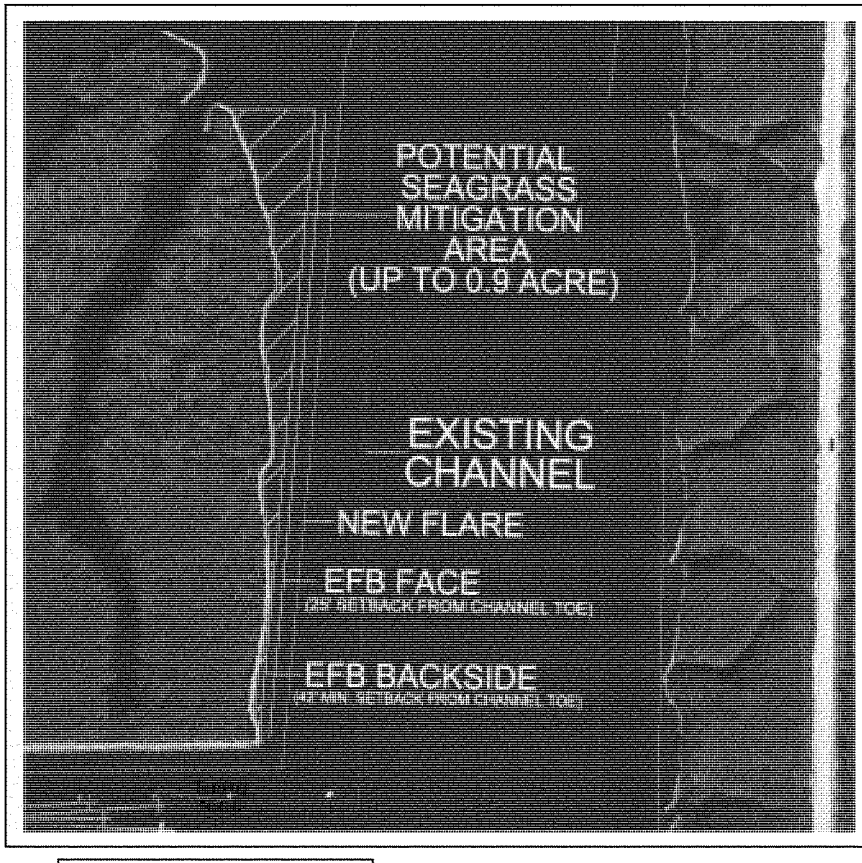
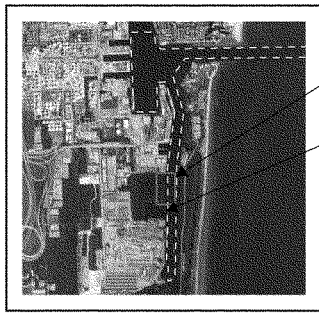


Figure 87 West Lake Park location





SAC Supplemental Seagrass Mitigation Site	
Final Environmental Impact Statement Navigation Improvements Port Everglades Harbor	
Scale: NTS	Drawn By: MR
Date: September 2014	Approved By: JE
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J11-1182
	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), and "*Dredging and Port Construction Around Coral Reefs*" (PIANC 2010). 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 concem 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.

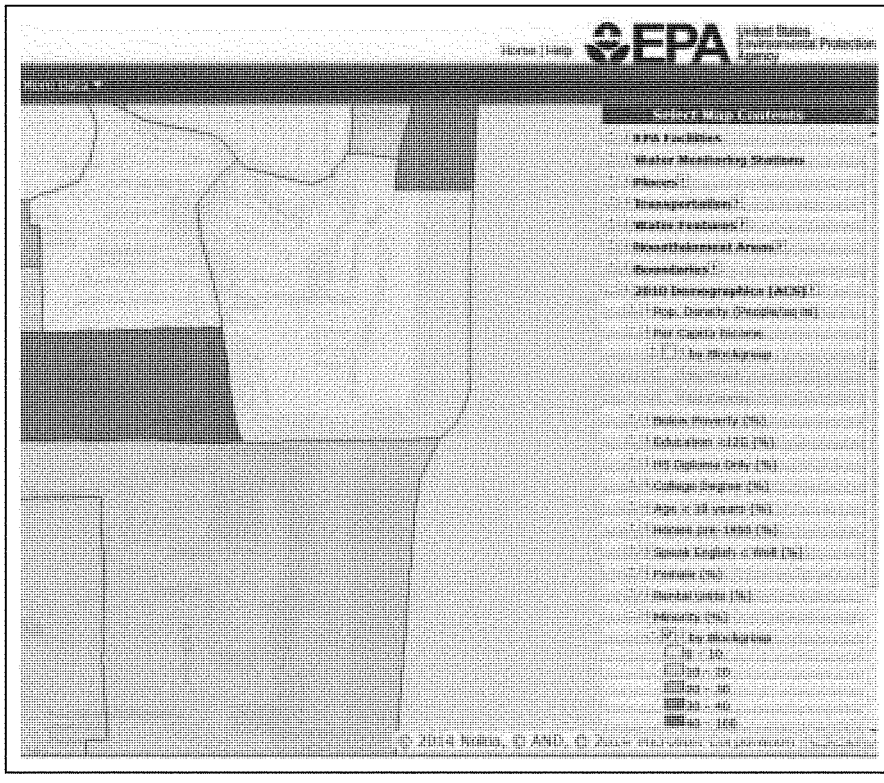


Figure 89 Minority representation within total population near project area

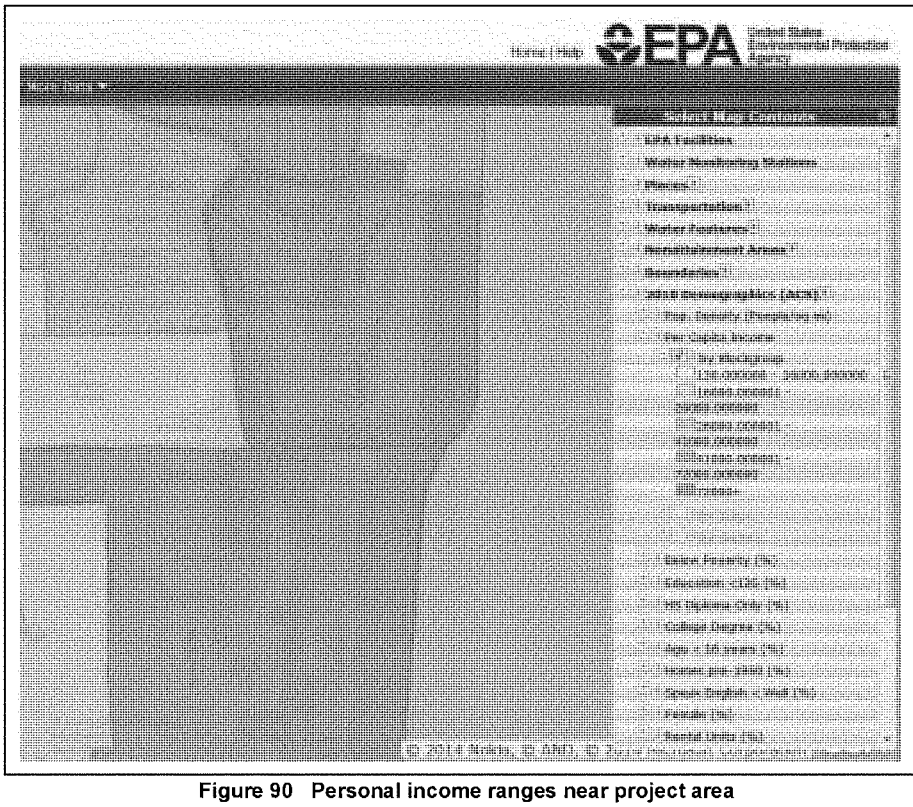


Figure 90 Personal income ranges near project area

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 the NEPA review process and responses can be found in Appendices A and L.

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APPENDICES

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FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
ON
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

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APPENDIX A

ENGINEERING

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FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
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1 INTRODUCTION

1.1 LOCATION

1. Port Everglades is located on the southeast coastline of Florida, approximately 23 miles north of Miami and 48 miles south of West Palm Beach (Figure A- 1). The port falls within the three cities of Dania, Fort Lauderdale, and Hollywood, as well as unincorporated Broward County. The full extent of the port covers over 448 acres of submerged land and 1,742 acres of upland territory. It is one of Florida's deepest ports.

2. Port Everglades has close proximity to north-south and east-west ocean trade lanes, interstate and state highway systems, extensive railroad networks, and the Fort Lauderdale/Hollywood International Airport. On the north, the port is bordered by residential and commercial developments, including private docks and marinas accessible from the Intracoastal Waterway (ICWW). Federal Highway 1, the airport, and additional residential and commercial developments lie to the west. At the southern border is Westlake Park adjoined by several private marinas. A narrow barrier island lies to the east occupied by John U. Lloyd State Park, U.S. Coast Guard Station Fort Lauderdale, the U.S. Navy South Florida Testing Facility, and Nova Southeastern University Ocean Science Center.

1.2 STUDY PURPOSE

3. Economic forecasts predict growth in containerized cargo, cruise, liquid bulk, and general cargo traffic at Port Everglades. The purpose of this feasibility study is to investigate improvements to the Federal navigation project at Port Everglades to accommodate this growth. All major basins and channels within the port were investigated. This engineering appendix provides detail regarding engineering studies necessary for development and analysis of proposed structural plans.

2 HISTORIC AND EXISTING CONDITIONS

2.1 HISTORY

4. Initial construction of Port Everglades began in 1925 and continued through 1928. Construction was accomplished through the excavation of Lake Mabel, a shallow water body separated from the Atlantic Ocean by a low sand ridge. Originally called Bay Mabel Harbor and later Hollywood Harbor, the port was the result of a cooperative effort between the cities of Hollywood, Fort Lauderdale, and a private investor. The Federal government became involved with the port after the passage of the River and Harbor Act of 1930 which provided the locally constructed project with Federal maintenance. The early harbor design was simple, consisting of a 7,300 foot long entrance channel; a single 1,200 foot long, 300 foot wide slip (Slip 1); two bulkheads; two jetties; two submerged breakwaters; and a single turning basin. Initial project depth was 35 feet. Since 1931, 11 Federal maintenance dredging projects at Port Everglades have been completed.

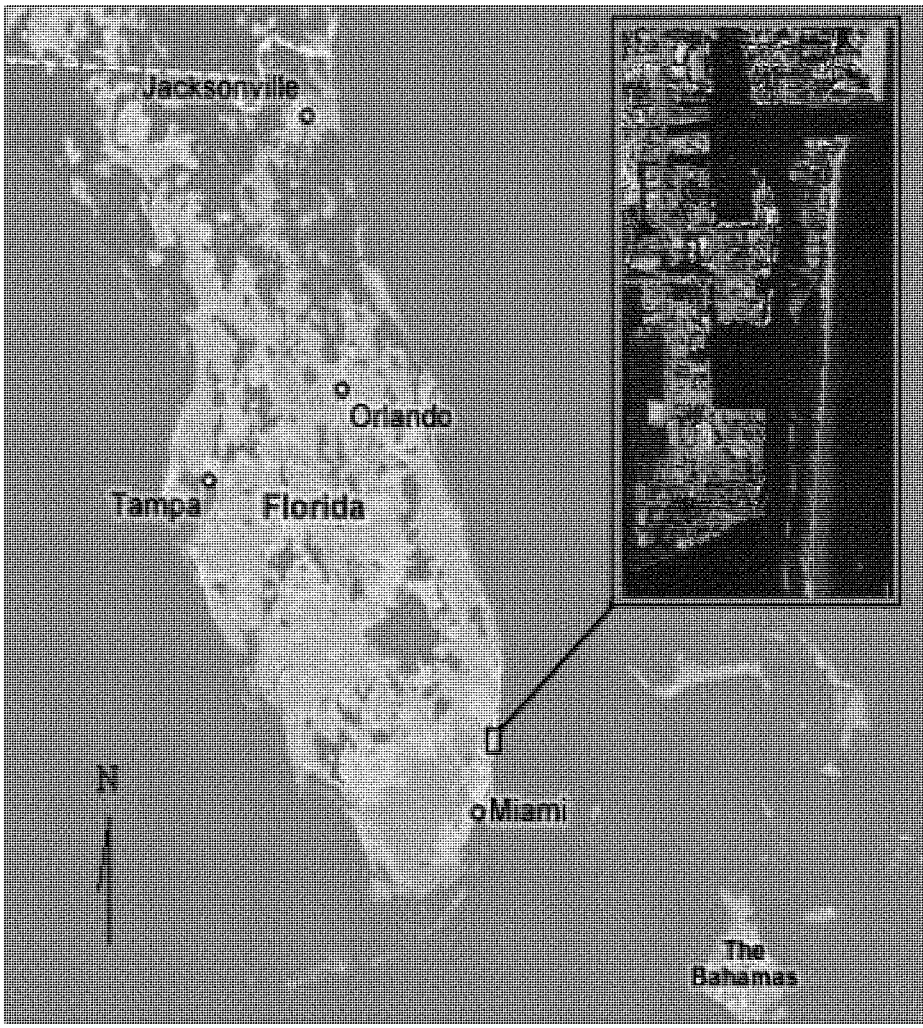

Figure A- 1. Study Location

5. Initially serving as the post of a battalion of marines known as the Fleet Marine Service and a hub for minor commercial trade, Port Everglades began full scale commercial services with the arrival of regularly scheduled calls by the Bull Line in 1931. This was followed by passenger ships of the United Fruit Company, commercial vessels of Hamburg American and Cunard Anchor Lines, and tankers of the petroleum shipper Aeroland Oil Company. The increase of commercial activity through the 1930's lead to the first port enlargement project, the construction of a new berth known as Slip 2.

6. In the 1940's Port Everglades dedicated a significant portion of its resources to military operations. By the 1950's, however, commercial tonnage had risen, prompting the expansion and deepening of the existing turning basin to 37 feet and deepening of the entrance channel to 40 feet. Improvements to the port's infrastructure were also made including construction of new buildings, open storage areas, roads, railways connections, utilities, and the addition of Slip 3.

7. The 1960's marked significant steps in port land development. Early in the decade, Florida Power & Light Co. brought four operating units on-line at its Port Everglades Plant. At this time, petroleum was the port's predominant commodity leading to significant expansion of the storage tank farm. Such strong growth prompted the initiation of a Master Plan process in 1965 followed in 1967 by the acquisition of 300 additional acres of land that would decades later become the Southport cargo terminal.

8. In the early 1970's the Federal Harbor Deepening Project was initiated. This provided for widening and deepening the port's entrance channel to 450 feet and 45 feet respectively, deepening the main turning basin to 42 feet, making improvements to the Pier 7 channel, extending Slip 2, and adding cold storage space to existing facilities. The late 1970's saw the opening of the Foreign Trade Zone No. 25 and the first rail-mounted container gantry crane.

9. Continued increases in commercial activity into the 1980's lead to the purchase of the first port-owned gantry crane in 1981 and implementation of proposals from the Master Plan 1984-2000, including the construction of the Southport facilities. By the late 1980's a third gantry crane was in place, the eighth cruise terminal opened, and a total of 30 berths were operational.

10. Port development continued through the 1990's beginning with the completion of the Southport Turning Notch in August of that year. In 1991, the Greater Fort Lauderdale/Broward County Convention Center at Northport opened, two parking garages were completed, and further cruise and cargo facility enhancements were made. In 1993 three post-Panamax, low profile gantry cranes were added to Southport facilities followed in 1995 by completion of the initial phases of the Southport Container Terminal. In the late 1990's three additional post-Panamax gantry cranes were acquired as well as approximately 270 acres of land for additional development adjacent to the Southport Container Terminal.

11. Beyond the year 2000 commercial activity is expected to continue to grow and diversify. Plans for further port development to accommodate increased berthing and cargo demands as well as increased vessel size are currently underway.

2.2 SITE LAYOUT

12. The current layout of Port Everglades is shown in Figure A- 2. Access to the Port begins at the sea buoy marking the outer limit of the port's entrance channel. The entrance channel itself is a 500 foot wide, 45 foot deep stretch that runs 1.7 miles due west, passing between north and south jetties at either side of the inlet entrance, and into the main turning basin. The main basin measures 1,200 feet from east to west and 2,450 feet north to south. Mean lower low water depth in the basin is 42 feet. Beyond the main basin, Port Everglades is divided into three main regions, Northport, Midport, and Southport with a total of 33 active berths.

13. For purposes of investigation and design, Port Everglades can be further sub-divided into nine components (Figure A- 3):

(1) Outer Entrance Channel (OEC), extending from the outer sea buoy to the harbor jetties

(2) Inner Entrance Channel (IEC), extending from the harbor jetties to the interior of the harbor

(3) Main Turning Basin (MTB) , covering the main bulk of the northern interior where vessel turning occurs

(4) North Turning Basin (NTB), the northern extension to the MTB

(5) South Turning Basin (STB), the southern extension of the MTB

(6) Widener Shoal (Widener), area covering the shallow shoal located in the southeast corner of the MTB

(7) Southport Access Channel (SAC), the channel that extends south from the MTB

(8) Turning Notch (TN), the turning basin located midway down and to the west of the SAC

(9) Dania Cutoff Canal (DCC), the boat canal extending westward from the south end of the SAC

14. Project components are described in greater detail under Section 3.4 (**Description and Engineering Analysis of Project Components).**

2.3 METEOROLOGICAL AND OCEANOGRAPHIC CONDITIONS

2.3.1 CLIMATE

14. The climate at Port Everglades is categorized as tropical, with a mean annual temperature of 75°F and 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 to October).

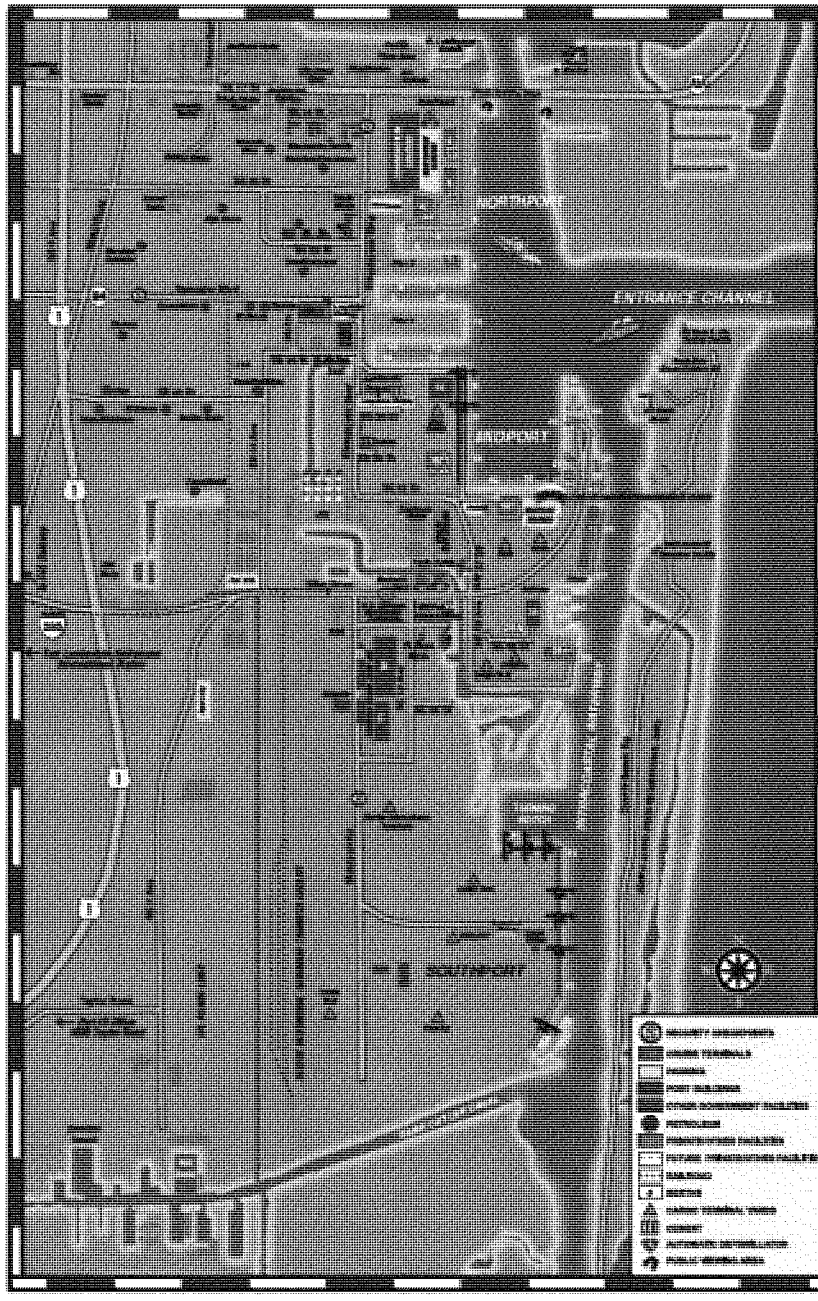

Figure A- 2. Port Layout and Berthing

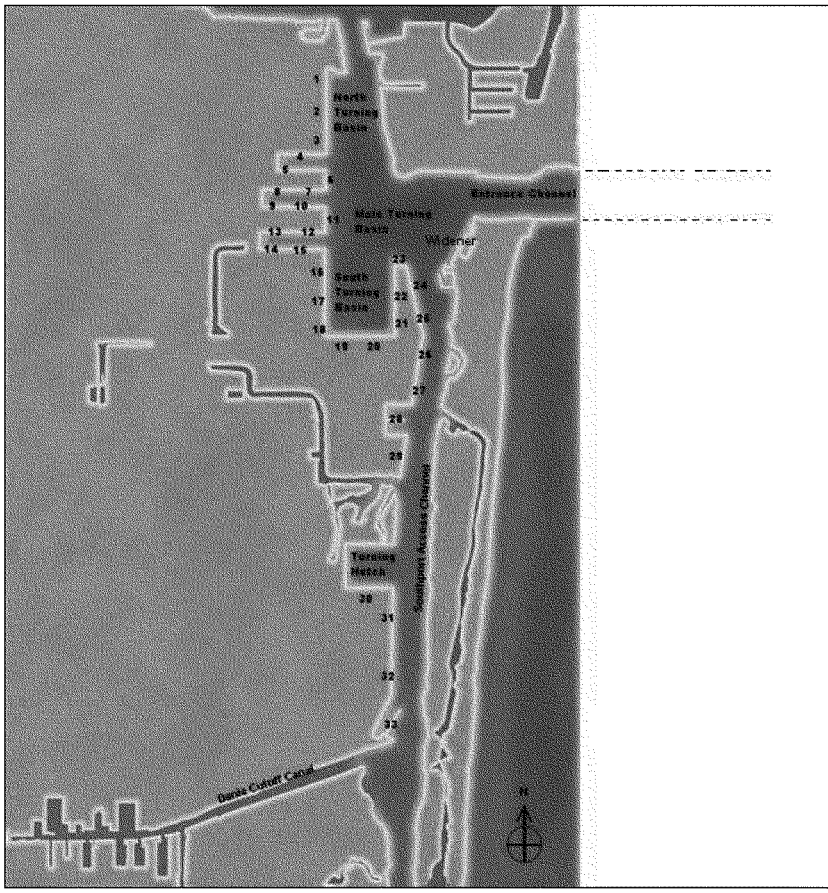

Figure A- 3. General Layout of Project Components

2.3.2 SEASONAL WINDS AND STORMS

15. During the summer months Port Everglades experiences predominantly east and southeast Trade Winds. This information is based on both offshore and upland wind data.

16. Measured offshore wind data is collected as part of the National Data Buoy Center (NDBC) Coastal-Marine Automated Network (C-MAN) program. The nearest C-MAN station to Port Everglades is located at Fowey Rocks, Florida, approximately 13 miles southeast of Miami (Figure A- 4). Meteorological observations at Fowey Rocks cover a period from January 1991 to December 2009.

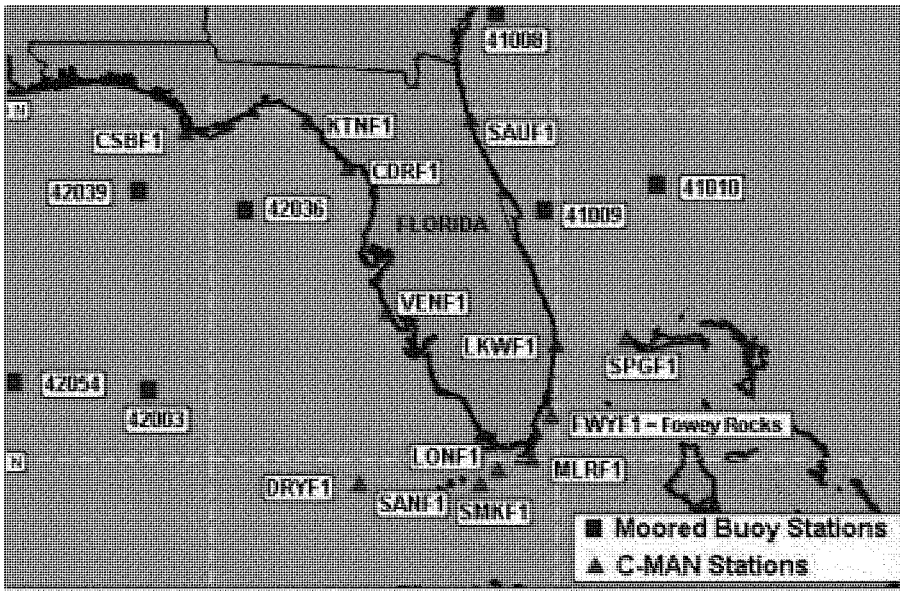

Figure A- 4. Fowey Rocks CMAN Station Location

17. In addition to measured offshore wind data, hindcast wind data are available from the U.S. Army Corps of Engineers (USACE), Wave Information Study (WIS) Program. WIS hindcast data are generated using the numerical hindcast model WISWAVE (Hubertz, 1993). WISWAVE is driven by wind fields overlaying a bathymetric grid. Model output includes significant wave height, peak and mean wave period, peak and mean wave direction, wind speed, and wind direction.

18. There are 523 WIS stations along the Atlantic Coast. WIS station 467 is considered to be the most representative of offshore deepwater wind and wave conditions for Port Everglades. Station 467 is located at Latitude 26.08N and Longitude 79.92W, approximately 11 miles due east of the Port Everglades Harbor jetties. The WIS hindcast is provided at 1 hour intervals and covers a period from 1980 to 1999.

19. Upland wind data is most often collected at airports. At the time of this report wind data from the Fort Lauderdale/Hollywood Airport, located just east of Port Everglades was not available for analysis. However, upland wind data collected as part of the University of Florida's Florida Automated Weather Network (FAWN) was available at a location approximately 7 miles west of the Port (Figure A- 5). The FAWN data set was obtained from weather station #420 and covers a time period from January 2001 through December 2010.

Figure A- 5. FAWN Weather Station Location

20. Table A- 1 provides a summary of average wind speeds and percentages of occurrence (based on direction) for both hindcast (WIS) and measured (C-MAN/FAWN) data. Review of both measured and hindcast offshore data reveal similar overall trends in direction and magnitude. Inland wind data displays similar trends in direction, but experiences a decrease in overall magnitude due to dissipation of energy as it travels over land.

21. Due to the variability of wind conditions in South Florida throughout the year, a further breakdown of data provides a summary of seasonal conditions (Table A- 2).

22. Between December and March, frontal weather patterns driven by cold Arctic air masses can extend as far as South Florida. These fronts typically generate winds that veer to the northwest before the frontal passage, and to the northeast behind the front. This post-frontal "Northeaster" behavior is responsible for the increased intensity of wind speed seen in the northeast sector winds during the winter months.

23. Daily breezes onshore and offshore result from differential heating of land and water masses. These diurnal winds typically blow perpendicular to the shoreline and have less magnitude than Trade winds and Northeasters. Daily breezes account for the general shift to east/southeast winds during the summer months when Northeasters no longer dominate.

Table A- 1. Average Wind Conditions

Wind Direction (from)	Fowey Rocks C-MAN Station (1991 – 2009)		WIS Station #467 (1980 – 1999)		FAWN Station #420 (2001 – 2010)	
	Percent. Occur. (%)	Average Wind Speed (mph)	Percent. Occur. (%)	Average Wind Speed (mph)	Percent. Occur. (%)	Average Wind Speed (mph)
North	6	14.1	8	14.0	12	3.5
Northeast	14	16.9	16	14.0	8	3.9
East	30	15.4	32	12.7	24	7.7
Southeast	20	14.0	29	11.1	21	6.3
South	11	13.9	9	10.6	10	5.5
Southwest	5	13.1	5	10.7	7	4.4
West	6	13.7	5	12.4	9	4.3
Northwest	8	15.1	6	14.4	10	4.3

Table A- 2. Seasonal Wind Conditions

Month	Fowey Rocks C-MAN Station (1991 – 2009)		WIS Station #467 (1980 – 1999)		FAWN Station #420 (2001 – 2010)	
	Average Wind Speed (mph)	Dominant Direction (from)	Average Wind Speed (mph)	Dominant Direction (from)	Average Wind Speed (mph)	Dominant Direction (from)
January	17.25	E-NE	14.35	E-NE	5.31	N
February	15.75	E	14.48	E	5.46	E-NE
March	16.85	E	14.36	E	6.50	E
April	16.03	E-SE	12.75	E-SE	6.61	E-SE
May	14.16	E-SE	11.39	E-SE	6.26	E-SE
June	12.27	E-SE	9.95	E-SE	4.93	E-SE
July	11.75	E-SE	9.91	E-SE	4.70	E-SE
August	11.73	E-SE	9.85	E-SE	4.74	E-SE
September	13.00	E	10.71	E	5.24	E
October	15.81	NE	13.23	NE	5.71	E
November	17.42	NE	15.05	NE	5.37	E-NE
December	16.59	E-NE	14.24	E-NE	5.40	E-NE

2.3.3 HURRICANES AND STORM SURGE

Hurricane season for the Atlantic runs from June 1 to November 30. During these months, hurricanes develop in the tropical and subtropical latitudes of the Atlantic Ocean north of the equator. Hurricanes are characterized by low barometric pressure, high winds in excess of 75 miles per hour, large waves, heavy rainfall, and surges. Such events 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. Figure A- 6 illustrates the locations of direct hits of hurricanes of ranking category 3 and above on the Saffir/Simpson scale

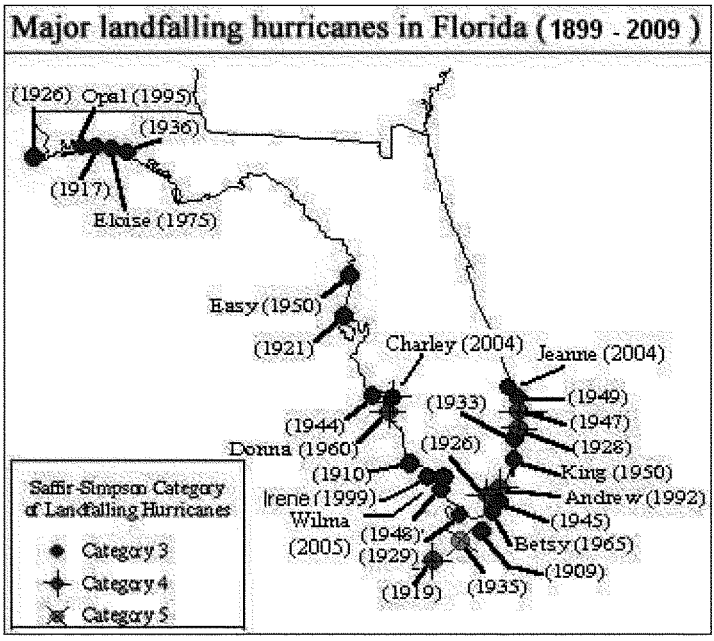

Figure A- 6. Hurricanes Achieving Landfall (1899 - 2009)

24. Storm surge is generally defined as an increase in water level that results from forcing by atmospheric weather systems, such as hurricanes. Storm surge elevations, based on storm event return period, for Broward County, Florida have been predicted by the University of Florida for the Florida Department of Transportation (FDOT) (Sheppard and Miller, 2003). These values are presented in Table A- 3.

Table A- 3. Storm Surge Frequencies and Elevations

Return Period (Years)	Surge Elevations (ft above MLLW)
	University of Florida
10	7.1
20	8.2
50	10.5
100	12.4
200	14.1
500	16.5

2.3.4 SEA LEVEL RISE

25. The geologic record of historical sea level variations indicates that both increases and decreases in global sea level have occurred. Both global cooling and warming contribute to sea level change. The National Ocean Service (NOS) has compiled long term records of measured water surface elevations along the Atlantic coast. This data is the basis for projecting future relative sea level rise at the Port Everglades Harbor.

26. Relative sea level (RSL) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea-level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form an Engineering Regulation, ER 1110-2-8162 (USACE, 2013).

27. ER 1110-2-8162 provides both a methodology and a procedure for determining a range of sea level rise estimates based on the local historic sea level rise rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a baseline estimate representing the minimum expected sea level change, an intermediate estimate, and a high estimate representing the maximum expected sea level change. Following procedures outlined in ER 1110-2-8162, Appendix B, baseline, intermediate, and high sea level rise values were estimated over the life of the project. 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://www.corpsclimate.us/ccaceslcurves.cfm); the project base year was specified as 2017; and the project life was projected to be 50 years. Figure A- 7 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, 0.84 ft, and 2.25 ft, respectively.

28. The total regional sea level rise predicted by the three scenarios (baseline, intermediate, and high) will not have a significant impact to the performance of the Port Everglades project. Potential impacts of rising sea level include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas.

29. Overtopping. Baseline and Intermediate sea level rise over the life of the project will have no impact to the proposed project structures. The proposed structures consist of a bulkhead system of sheetpile topped with a sloped riprap revetment that is designed to allow for tidal flushing of upland mangroves and other habitat (see Figure A- 78, Section 4.3.2). Presently the conceptual design of these structures includes a riprap revetment that extends from -5 feet MLLW to approximately +3 feet MLLW. While the baseline and intermediate sea level rise could result in some overtopping of the structure it would occur only during the highest of tides. Because the structure is already designed to accommodate a fair degree of overtopping (due to wave action and storm surge), the relatively small increase in overtopping due to the predicted increase in water depth will not adversely impact either the integrity of the structure or its intended purpose. The highest level of sea level rise could potentially result in nearly constant

overtopping of the structure as it is presently designed. However, such sea level rise is expected to occur at a given rate over a period of years, allowing for the application of adaptive management measures. Should the rate of sea level rise reflect the high scenario, the riprap design is adaptable and allows for additional and/or larger stone to be added as necessary.

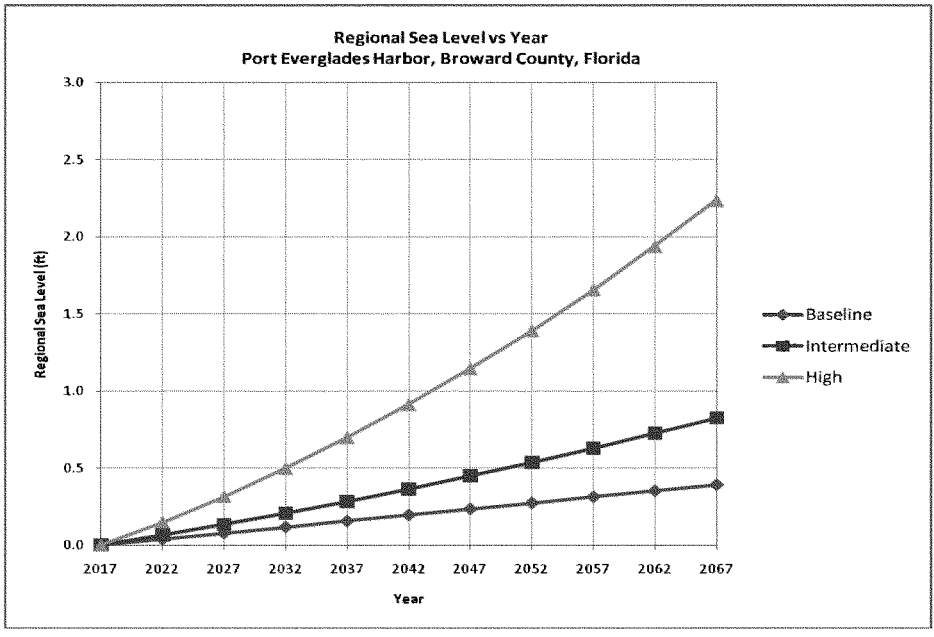

Figure A- 7. Projected Future Sea Level Rise at Port Everglades

30. Shoreline erosion and flooding. While there are regions of Port Everglades that may be susceptible to increased erosion and flooding, these regions are not within the scope of the present study.

31. In general, regional sea level rise (baseline, intermediate, and high) will not affect the functioning of the project alternatives or the overall safety of the vessel. While there is expected to be a small increase in tide range and storm surge penetration for all three scenarios, the structural aspects of the project will be either unaffected or can be easily adapted to accommodate the change.

2.3.5 TIDES

32. Three NOAA tide stations are located within Port Everglades (Figure A- 8). The first is in the Main Turning Basin near Slip 1 (Station 8722951), the second is located in the Southport Access Channel near berth 28 (Station 8722956), and the third is near the western port boundary along the Dania Cutoff Canal (Station 8722968). Tide datums at the Main Turning Basin station are based on a 3-year time series and a 19-year National Tidal Datum Epoch. Datums at the remaining two locations are based on a 1-month time series and a 19-year National Tidal Datum Epoch. Elevations of tidal datums for all three locations are provided in Table A- 4.

33. Tides at Port Everglades are semi-diurnal. Mean tide level is less than 2ft-MLLW throughout the Port, while storm tides can range from 3 to 10 ft above NAVD88 (~1 to 8 ft above MLLW) during severe hurricanes (South Florida Regional Planning Council, 2009).

2.3.6 CURRENTS

2.3.6.1 General

34. Two types of currents affect Port Everglades, offshore currents and currents within the harbor itself. Offshore currents affecting Port Everglades Harbor include littoral currents adjacent to the shoreline, inlet related tidal currents, and strong currents resulting from the proximity of the Florida Current, a component of the Atlantic Gulf Stream. Harbor currents arise from flood and ebb tides, river outflows, and power plant discharge.

2.3.6.2 Nearshore and Offshore Currents

35. Littoral currents may be classified as longshore or cross-shore currents. Longshore currents are caused by waves breaking at an angle relative to the shoreline. The most influential cross-shore currents are typically generated during storm events that may be characterized by short-term extreme wave and/or water level conditions.

36. Tidal currents are generated due to the natural ebb and flood of ocean waters caused by the gravitational attraction of the moon and sun on the earth. As water levels rise and fall, flood and ebb currents are formed. Currents are strongest at points of constriction such as the inlet entrance. Tidal currents are present both exterior and interior of the harbor jetties.

37. The Florida Current produces the strongest offshore current that affects Port Everglades. As it flows north along the eastern coastline, the Florida Current migrates randomly to the East and West, at times coming within close proximity to the coastline (Gyory, et al., 2009). The presence of the Florida Current creates a strong northerly current that acts perpendicular to vessels approaching and transiting the port's entrance channel.

Figure A- 8. Port Everglades Tide Stations

Table A- 4. Tidal Statistics for Port Everglades

Tidal Statistics Relative to Mean Lower Low Water (MLLW)			
	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
North American Vertical Datum – 1988	2.24 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

* Highest and lowest observed water levels were not recorded for this station.
** During the course of this study, this station has been deactivated. Available data is historical. No additional water levels (NAVD88 or MSL) are available at this location.

38. Secondary currents are frequently produced when back eddies form from the main flow of the Florida Current. A back eddy is defined as a circular current having the same magnitude as the originating flow, but moving in an opposite direction. Conditions are created in which a northerly current may be present in the farshore (i.e. near the outer sea buoy), while the back eddy creates a southerly current nearer to the harbor's entrance. It is also possible for a third current to form even closer to shore when a back eddy spawns a third eddy. In this case the new current is equal in magnitude to the original but returns to a northerly direction. When one or more back eddies is present, it is possible for a long vessel to experience both north and south flowing currents at the same time on different portions of the hull.

39. Currents shed from the Florida Current are highly variable in magnitude and unpredictable in occurrence. On the average, surface current velocities range from 2 to 4 knots (Bowditch, 1995). Research conducted in the Fort Lauderdale area indicates that the complex relationship between the Florida Current and the locally narrow continental shelf results in an inshore front that is dominated by horizontal wave-like meanders and submesoscale eddies with strong horizontal shear (Shay et al., 1998). During a National Research Laboratory experiment conducted in 2001, both surface current mapping, and bottom mounted current profilers captured significant current reversals and the presence of eddies in the vicinity of Port Everglades (Martinez-Pedraja et al., 2004). These and previously recorded events corroborate observations made by members of the Port Everglades Pilot Association regarding the magnitude and unpredictability of horizontal shear in the navigation channel.

2.3.6.3 Harbor Currents

40. Flood and ebb currents are present throughout the harbor. They occur on predictable time tables with average velocities of 0.5 to 2 knots (http://tidesandcurrents.noaa.gov/currents09). In the Main Basin, ebb currents create a particularly strong north to south flow along the face of the tanker slips on the east side of the basin. The currents in this vicinity can reach a maximum if a back eddy is also present. Along the south side of the basin in the vicinity of the finger pier at Berth 22, a steady west to east current exists at all stages of ebb and flood. In the Southport Access Channel, the presence of the flood and ebb currents has the most effect when vessels travel into the notch 90deg to the direction of the flow.

41. In addition to tides, spill out from New River and the Dania Cutoff Canal generates currents within Port Everglades. Spill out from these freshwater sources is controlled by inland flood gates. The outflow and therefore the resulting current magnitudes are highly variable. During heavy inland rain, the gates are opened and a strong flow is generated. Currents can be so strong that they can change the predicted magnitude and even direction of the tidal flow. During the rainy season (approximately June to September), the outflow increases and ebb currents become markedly stronger while flood currents are diminished or reversed. Outside of the rainy season, tidal currents are closer to predicted values.

42. Power plant discharge and intake are another example of localized currents. The discharge canal for the power plant lies just south of Berth 29. The rate of outflow is highly variable depending on plant production rates. Currents from the discharge canal are most strongly felt at Berth 29. The intake for the power plant is located at the east end of Slip 3. Vessels at Berths 13 and 14 often experience an acceleration due to the east to west flow created by suction when the plant is operational.

43. Swirling currents are an additional current type found within Port Everglades. Swirling currents are generated when the strong flow of tidal or other currents encounter solid bulkheads. Swirling currents are unpredictable and vary in magnitude. While they can be present throughout the harbor, they are most often encountered in the vicinity of the Knuckle (a "bend" in the channel at the juncture of berths 25 and 26), the Turning Notch, South Turning Basin, and Berth 33.

44. Wind and barometric pressure changes (set-up and set-down) also have an influence on observed currents. Strong winds can act to either increase or decrease current velocities depending on wind speed and direction while pressure changes effect water levels. The highly variable conditions at Port Everglades make it difficult to isolate the exact extent to which wind and barometric pressure effect local conditions. However, observed wind effects were included in ship simulation runs of Port Everglades. Predominant wind conditions for the simulations were 15 knot winds originating from east and northwest (see Sub-Appendix A). Barometric pressure changes were considered to be negligible.

45. The combination of generally predictable flood and ebb currents with various other sources of flow intrinsic to Port Everglades creates a highly unpredictable environment where localized currents can develop unexpected with extreme magnitude and variable direction.

2.3.7 WAVES

46. Deep water wave conditions representative of Port Everglades were obtained using hindcast data available from WIS station 467. Hindcast wave conditions cover the twenty year period between 1980 and 1999. Table A- 5 summarizes the percentage of occurrence and average wave height of waves by direction.

Table A- 5. Average Deep Water Waves (1980 to 1999)

Direction	Percent Occurrence (%)	Average Wave Height (feet)
North	17	3.9
Northeast	31	2.9
East	26	3.1
Southeast	16	2.3
South	6	2.8
Southwest	1	2.2
West	1	2.3
Northwest	2	2.6

47. Similar to wind conditions, wave conditions in South Florida experience seasonal variability (Figure A- 9). Winter months show a marked increase in wave height due to Northeaster activity. The intensity and direction of these winter wave conditions are reflected in the dominant southward sediment transport and seasonal erosional patterns. Summer months experience milder conditions with a more shore normal propagation of incident waves.

Table A- 6. Seasonal Wave Conditions

Month	Average Wave Height (ft)	Predominant Direction (from)
January	3.6	N
February	3.7	NE
March	3.6	NE
April	3.0	NE
May	2.6	E
June	2.0	E
July	1.8	E
August	1.9	E
September	2.6	NE
October	3.6	NE
November	4.1	NE
December	3.7	NE

48. Overall, wave conditions at Port Everglades are dominated by wind waves with limited exposure to open-ocean swell. Open-ocean swells originating from southeast through the northeast are blocked by two large shoals north and west of the Bahamas known as the Little Bahama Bank and the Great Bahama Bank, respectively (Figure A- 9). Water depths across the Bahama Banks average about 30 feet, so longer-period swells are reduced by bottom friction or the presence of land masses as they traverse the Bank. The minimum fetch between the western edge of the Banks and Port Everglades is about 50 miles, which allows ample distance for the generation of shorter-period wind waves in the deep waters of the Florida Straits. During severe storm events such as hurricanes and tropical storms, high wind velocities can generate large, damaging waves over the relatively short distance between the Bahamas and Florida.

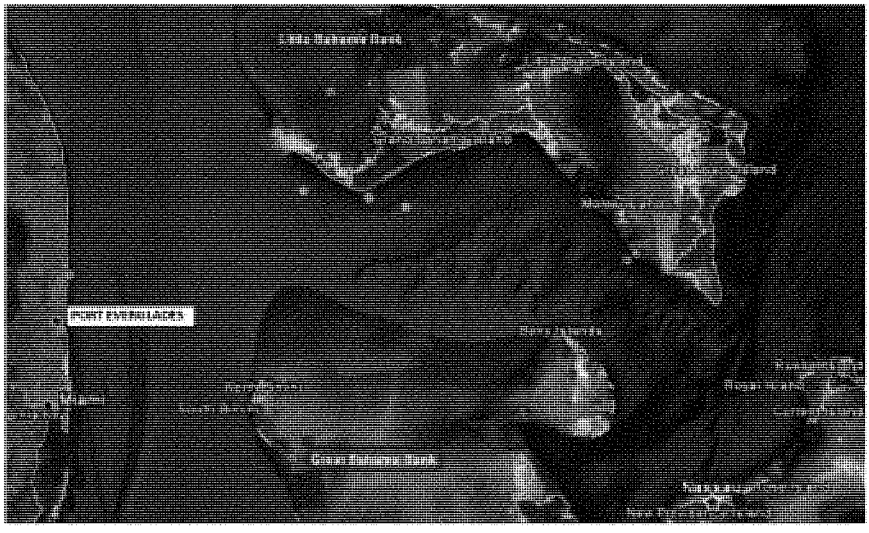

Figure A- 9. Little and Great Bahama Banks

2.3.8 SALINITY

49. The Broward County Department of Planning and Environmental Protection (DPEP) maintains multiple monitoring stations throughout the waterways of Broward County. Three of these stations fall within Port Everglades Harbor (Figure A- 10). Station 38 is located at the ICWW 100ft north of the east fender of the 17th street Causeway Bridge and 100ft west of the east bank. Station 39 is located 50ft west of the east bank. Station 47 is located at the Dania Cutoff Canal 200ft west of the ICWW. Salinity values at each station, measured 2 to 4 times annually between 1997 and 2007 are given in Table A- 7. Changes in salinity levels may be attributed to fluctuations in local rainfall levels as well as variations in freshwater discharge levels from New River and the Dania Cutoff Canal.

Figure A- 10. Port Everglades Salinity Stations

Table A- 7. BCDPEP Salinity Data 1997-2007

Broward County Department of Planning and Environmental Protection Salinity Data									
DATE	STATION	TIME	SAL (PPT)	STATION	TIME	SAL (PPT)	STATION	TIME	SAL (PPT)
970128	38	1045	33.2	39	1115	32.9	47	1145	33.5
970430	38	950	30.2	39	1038	31.0	47	1054	29.9
970729	38	1030	24.3	39	1125	28.9	47	1140	27.0
971028	38	945	27.5	39	1020	32.3	47	1035	28.2
980127	38	1035	22.1	39	1110	32.6	47	1135	26.4
980429	38	1030	33.2	39	1110	32.4	47	1215	33.1
980729	38	955	31.2	39	1035	30.9	47	1045	29.3
981028	38	1045	32.5	39	1110	32.0	47	1220	33.2
990127	38	1005	26.5	39	1045	33.4	47	1110	30.0
990414	38	955	37.1	39	1030	37.1	47	1045	37.2
990721	38	945	21.3	39	1030	30.9	47	1037	27.4
991025	38	1055	23.6	39	1200	29.3	47	1215	26.5
000126	38	1025	34.2	39	1105	33.0	47	1115	33.7
000427	38	1217	29.0	39	1144	30.5	47	1133	27.0
000727	38	1413	30.1	39	1157	31.2	47	1211	28.2
001026	38	1300	29.8	39	1150	32.5	47	1203	32.2
010201	38	1515	34.5	39	1245	34.5	47	1430	34.8
010426	38	1450	33.6	39	1230	35.0	47	1245	34.8
010719	38	1125	33.6	39	1100	36.2	47	1048	34.4
011108	38	1245	29.7	39	1135	30.8	47	1200	27.7
020131	38	1205	37.2	39	1130	36.9	47	1115	37.0
020425	38	1032	36.8	39	1135	37.4	47	1145	37.1
020724	38	1125	28.7	39	1225	32.8	47	1255	27.6
021031	38	1350	35.4	39	1315	35.2	47	1255	35.1
030106	38	1245	34.1	39	1215	33.9	47	1205	35.0
030424	38	1550	34.7	39	1230	33.8	47	1200	33.6
030813	38	1500	21.8	39	1430	30.5	47	1400	24.2
031105	38	1330	24.5	39	1250	26.8	47	1240	22.6
040212	38	1105	27.8	39	1210	30.4	47	1225	31.5
040506	38	1415	32.9	39	1320	33.9	47	1300	34.0
040811	38	1440	26.8	39	1400	29.1	47	1350	23.0
041118	38	1330	31.7	39	1235	33.6	47	1255	31.4
050224	38	1300	33.6	39	1240	35.0	47	1220	35.0
050608	38	1300	23.4	39	---	---	47	---	---
050811	38	1315	27.3	39	1230	30.6	47	1200	35.0
051201	38	1255	22.8	39	1200	32.1	47	1145	26.4
060223	38	1320	32.2	39	1215	31.1	47	---	---
060601	38	1330	32.8	39	1245	32.9	47	---	---
060824	38	1205	30.5	39	1135	32.9	47	---	---
061130	38	850	31.8	39	---	---	47	---	---
070221	38	1215	33.7	39	1150	33.4	47	---	---
070516	38	1145	35.0	39	---	---	47	---	---
070822	38	1100	25.8	39	1025	32.7	47	---	---
071115	38	1200	32.1	39	1125	30.1	47	---	---

2.4 GEOLOGY

2.4.1 REGIONAL

50. Peninsular Florida occupies a portion of a much larger geologic unit called the Florida Plateau. The plateau is a partially submerged platform nearly 500 miles long and 450 miles wide that separates the deep water of the Gulf of Mexico from the deep water of the Atlantic Ocean. In the last 200 million years, the plateau has been alternately dry or covered by shallow seas. During that time up to 20,000 feet of carbonate and marine sediments were deposited. Additionally, there has been a tilting of the Florida Plateau about its longitudinal axis. This tilting has caused the West Coast of Florida to be partially submerged, as indicated by the wide estuaries and offshore channels. The East Coast is correspondingly elevated, showing the characteristics of an emergent coastline.

51. During the last million years, a series of four glacial periods, or ice ages, brought about significant changes in sea level. As a result of these sea level fluctuations, the Florida peninsula has been alternately covered and uncovered by shallow seas. Following the first glacial period, sea level rose 270 ft above its present level, restricting dry land on the peninsula to a few small islands in northeast Florida and along the central Florida ridge. During the last glacial period, approximately 100,000 years ago, sea level fell to 300 ft below its present level, causing the Florida Plateau to emerge as dry land.

52. Approximately 15,000 years ago, sea level began its most recent rise towards present sea level. The average rate of rise was 30 feet per 1,000 years. About 7,000 years ago, when sea level had risen within 30 feet of its present level, rate of rise slowed. It was during this most recent slowing of sea level rise that the modern barrier islands of southeast peninsular Florida formed and the present coral reefs in south Florida began to develop.

53. It is generally accepted that sea level has continued to rise and is a major contributor to erosion at the shoreline. The primary causes of sea level rise today are the melting of the polar ice caps and thermal expansion of ocean waters.

2.4.2 SOUTHEAST FLORIDA

54. The surficial geologic deposits of southeast Florida are the Fort Thompson, Key Largo, Anastasia, and Miami Formations. These limestone formations were deposited in shallow Pleistocene seas. The Fort Thompson Formation is the oldest formation and was deposited in warm shallow seas similar in environment to the broad barren marine plains covering the Bahamas Banks today. Later, coral reefs of the Key Largo Limestone formed. This in turn created sheltered waters behind which the bryozoan facies of the Miami Limestone formed. Deposition of broad shoals of oolitic sediments along the coast followed.

55. The Anastasia and the Miami Formations were formed as sand shoals and beach ridges 100,000 to 125,000 years ago. Tidal channels cut through the carbonate and oolitic shoals, connecting the Atlantic Ocean with the shallow sea covering the Everglades. These channels form the parallel cuts known today as the Transverse Glades in Dade County.

56. The topography of Palm Beach, Broward, and Dade counties are dominated by Lake Okeechobee, the Everglades, sandy flatlands, the Atlantic Coastal Ridge, coastal lagoons, and the modern barrier islands

57. The Atlantic Coastal Ridge extends along the Atlantic coast as an irregularly shaped highland composed of broad marine plains, beach ridges and bars north of Boca Raton. The Anastasia Formation forms the backbone of the Atlantic Coastal Ridge. South of Boca Raton, the Atlantic Coastal Ridge is formed by the Miami Oolite.

2.4.3 BROWARD COUNTY – LOCAL COASTAL

58. Broward County is geologically divided into the Everglades to the west, the heavily populated Atlantic Coastal Ridge on the east, the barrier islands, and nearshore deposits. The barrier islands and the nearshore deposits are underlain by the Miami Limestone. The nearshore shelf off Broward County is characterized by 3 step-like plateaus, each lower than its immediate shoreward neighbor and separated by irregular, rock reef ridges. The plateaus were created by sediments filling depressions located between the rock ridges. Each reef grew offshore during a different lower stand of sea level.

59. 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 outcropping Pleistocene formations offshore. The quartz sand component is a combination of quartz sand that has migrated southward along the Atlantic coast and Pamlico Sand that was previously deposited over the entire region. The beach sand in Broward County consists predominantly of carbonate grains and shell fragments. A small amount of quartz grains are present. In general, the mean grain size ranges from 1.38 phi (0.38 mm) to 1.06 phi (0.48 mm). The phi standard deviation ranges from 1.12 to 1.36.

2.5 SHOALING AND MAINTENANCE

60. Littoral processes at Port Everglades are influenced heavily by the presence of man-made structures in the vicinity of the port's entrance channel. A spoil shoal to the north of the inlet, the inlet's jetties, and the navigation channel itself lead to the occurrence of accretion and erosion at the adjacent shorelines.

61. The spoil shoal originated in 1962 when a Port improvement project resulted in the deposition of approximately 2 million cubic yards of dredged material at a spoil area 2,000 feet offshore north of the entrance channel. Evaluation of hydrographic surveys performed between 1962 to 1994 show that the spoil shoal area has slowly migrated towards the shore, but is presently relatively stable. Along with the North jetty the shoal acts to impound sediment contributing to high accretion rates on the beach north of the inlet.

62. The navigation channel and south jetty act jointly as a sediment sink for sediment that reaches the inlet. Based on surveys of channel dredging, it is estimated that approximately 21,700 cubic yards of sand enters the inlet each year (Olsen Associates Inc., 2007). This material migrates westerly along the northern seawall and deposits on the side slopes of the channel, at the western end of the wall adjacent to the Main Turning Basin, and in the Main Turning Basin.

63. In June 2004, Olsen Associates Inc., under contract with Broward County, completed the Port Everglades Inlet Sand Management Phase I: Sand Bypassing Feasibility Study (Olsen Associates Inc., 2004). This study determined that the shoreline north of the jetty to be fully impounded and proposed several bypassing alternatives to prevent annual sand transport moving past the jetty and increasing shoaling within the federal navigation channel. Phase II: Sand Bypassing Feasibility –Addendum (Olsen Associates Inc., 2007) determined the most feasible and acceptable plan based upon logistical and environmental criteria. This project plan includes modification of the rubble spoil shoal, sand-tightening of the northern jetty, and creation of a sediment trap. The result is expected to be the alleviation of increased sand shoaling of the navigation channel between sand bypassing events.

64. As the plan recommended in Phase II has not yet been implemented, the present study will rely on shoaling rates determined in the absence of a sand bypassing system for the purposes of planning and cost estimating. See Section 4.5.2 (Maintenance of the NED Plan) for discussion of future shoaling rates.

65. Since Port Everglades was adopted as a Federal navigation project in 1930, there have been eleven federally sponsored maintenance dredging projects aimed at removing accumulated sediments within the entrance channels and Main Turning Basin. The last maintenance dredging occurred in 2005. The chronology of these episodes is given in Table A- 8.

2.6 SEDIMENT BUDGET

66. The combination of the inlet and jetty system at Port Everglades acts as a complete sediment barrier which interrupts the southerly littoral drift, creating a sediment surplus to the north of the inlet and a deficit at the beaches to the south.

67. A sediment budget for Port Everglades Inlet is illustrated in Figure A- 11 (Olsen Associates, 2007). This budget is based on the long-term volumetric changes (1979 to 2006) along adjacent beaches from Florida Department of Environmental Protection survey monuments R-77 and R-94, including the inlet channel. The net southerly longshore sediment transport rate 8,000 feet north of the inlet is 54,900 cubic yards per year, of which 37,700 cubic yards accumulate along the north beach and 17,200 cubic yards deposit in the inlet. The annual erosion rate of 48,500 cubic yards at John U. Lloyd includes an additional 4,500 cubic yards entering the inlet and 7,500 cubic yards being lost in the cross-shore. The resultant net southerly transport rate 8,000 feet south of the inlet is 36,500 cubic yards.

Table A- 8. Chronology of Maintenance Dredging at Port Everglades

Year	Location	Volume (cy)	Disposal
1934	Entrance Channel and Turning Basin	139,900	Ocean
1935	Entrance Channel and Turning Basin Turning Basin	97,400 73,100	Ocean Upland
1939	Entrance Channel and Turning Basin	48,300	Upland
1948	South side of Turning Basin Entrance Channel and N. side of Turning Basin	93,900 206,300	Upland Ocean
1950	Northern portion of Turning Basin	47,300	Upland
1953	Entrance Channel Turning Basin	97,300 179,800	Ocean Upland
1954	Turning Basin	101,200	Upland
1960	Entrance Channel Turning Basin	38,700 179,800	Ocean Upland
1961-1962	Entrance Channel Turning Basin Turning Basin	22,500 9,600 12,200	Beach/Ocean Upland Ocean
1978	Turning Basin	144,500	Ocean
2005	Turning Basin	46,700	Ocean

3 ENGINEERING ANALYSIS OF STRUCTURAL PLANS

3.1 GENERAL

68. This section describes engineering analyses of the structural improvement plans proposed at Port Everglades. The Main Report provides more information regarding plan formulation and screening. This section is organized as follows:

(1) Design Vessels
(2) Depth
(3) Project Components
(4) Design Plans
(5) Hydrology and Hydraulics
(6) Geotechnical Investigations
(7) Structural Design Considerations
(8) Civil Design of USCG Facility Reconfiguration
(9) National Economic Development Plan
(10) Selected Plan

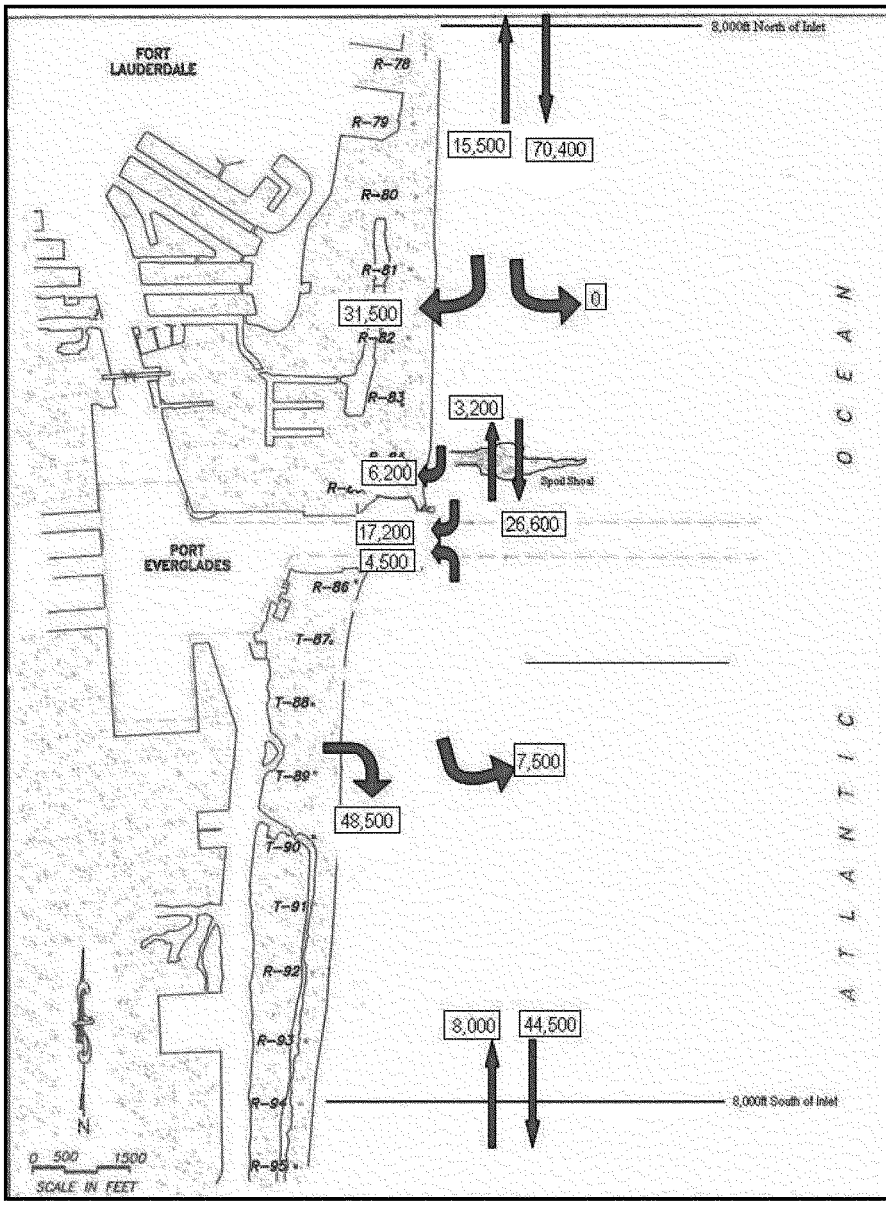

Figure A- 11. Sediment Budget, Port Everglades

3.2 DESIGN VESSELS

69. The following design vessels were used in the development and analysis of structural design plans for Port Everglades Harbor.

70. Post Panamax Design Vessel. The design vessel selected as representative of the Post Panamax Container Class was a 6,600 TEU containerized S-Class cargo vessel with a 141 foot beam, 48 foot draft, and a length of 1,139 feet.

71. Liquid Bulk Design Vessel. The vessel selected as representative of the liquid bulk carrier was a generic oil product tanker with a beam no greater than 142 feet, a draft no greater than 55 feet and a length not to exceed 900 feet.

72. Future Cruise Design Vessel. The vessel selected as representative of the future class of cruise ships was the Eagle Class cruise ship, Voyager of the Seas. "Voyager" has a beam of 156 feet, a draft of 28 feet, and a length of 1,020 feet.

73. Panamax Design Vessel. The design vessel selected as representative of the Panamax Container Class was the cargo vessel Bellatrix. The Bellatrix is a containerized cargo vessel with an 82 feet beam, 29 feet draft, and an overall length of 524 feet.

74. South Turning Basin Design Vessel. The design vessel selected for the development of plans to facilitate transit of a Panamax class vessel to the STB was a generic vessel with a beam of 106 feet, a draft of 43 feet, and a length of 926 feet. These dimensions are considered representative of Panamax class vessels which will berth in the STB.

75. Pleasure Craft. To represent pleasure craft traffic in the design process, a generic 20 foot beam vessel was selected.

76. Table A- 9 provides a summary of selected design vessels, their dimensions, and the project components to which they were applied during engineering design.

3.3 DEPTH

3.3.1 GENERAL

77. The total depth of a Federal navigation project is determined by several factors. The project depth (also known as the authorized depth upon project completion) is based on maximizing net transportation savings while considering safety, physical conditions, and vessel operating characteristics. Additional depth, known as advanced maintenance, addresses the reliability of the channel, based on the degree of expected shoaling and maintenance. Finally, the variability and limitations of construction techniques are accounted for with a depth increment known as allowable overdepth.

Table A- 9. Design Vessels

Design Vessel	Beam (ft)	Draft (ft)	Length (ft)	Project Component
Post Panamax"S-Class"	141	48	1,139	OEC, IEC, MTB, Widener, SAC, TN
Liquid Bulk	≤ 142	≤ 55	≤ 900	OEC, IEC, MTB
Future Cruise "Voyager"	156	28	1,020	OEC, IEC, MTB, Widener, SAC
Panamax "Bellatrix"	82	29	524	DCC
South Turning Basin	106	43	926	STB
Pleasure Craft[1]	20	N/A	N/A	All
[1] Pleasure Craft design vessels were used as "passing vessels" in the determination of channel and turning basin dimensions				

78. For new work projects that include areas of hard rock or heavily consolidated materials, USACE regulations require an additional depth increment known as required overdepth (USACE, 1996). Required overdepth ensures an additional margin of safety for vessels during transit and acts to minimize future maintenance dredging.

3.3.2 PROJECT DEPTH/AUTHORIZED DEPTH

79. The project depth[1] is determined from both economic analysis and engineering considerations. It is a depth that maximizes the net transportation savings while simultaneously optimizing the physical dimensions of channels and turning basins based on vessel safety (avoidance of collisions and groundings), physical conditions (winds, waves, tides, currents, etc…), and vessel dimensions and operating characteristics (turn radius capabilities, tug assist requirements, etc…). Maximum project depths evaluated for each project component are provided in Section 3.4 (Description and Engineering Analysis of Project Components), while NED project depths are provided in Section 3.10 (Economic Development Plan).

80. Included in the project depth of each project component is an allowance of safety known as underkeel clearance. Underkeel clearance provides a safety margin that accounts for wave action and vessel squat, especially in entrance channels where adverse conditions are most likely to occur. Underkeel clearance requirements for each of the Port Everglades project components are discussed in detail in Section 3.4.11 (Underkeel Clearance).

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[1] All channel and basin depths indicated in this report are project depths unless otherwise specified. Project depth is the authorized depth to which the federal government maintains channels and basins. For construction purposes, the Federal government may dredge channels and basins an additional amount below project depth. For this study, that additional amount consists of 1 foot of required overdepth (allowance for maintenance purposes) and 1 foot allowable overdepth (allowance for dredge tolerances). See Section 3.3 (Depth) for more details.

3.3.3 ADVANCED MAINTENANCE

81. Advance maintenance is dredging beyond the project (authorized) depth/width of a channel or basin in critical and fast-shoaling areas in order to avoid frequent redredging. This ensures reliability and least cost operation and maintenance of the project's authorized dimensions.

82. Port Everglades has been categorized as a slow-shoaling harbor with a present shoaling rate of approximately 21,700 cubic yards per year, including entrance channels (Section 4.5.2 - Maintenance of the NED Plan). Therefore, advanced maintenance is not required as part of the Port Everglades project depth.

3.3.4 ALLOWABLE OVERDEPTH

83. Allowable overdepth is additional depth increment included to compensate for inaccuracies in the dredging process due to physical conditions (tides, currents, waves, etc...), dredged material types, (silt, clay, sand, gravel, rock, etc...); and equipment type (mechanical, hydraulic, hopper, etc...). Allowable overdepth generally ranges from 1 to 2 feet. Based on a review of allowable overdepth values applied to an array of previously studied/constructed USACE deep draft navigation projects, an allowable overdepth of 1 foot is considered applicable at Port Everglades.

3.3.5 REQUIRED OVERDEPTH

84. Required overdepth is additional depth increment in areas where hard rock or heavily consolidated materials may be present that provides an additional margin of safety and acts to minimize future maintenance. Based on geotechnical analysis, regions of hard rock and/or consolidated materials are present throughout the project area. Therefore, required overdepth is mandated (USACE, 1996). Combined with the existing safety margins resulting from the underkeel clearance analyses (Section 3.4.11– Underkeel Clearance), a required overdepth of 1 foot is considered sufficient for the new work at Port Everglades.

3.3.6 CHARACTERIZATION DEPTH

85. Characterization and evaluation of dredged material is a vital component in the dredging process. This component is initiated by assessing existing core borings from the project area and/or taking new core borings. For a complete evaluation, the depth to which this data is obtained (characterization depth) must account for not only material up to the maximum allowable project depth (project depth + advance maintenance + allowable overdepth + required overdepth), but also material beyond that depth that can reasonably be expected to be removed due to such factors as unanticipated variation in substrate, submerged obstructions, or environmental conditions that reduce the operator's ability to maintain the proper dredging depth.

86. To aid in the determination of the characterization depth for a given project, the USACE,

Engineer Research and Development Center (ERDC) has provided general guidance based on project type (new work or maintenance), location (open water or sheltered/harbor), material type (hard, consolidated or soft), and dredge type (mechanical, cutterhead, or hopper) (Tavolaro, et. al., 2007). Using this guidance, the maximum characterization depth in open water portions of the project (exterior of the harbor jetties) is 10 feet. The maximum characterization depth in sheltered portions of the project (interior of the harbor jetties) is 7 feet.

3.4 DESCRIPTION AND ENGINEERING ANALYSIS OF PROJECT COMPONENTS

3.4.1 GENERAL

87. The following sections describe the existing conditions at each of the project components, initial design changes to meet project goals, and further refinements due to structural, environmental, and/or navigational considerations. Preliminary designs were drafted based on USACE guidance (USACE, 2006) and subsequently refined through ship simulation and coordination with USACE Engineer Research and Development Center (ERDC), Port Everglades Pilots Association, and the Port Everglades Port Authority.

3.4.2 OUTER ENTRANCE CHANNEL (OEC)

3.4.2.1 Existing Dimensions

88. The existing OEC extends approximately 5,000 feet from the outer sea buoy to the seaward end of the harbor jetties (Figure A- 12). The channel has a constant width of 500 feet and an authorized project depth of -45 ft-MLLW.

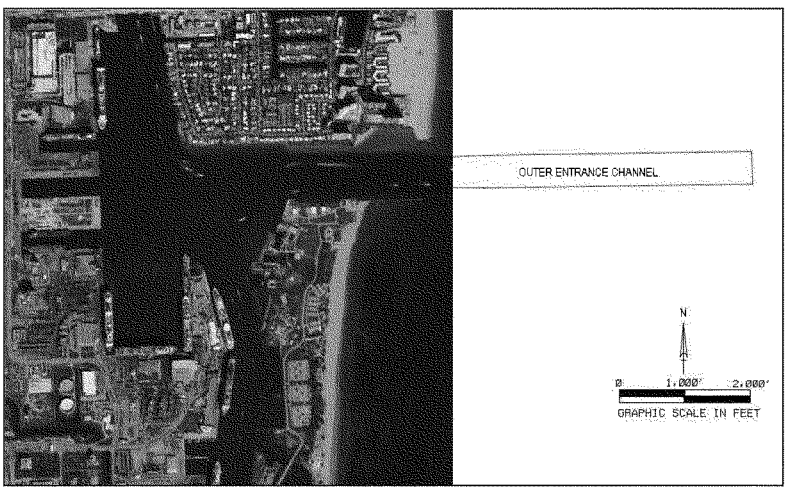


Figure A- 12. OEC Existing Layout

3.4.2.2 Preliminary Design

89. Under conditions of strong, variable currents, the 500 foot OEC presents a hazard to both the existing and future design fleet. Presently, Pilots are required to line up with the channel before the outer marker and bring vessels in at high speed to maintain a straight course. Rapid deceleration of the vessel is then required for safe negotiation of the entrance jetties. To alleviate the need for potentially dangerous maneuvering for the existing and future design fleet, the OEC requires lengthening as well as widening of the seaward end of the channel. By extending and expanding the outer end of the existing channel and then tapering evenly over a distance back to the original design width, a "flare" is created. The flared entrance allows the vessel room to maneuver in the presence of strong currents while still maintaining safe speeds when lining up to the entrance channel.

90. Improvement of the OEC is based on a combination of project design vessel dimensioning and local environmental conditions. In this case, the maximum width to be considered is the 156 foot beam of the "Voyager" cruise ship. The maximum length is the 1,139 foot LOA of the "S-Class" post-panamax vessel. These dimensions along with the local high velocity currents in the vicinity of the OEC and average and seasonal incident wind conditions resulted in the development of a 1,000 foot flare extending an additional 2,200 feet from the existing seaward end of the OEC (Figure A- 13). The depth of the OEC is highly site specific and based heavily upon local environmental conditions. Determination of the underkeel clearance in the OEC (and other project components) is discussed in detail in Section 3.4.11(Underkeel Clearance). In summary, the maximum OEC depth evaluated was -58 ft-MLLW.

91. While this channel layout provided for a high margin of safety under adverse weather and current conditions, it also created significant impacts to natural resources, specifically a relic reef (denoted the "third reef") that runs shore parallel, approximately 1.3 miles east of the entrance jetties and still maintains some degree of live coral coverage. After consultation with the Port Everglades Pilots and further evaluation including a series of ship simulations (Sub-Appendix A) it was possible to reduce the maximum width of the flare from 1,000 feet to 800 feet, decreasing impacts to the third reef without significant impact to vessel safety.

3.4.2.3 Alternative OEC Alignments

92. To further minimize impacts to the third reef, several alignments for the OEC were considered. These alignments included two with "dogleg" turns at the seaward end and two alignments that would make use of natural gaps in the outermost reef. The latter would require vessels to transit between the second and third reefs until reaching the existing entrance channel location. The two "dogleg" alignments (1) Double Dog-Leg (Figure A- 14) and (2) Single Dog-Leg (Figure A- 15) would bring vessels through a portion of the third reef that early biological surveys indicted might sustain less live coverage than the original alignment. The natural gap alignments included orienting the channel through (1) a gap approximately ¾ mile to the north of the existing entrance channel (Northern Reef-Gap Alternative) and (2) a gap approximately 3 miles to the south of the existing entrance channel (Southern Reef-Gap Alternative). Each of the natural gap alternatives would avoid all impacts to the third reef with only minor additional impacts to the second reef line (approximately ½ mile east of the jetties).

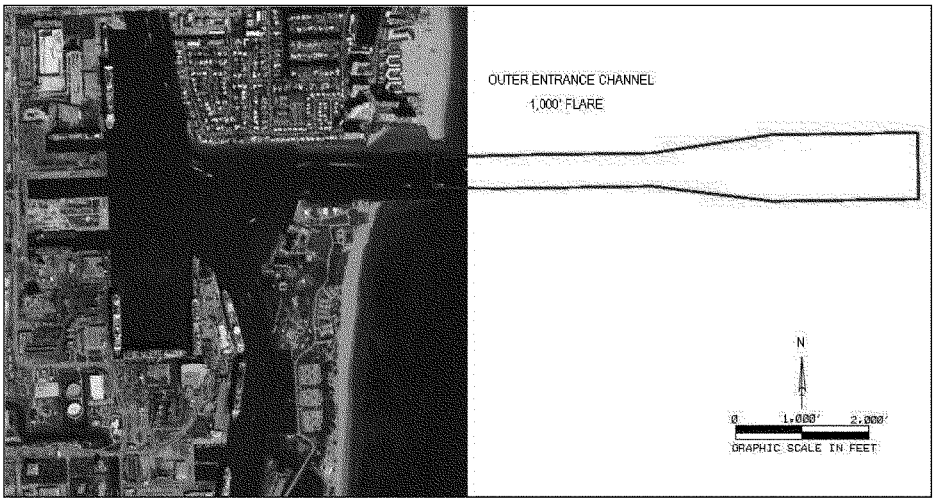


Figure A- 13. OEC – Extension with 1,000 foot Flare

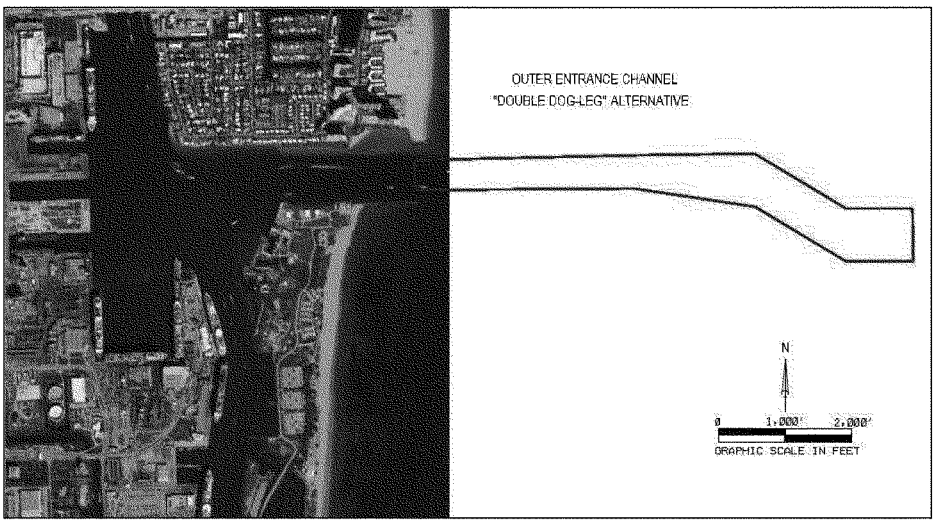


Figure A- 14. OEC – Double Dog-Leg Alignment (1)

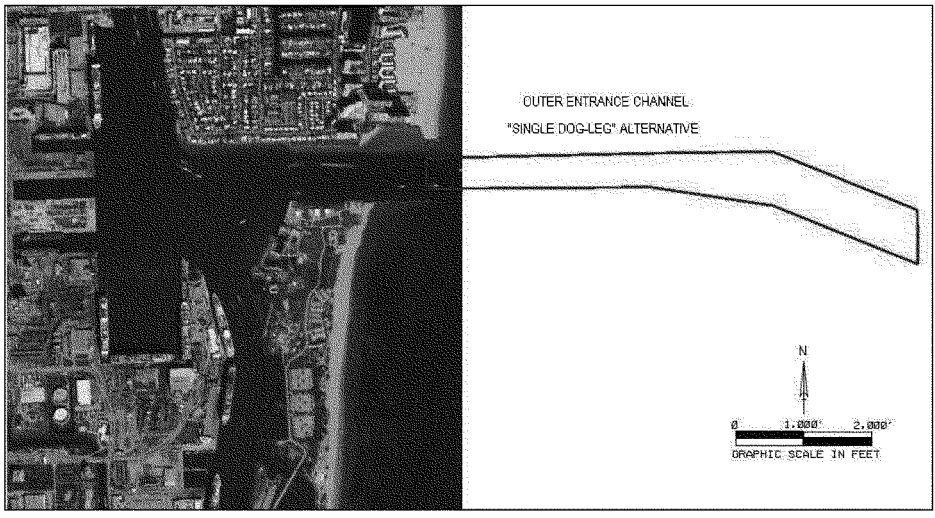


Figure A- 15. OEC – Single Dog-Leg Alignment (2)

93. Due to navigational and environmental concerns as well as security issues raised by environmental groups, the U.S. Coast Guard, the U.S. Navy, and the Port Everglades Pilot Association, the four alternative alignments were removed from consideration. Concerns and security issues included increased impacts to offshore reefs during construction necessary for offshore turning basins, increased difficulty in vessel handling due to additional turning maneuvers in a high current region, a high level of unknown risk to vessels and potential for environmental damage to regions previously not impacted, and violation of U.S. Navy offshore exclusion zones. A detailed discussion of these concerns, including pertinent correspondence can be found in the Environment Impact Statement (EIS).

3.4.2.4 OEC Project Component – Final Design

94. Figure A- 16 shows the final dimensions and alignment of the OEC project component.

3.4.3 INNER ENTRANCE CHANNEL (IEC)

3.4.3.1 Existing Dimensions

95. The existing IEC extends approximately 2,340 feet from landward end of the OEC to the main basin of the harbor (Figure A- 17). The channel has a constant width of 450 feet and an authorized project depth of -42 ft-MLLW.

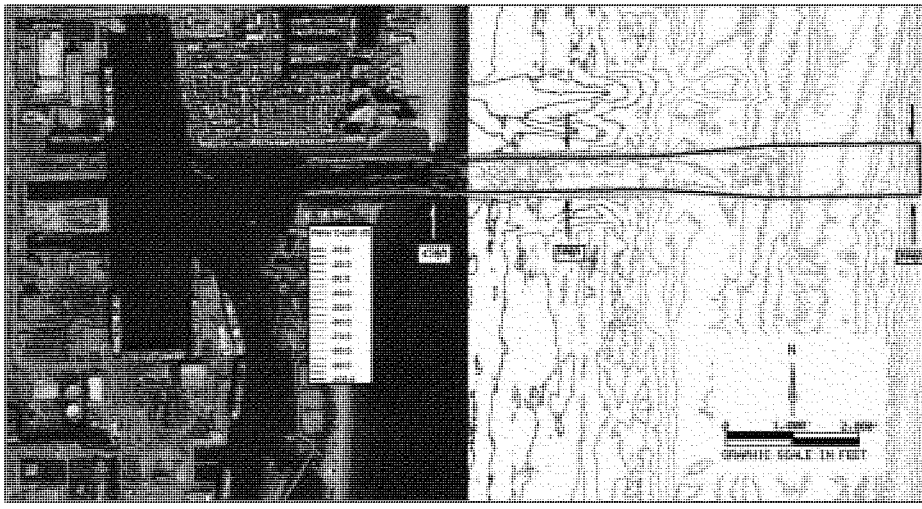


Figure A- 16. OEC Project Component – Final Design

3.4.3.2 Preliminary Design

96. Due to landside development to the north and south of the channel, there is no option to further widen the IEC without considerable impact to surrounding property. Ship simulation (Sub-Appendix A) indicates that the existing channel width is suitable for the largest vessels of the design fleet. Optimization for the IEC component consists of deepening only. The maximum project depth to be considered is -51 ft-MLLW.

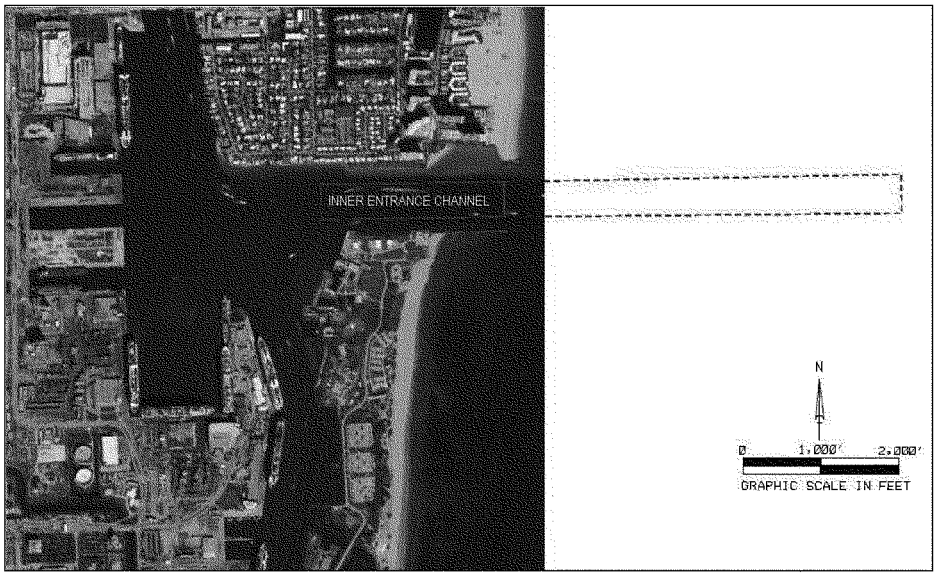
3.4.3.3 IEC Project Component – Final Design

97. Figure A- 17 shows the final (and existing) layout of the IEC project component.

3.4.4 MAIN TURNING BASIN (MTB)

3.4.4.1 Existing Dimensions

98. The authorized limits of the main turning basin measure approximately 1,200 feet from east to west and 2,450 feet north to south (Figure A- 18). The MTB covers approximately 95 acres and has a current authorized project depth of -42 ft-MLLW.



Fignre A- 17. IEC Project Component – Final (and Existing) Design

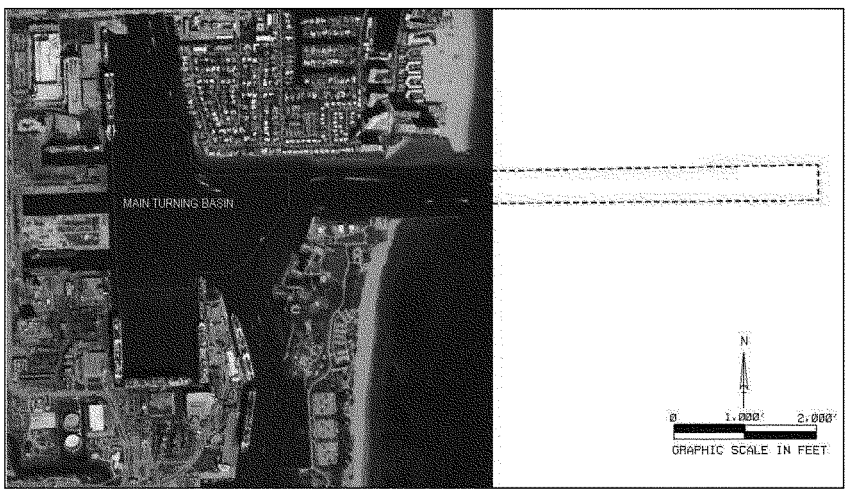


Figure A- 18. MTB Project Component – Existing Layout

3.4.4.2 Preliminary Design

99. As with the IEC, the MTB is surrounded by development and does not lend itself to widening. In this case, widening of the MTB is unnecessary to accommodate the goals of the project. The original goal of deepening the MTB was to accommodate both the turning of S-Class design vessels and to provide additional depth for liquid bulk vessels transiting to berths 7 through 15. Based on results of the ship simulation a preliminary design was developed that deepened only a portion of the existing authorized footprint, based on the turning requirements of the "S Class" container vessel. Due to changes in the projected tanker fleet, only a single "slip" was added to allow deeper draft tanker vessels to reach berths 7 through 10. For this, and subsequent alternatives, both the reduced turning basin and tanker slip would be deepened, while the remainder of the authorized footprint would continue to be maintained at the authorized project depth of -42 feet. This alternative was denoted "MTB (Container and Tanker)" and is shown in Figure A- 19.

100. Upon consultation with the Port Everglades Pilots it was determined that while the reduced MTB footprint would technically allow for vessel turning it generated significant risks to vessel safety. Specifically the reduced footprint did not allow adequate room to slow or turn a vessel in the event of tug failure. This is a scenario that has occurred in the past at Port Everglades and would result in significant vessel damage and possible risk to human life if it occurred with a deep draft vessel in the confines of the proposed turning area. The sharp difference in depth between the deeper proposed turning area and the surrounding 42 foot existing depth also has the potential of creating hydraulic conditions that would make vessel maneuvering difficult and unpredictable. Based on these concerns two additional alternatives were proposed, an extension of the turning area to the western existing Federal limits with a small "flare" to the south (Figure A- 20) and an extension to the west with "flares" to both the south and the north (Figure A- 21).

101. While the expansion of the turning area and the addition of flares alleviated some safety concerns regarding emergency maneuvering, the potential for difficult and unpredictable vessel handling due to the depth differences in the confined turning area could not be eliminated. Of particular concern was the proximity of the depth transition (essentially a vertical rock shelf) to the oil tanker slips at the west end of the MTB. A small course deviation, resulting in impact with the shelf could result in serious environmental consequences. USACE personnel and the Port Everglades Pilots concurred that for maximum safety, deepening of the MTB should encompass the full extents of the existing MTB footprint. The maximum project depth to be considered for the MTB is -51 ft-MLLW.

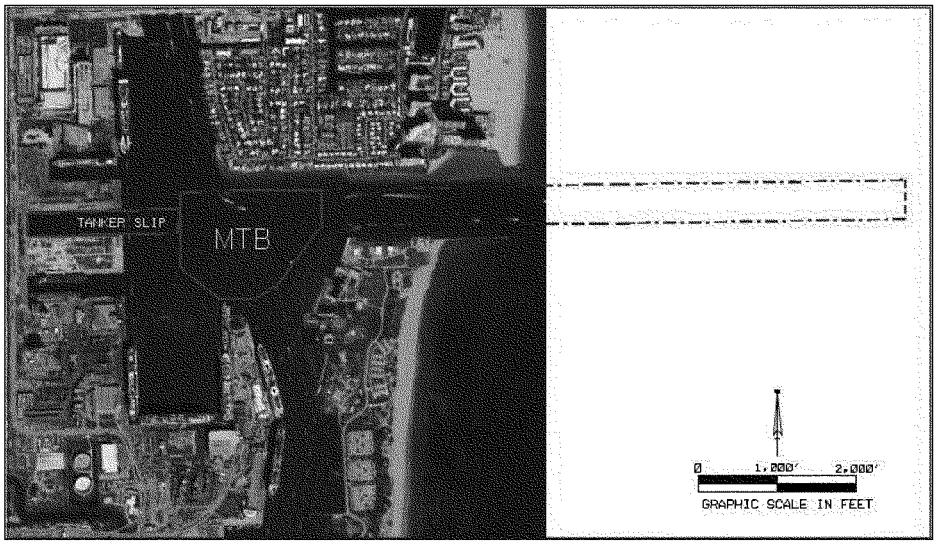


Figure A- 19. MTB (Container and Tanker) Project Component

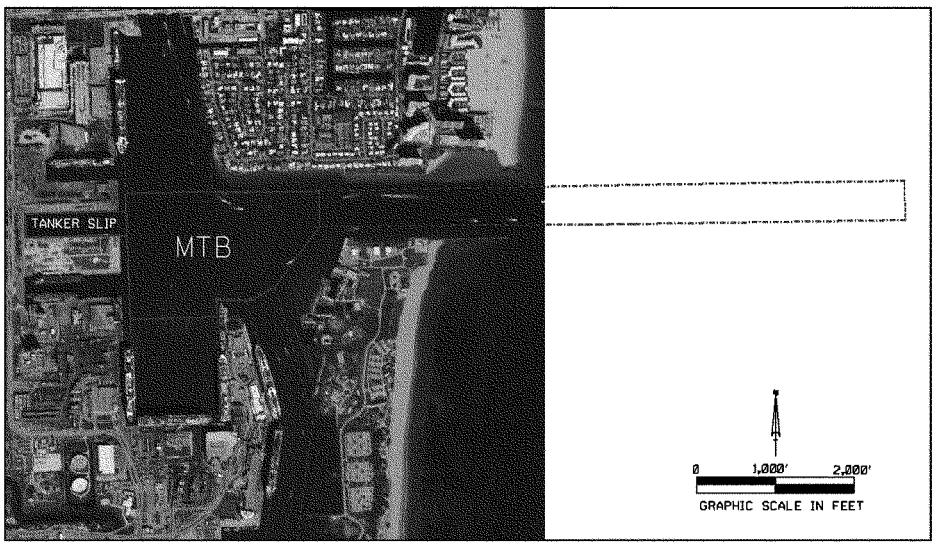


Figure A- 20. MTB (Extended with South Flare) Alternative

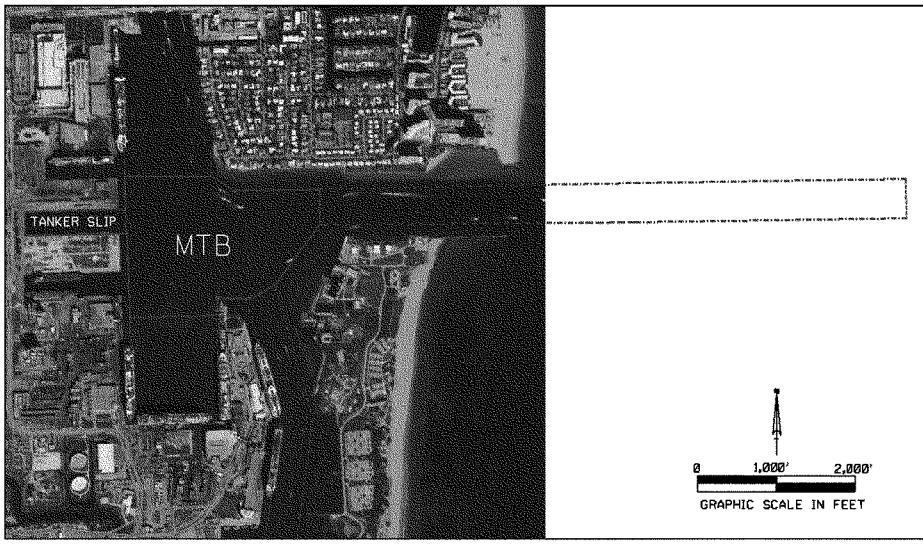


Figure A- 21. MTB (Extended with North and South Flares) Alternative

3.4.4.3 MTB Project Component – Final Design

102. Figure A- 22 shows the final layout of the MTB project component. This MTB alternative was denoted "MTB (Full)". Although it is no longer shown graphically (berthing is not considered to be part of the Federal project channel/basin layout) it is assumed that the tanker slip encompassing berths 7 through 10 will be deepened to match the project depth of the MTB.

3.4.5 NORTH TURNING BASIN (NTB)

3.4.5.1 Existing Dimensions

103. The NTB covers 19 acres immediately to the north of the MTB (Figure A- 23). The current authorized project depth for the NTB is -31 ft-MLLW.

3.4.5.2 Preliminary Design

104. The present project depth of -31 ft-MLLW in the NTB is adequate to accommodate the full draft of the "Voyager" cruise ship (design vessel for the NTB) with an acceptable safety clearance of 3 feet.

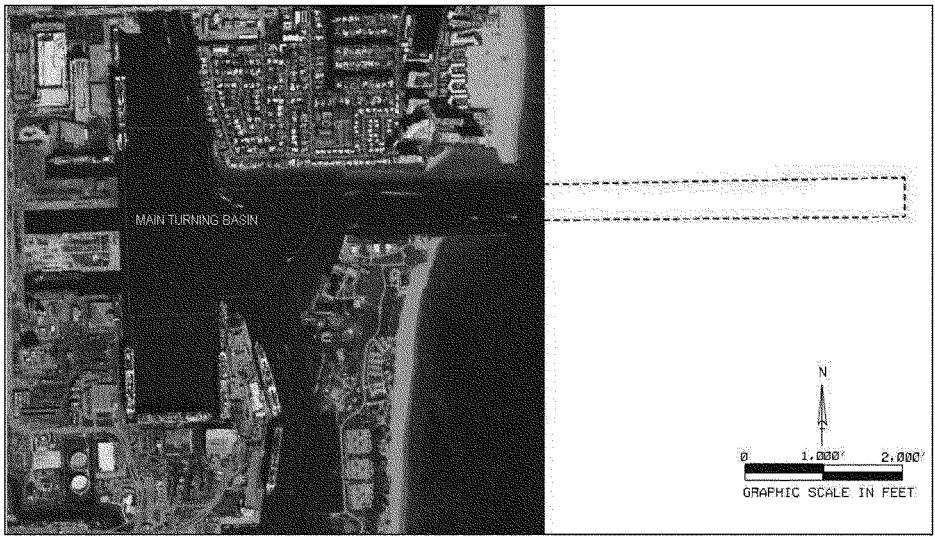


Figure A- 22. MTB (Full) Project Component – Final Design

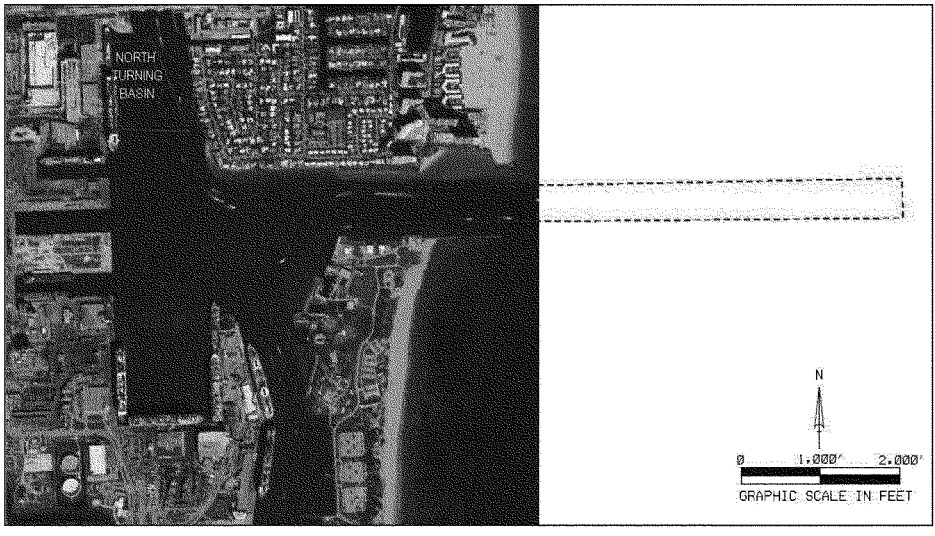


Figure A- 23. NTB Existing Layout

3.4.5.3 NTB Project Component – Final Design

105. Further modification of the NTB was not necessary. Therefore, the NTB project component was removed from the study.

3.4.6 SOUTH TURNING BASIN (STB)

3.4.6.1 Existing Dimensions

106. The STB covers 32 acres immediately to the south of the MTB (Figure A- 24). The current authorized project depth for the STB is -31 ft-MLLW.

3.4.6.2 Preliminary Design

107. Due to the 39 foot draft of the design vessel, it is necessary to deepen the STB from a present project depth of -31 ft-MLLW to a maximum depth of -42 ft-MLLW. This allows for the fully loaded draft of the vessel as well as a 3 foot safety clearance. Because the vessel will be berthed only at Berths 16 and 17, deepening is not required over the entire extent of the STB. Therefore, depth requirements can be met with a cut across the western side basin from north to south. This provided a uniformly deepened area, 260 feet wide from the south wall of the basin to the north where the STB and MTB merge.

3.4.6.3 Refinement of Design

108. The initial uniform north-south layout of the STB was found to have inadequate maneuvering room for vessels transiting to Berths 17 and 18. In order to increase access, the original north to south straight cut along the western side of the STB was replaced by a diagonal cut that provides a uniformly deepened area that is 260 feet wide to the south and 1,100 feet wide to the north where the STB and MTB merge.

3.4.6.4 STB Project Component – Final Design

109. Figure A- 25 shows the final layout of the STB project component. However, due to operational changes, the Port has asked that the STB component be withdrawn from this study. While the STB component remains feasible from an engineering standpoint, it will not be considered further.

3.4.7 WIDENER SHOAL (WIDENER)

3.4.7.1 Existing Dimensions

110. The Widener shoal is a shallow shoal located in the southeast corner of the MTB (Figure A- 26). This portion of the harbor is not presently part of a federal project and does not have an authorized project depth. Current average depth over the shoal is approximately -6 ft-MLLW.

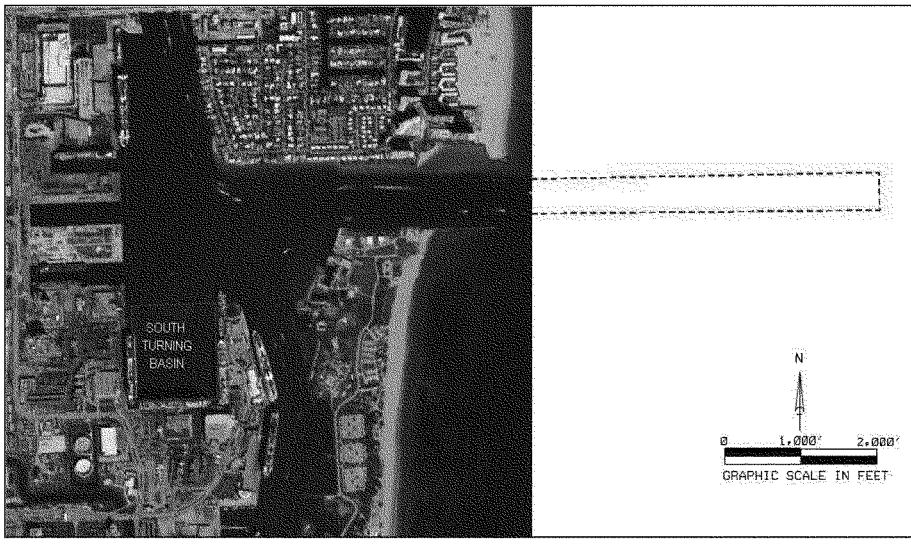


Figure A- 24. STB Existing Layout

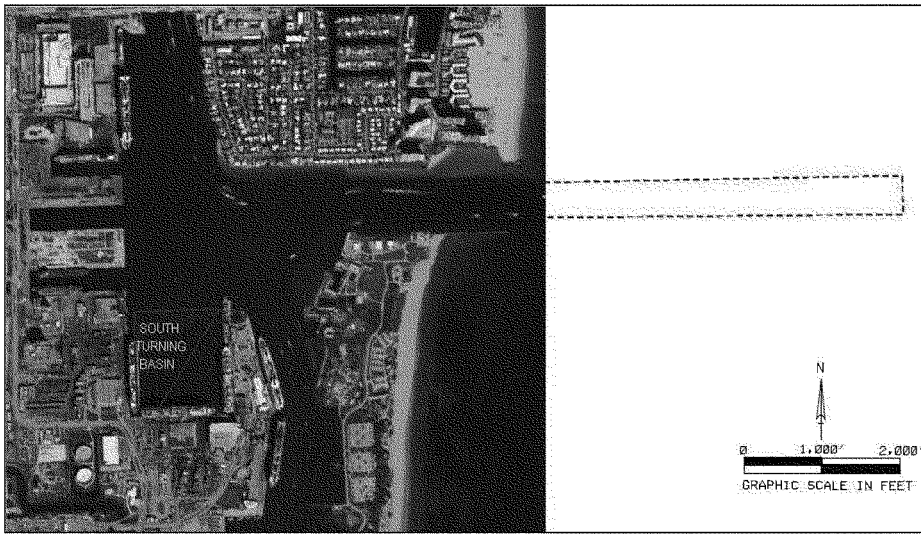


Figure A- 25. STB Project Compouent – Final Design

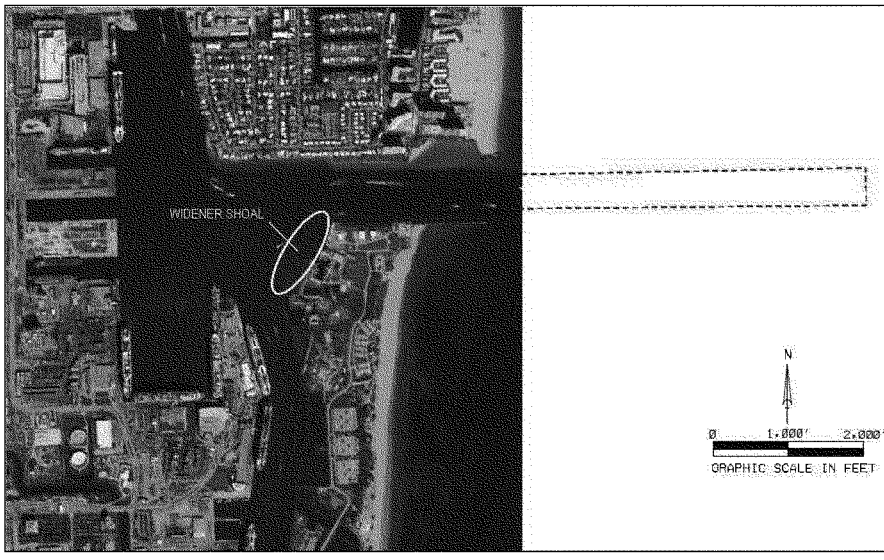


Figure A- 26. Widener Shoal Location

3.4.7.2 Preliminary Design

111. The presence of the shallow Widener currently restricts the amount of maneuvering room a vessel has when turning in the MTB in preparation for backing down the SAC (a common method of transit). The Widener also prohibits other traffic from transiting and exiting the SAC while another vessel is in the MTB. Removal of the Widener shoal is necessary to turn the "S-Class" (post-panamax container design vessel). Removal will also alleviate existing congestion by allowing for two-way traffic in the MTB. The dimensions of the widener footprint were determined by a combination of the size and shape of the shoal, adequate offset from existing structures to the southeast, and vessel maneuverability requirements (verified through ship simulation). To accommodate the full draft of the design vessel and safety clearance, a maximum project depth of -51 ft-MLLW was considered.

3.4.7.3 Widener Project Component – Final Design

112. Figure A- 27 shows the final dimensions of the Widener project component.

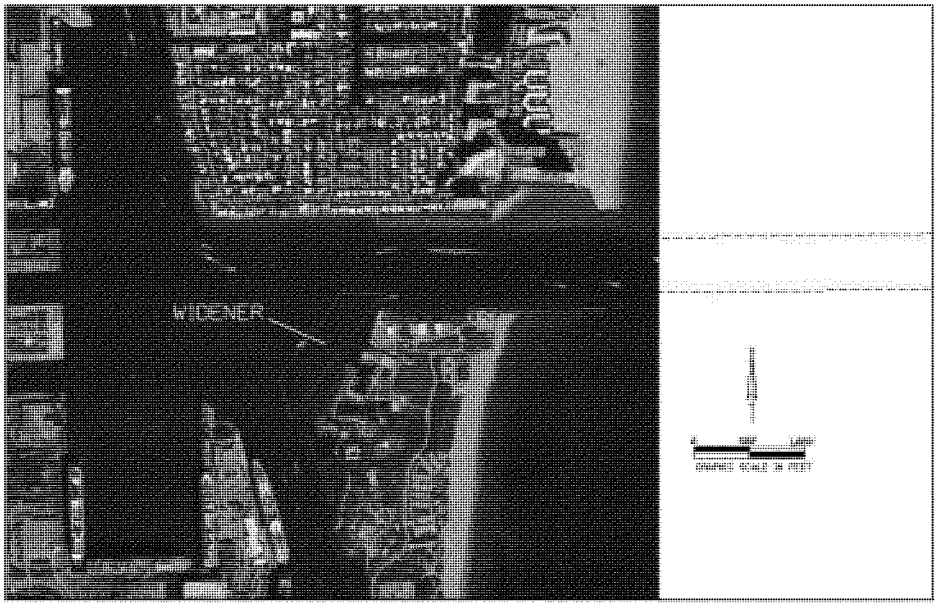


Figure A- 27. Widener Project Component – Final Design

3.4.8 SOUTHPORT ACCESS CHANNEL (SAC)

3.4.8.1 Existing Dimensions

113. The existing SAC is a 400 foot wide channel that extends south approximately 8,500 feet (1.6 miles) along the Intracoastal Waterway from the MTB to the southern end of berth 33 (Figure A- 28). The SAC layout includes a 150 deg bend at the north end known as "the knuckle", seven channel parallel berths, and has a uniform authorized project depth of -42 ft-MLLW.

3.4.8.2 Preliminary Design

114. In order for the design container vessel, "S-Class", to transit the SAC to one of its proposed berths (berth 30, 31, or 32) it must make the turn at the knuckle. Based on the projected fleet it is likely that this transit will occur when one or more "Voyager" cruise ships are at berth in the knuckle area (berths 24 – 27) or at berth 29. It is equally likely that passing of pleasure craft and/or other commercial vessels in the channel itself will occur. From these likelihoods, two design scenarios were developed (1) "S-Class" passing a pleasure craft with "Voyager" vessels at berth, and (2) 'S-Class" passing the "Bellatrix" design vessel with "Voyager" vessels at berth.

Figure A- 28. SAC Existing Dimensions

115. Another consideration in the design of the SAC project component is the presence of a USCG station at the north end of the SAC on the eastern edge of the channel. The USCG station includes a 58,000 square foot boat basin with a 240 foot bulkhead that extends within 115 feet of the existing channel. The presence of the USCG bulkhead complicates the turning maneuver required in the knuckle by limiting the available open space and creating the potential for collision.

116. Given present channel dimensions, wider berth requirements for "Voyager" vessels, the presence of the USCG bulkhead, and the likely distribution of vessels at berth, turning through the knuckle with a vessel the size of "S-Class" is not possible. To allow for passage of the "S-Class", the knuckle alignment must be altered to provide for a lesser degree of turning and allowing more maneuvering room.

3.4.8.3 Alternative SAC Designs

117. Incorporating the design considerations described above, six initial designs were developed to address transit of the "S-Class" vessel from the MTB to berths 30 – 32. The six alternative component designs are detailed as follows:

(1) SAC Alt. Comp. 1 (Figure A- 29): Eastern expansion of the SAC to accommodate "S-Class" passing a pleasure craft with "Voyager" vessels at berth. Eastern channel edge stabilized by bulkheads to minimize property and habitat impacts.

(2) SAC Alt. Comp. 2 (Figure A- 30): Eastern expansion of the SAC to accommodate "S-Class" passing a "Bellatrix" vessel with "Voyager" vessels at berth. Eastern channel edge stabilized by bulkheads to minimize property and habitat impacts.

(3) SAC Alt. Comp. 3 (Figure A- 29): Eastern expansion of the SAC to accommodate "S-Class" passing a pleasure craft with "Voyager" vessels at berth. Eastern channel edge allowed to stabilize with a natural sideslope projected to be 1V:2.5H.

(4) SAC Alt. Comp. 4 (Figure A- 30): Eastern expansion of the SAC to accommodate "S-Class" passing a "Bellatrix" vessel with "Voyager" vessels at berth. Eastern channel edge allowed to stabilize with a natural sideslope projected to be 1V:2.5H.

(5) SAC Alt. Comp. 5 (Figure A- 31): Western expansion of the SAC to accommodate "S-Class" passing a pleasure craft with "Voyager" vessels at berth. Eastern channel edge stabilized by Port bulkheads.

(6) SAC Alt. Comp. 6 (Figure A- 32): Western expansion of the SAC to accommodate "S-Class" passing a "Bellatrix" vessel with "Voyager" vessels at berth. Eastern channel edge stabilized by Port bulkheads.

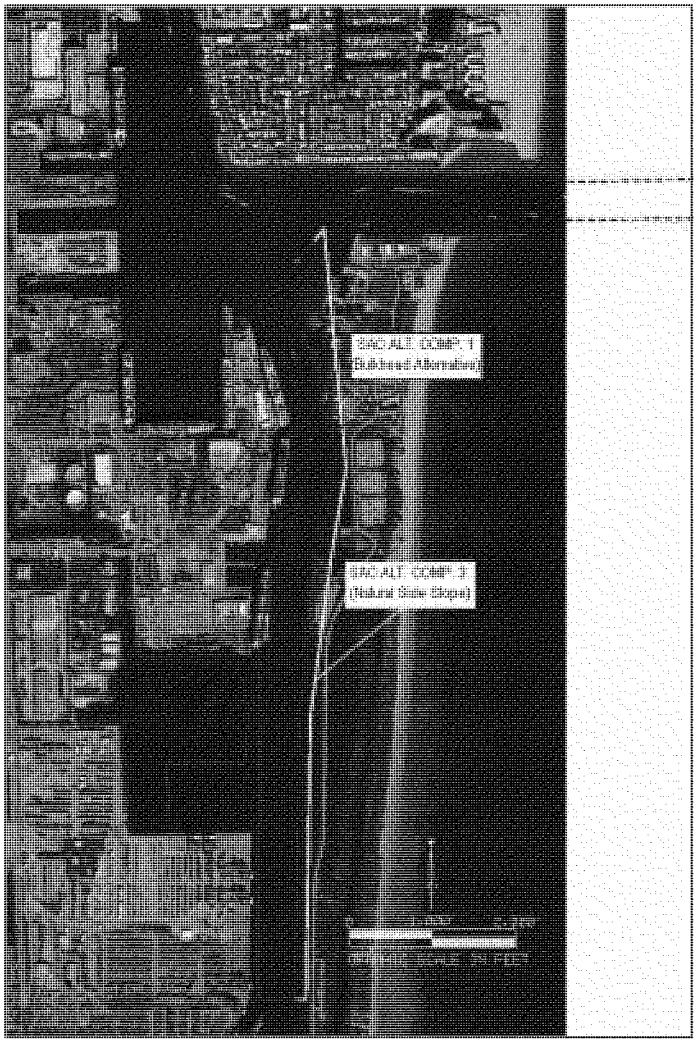


Figure A- 29. SAC – Eastern Expansion (Alternatives 1 and 3), Pleasure Craft Passing

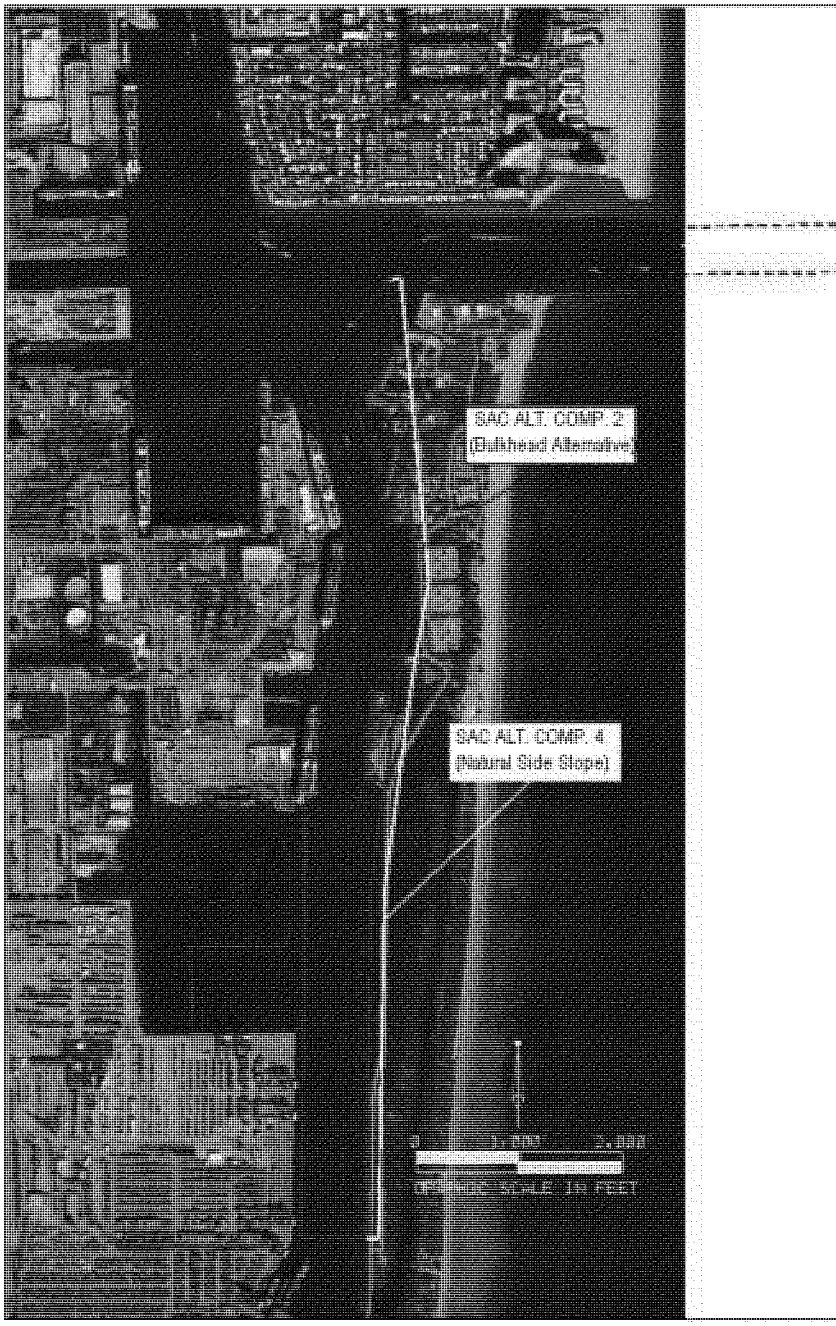


Figure A- 30. SAC – Eastern Expansion (Alternatives 2 and 4), "Bellatrix" Passing

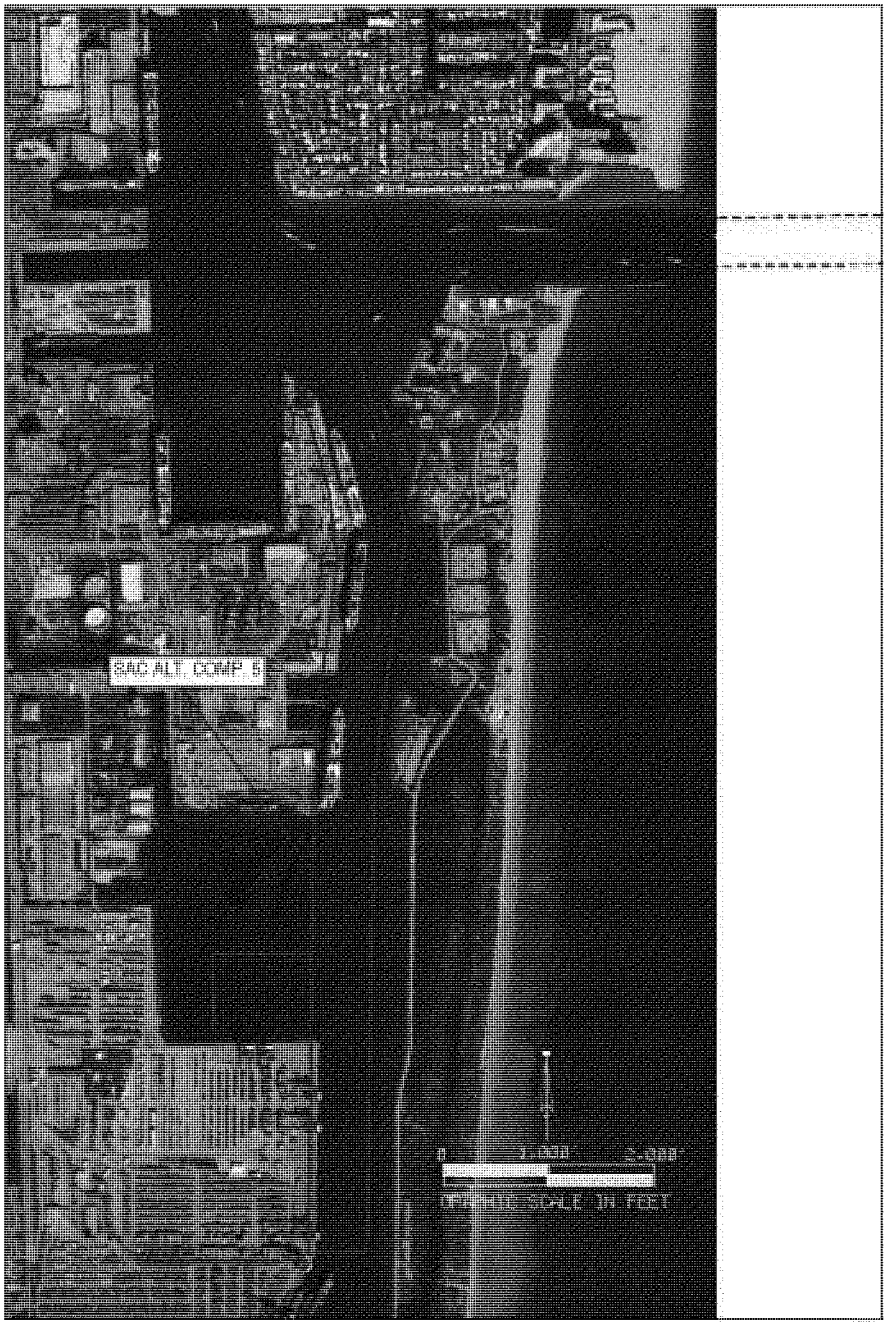


Figure A- 31. SAC – Western Expansion (Alternative 5), Pleasure Craft Passing

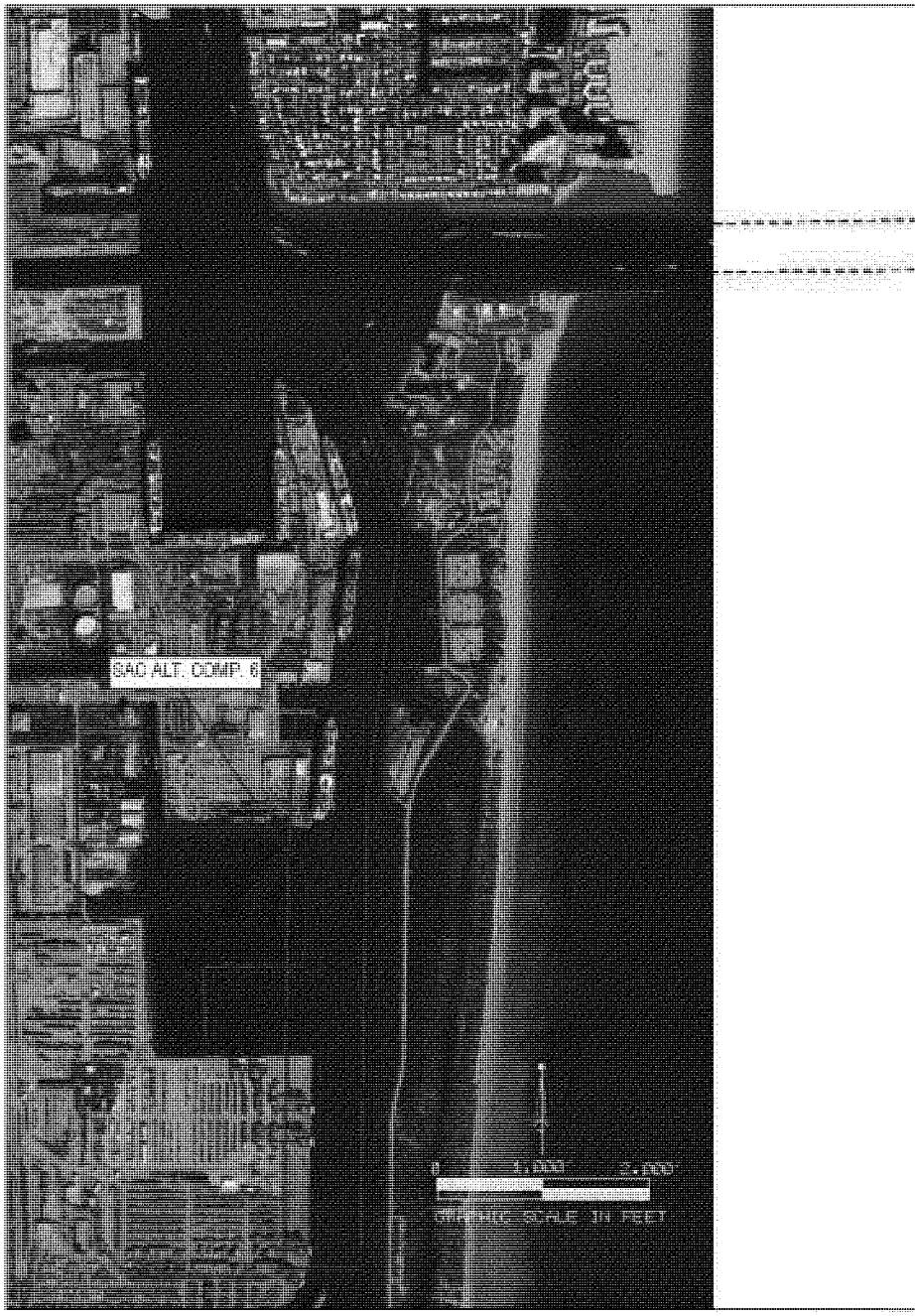


Figure A- 32. SAC – Western Expansion (Alternative 6), "Bellatrix" Passing

118. Each of the above alternative component designs includes widening of the existing northern SAC berths (24 – 27, and 29) from 90 feet to 160 feet, widening of the southern SAC berths (31 and 32) from 90 feet to 145 feet, and channel widening along the length of the channel in accordance with USACE design guidance for vessel passing (USACE, 2006). The maximum project depth in each case is -51 ft-MLLW. Eastern expansion includes significant environmental impacts and reconfiguration of the USCG station. Western expansion includes significant impact to Port infrastructure and cargo storage capabilities.

119. Initial screening of the six alternative component designs resulted in elimination of all but one alternative. Eliminations were made due to severe environmental impacts to John U. Lloyd State Park (alternative designs 2 – 4) and excessive impacts to Port infrastructure and adjacent cargo/passenger facilities (alternative components 5 and 6). Table A- 10 provides a summary of the screening process.

Table A- 10. Summary of SAC Alternative Component Screening

Alternative Component	Screening Results
SAC Alt. Comp. 1	Retained
SAC Alt. Comp. 2	Eliminated due to excessive impacts to John U. Lloyd State Park
SAC Alt. Comp. 3	Eliminated due to excessive impacts to John U. Lloyd State Park
SAC Alt. Comp. 4	Eliminated due to excessive impacts to John U. Lloyd State Park
SAC Alt. Comp. 5	Eliminated due to excessive impacts to Port infrastructure
SAC Alt. Comp. 6	Eliminated due to excessive impacts to Port infrastructure

120. The remaining alternative component, SAC Alt. Comp. 1, allows the "S-Class" to pass "Voyager" at berth in the knuckle (Berths 24 to 27), while passing a pleasure craft in the channel. To accommodate the larger design vessels, the north end of the channel, the knuckle is expanded from a design width of 400 feet to a width of 786 feet. The width at the center of the knuckle (juncture of Berths 25 and 26) is widened from 400 feet to 480 feet. At the south end of the knuckle, adjacent to Berth 27, the width of the channel changes from 400feet to 575 feet. Channel width is then tapered in a southerly direction over a distance of 3,030 feet to a design width of 460 feet. A constant width of 460 feet is maintained over the remainder of the channel until reaching berths 31 and 32 where it decreases to a width of 315 feet.

3.4.8.4 Refinement of Design

3.4.8.4.1 Ship Simulation

121. After initial screening of all project components was accomplished, a series of ship simulations were initiated to evaluate and refine channel dimensions of the remaining alternative components. The ship simulation study was conducted at the RTM Simulation, Training, and Research (STAR) Center, located in Dania Beach, Florida. The simulation involved the

evaluation of the initial and final designs of the alternative components to determine if proposed dimensions were adequate to safely transit the design vessels. Based on results from the ship simulation study (Sub-Appendix A), the following observations were recorded for the initial design of the SAC component:

- The US Coast Guard boat basin presents a navigation hazard to Post-Panamax vessels transiting the SAC and must be relocated to the east to allow for safe vessel passage.
- Additional widening of the SAC from berths 24 to 29 is required to allow for safe transit of a Post-Panamax vessel past berthed cruise ships. Expansion of the SAC to the east by 60 feet north of Berth 26 and 50 feet south of Berth 26 will provide suitable clearance.
- Present SAC design width of 400 feet is sufficient south of Berth 29 to allow a Post-Panamax vessel to transit while passing a Panamax vessel at berth and a pleasure craft in the channel

3.4.8.4.2 USCG Reconfiguration and Basin Oscillation Study

122. 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.

123. Proposed modification and/or reconfiguration of the US Coast Guard ship basin presented a significant problem. Any degree of decreased protection to Coast Guard vessels within the basin from ship wake and wind generated waves could have major negative impacts on operations. In order to ensure that any proposed USCG basin would afford, at a minimum, the same protection from ship wake, wind waves, and swell, a harbor oscillation study was conducted to evaluate both the existing USCG basin and proposed reconfiguration alternatives (Sub-Appendix B).

124. During the course of the harbor oscillation study, multiple harbor designs were created and evaluated. Some focused on relocating the outer breakwater of the existing basin, others on relocating 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.

125. 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 impacted negatively on operations at the station.

126. During further coordination efforts, the USCG lifted the restriction on relocating certain buildings. This allowed for a simple translation of the existing basin configuration 158 feet to the east, limiting the extent of USCG property impacted. 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. Figure A-33 illustrates the proposed configuration for the relocated USCG basin. A complete discussion of the USCG basin oscillation study and final USCG basin configuration is presented in Sub-Appendix B.

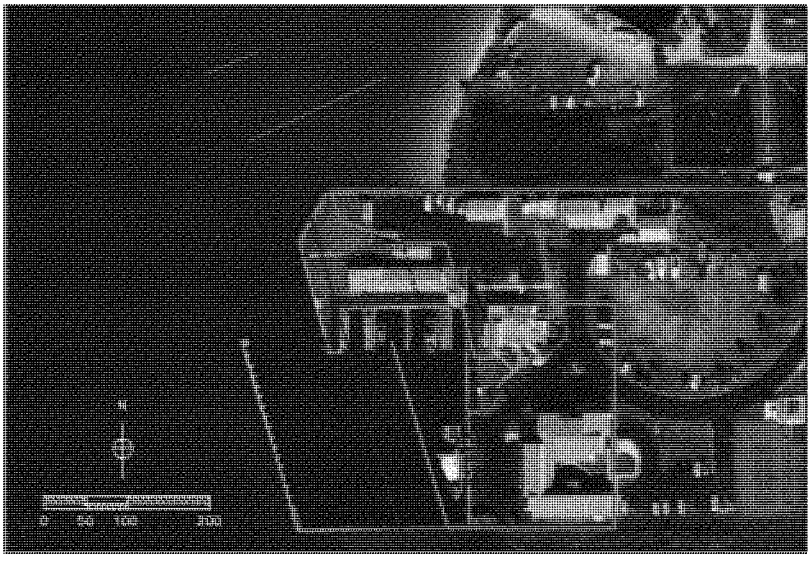


Figure A- 33. Proposed USCG Station Reconfiguration Plan

3.4.8.5 SAC Project Component – Final Design

Figure A- 34 shows the final layout of the SAC project component.

3.4.9 TURNING NOTCH (TN)

3.4.9.1 Existing Dimensions

127. The TN measures approximately 1,000 feet from east to west and 750 feet north to south (Figure A- 35). The TN covers roughly 17 acres, including a single berth along the southern extent (berth 30). The current authorized project depth in the basin is -42 ft-MLLW.

Figure A- 34. SAC Project Component – Final Design

Figure A- 35. TN Existing Layout

3.4.9.2 Preliminary Design

128. Two scenarios were considered for the modification of the TN to accommodate the "S-Class" design vessel. The first was to modify the notch by extending the total east-west extent westward to 1,500 feet to allow for berthing the "S-Class" vessel at berth 30 as well as turning the same vessel in preparation for berthing in the SAC at berths 31 and 32. The second was to expand the TN by 150 feet to the north or south to allow for turning of the "S-Class" only. Due to a deficiency in available berthing, environmental factors (north expansion), and infrastructure impacts (south expansion), the north and south expansions were eliminated. The maximum project depth for the westward expansion TN component was -51 ft-MLLW.

3.4.9.3 Refinement of Design

3.4.9.3.1 Ship Simulation

129. Based on results from the ship simulation study (Sub-Appendix A), the following observations were recorded for the initial design of the TN component:

- To accommodate berthing of the design vessel at berth 30, the TN must be extended to west.
- To accommodate turning of the design vessel in the TN, the northern channel limits must be repositioned further to the north (without impact to the conservation easement located north of the existing TN) to allow adequate maneuvering room.
- To accommodate berthing and turning of the design vessel in the TN at berth 30, the western side of the SAC just north of the TN and the eastern side of the SAC across from the TN must be widened.

130. Ship simulation results indicate that due to flood and ebb tide currents in the SAC as well as the overall size of the design vessel, the existing design of the TN does not provide adequate maneuvering room to allow for either berthing or turning of the "S-Class" design vessel. To accommodate berthing, it was necessary to first increase the interior dimensions of the TN and to modify the SAC to the north and east of the TN. This involved relocating the western limit of the federal channel 320 feet to the west, expanding the limits of the TN to the north by 50 feet, gradually increasing the SAC channel width from 400 feet to 530 feet along the conservation easement beginning just south of berth 29 and ending at the TN, and adding a 1,340 foot long by 75 foot wide expansion to the eastern SAC channel limits east of the TN. To incorporate turning of the design vessel, an additional 500 foot by 75 foot expansion cut was added to the eastern SAC limits south of the previous 1,340 foot cut.

131. Additional modification for berthing the "S-Class" resulted from operational criteria provided by the sponsor. Port plans to add Post Panamax cranes along the southern edge of the TN required changes to east-west dimensions of the notch and berth. In order to allow the cranes to reach all cargo areas of the "S-Class" design vessel , the federal channel and berth

limits had to be moved an additional 290 feet to the west, resulting in a TN measuring 800 feet north to south (655 feet, Federal Channel + 145 feet, Berth 30 width) and 1,500 feet west to east.

132. In order to eliminate additional environmental impacts to either John U. Lloyd State Park to the east or the conservation easement to the north, bulkheads were added to the northern interior of the TN, along the west side of the SAC from berth 29 to the TN, and along the expansion cuts made at the east side of the SAC opposite the TN.

3.4.9.4 TN Project Component – Final Designs

133. Originally, expansion of the TN was investigated as two separate alternatives, a "Turning Only" alternative that included only those modifications necessary to turn the "S-Class" vessel and a "Turning and Berthing" alternative that included all of the proposed modifications. However, during the course of the study, the sponsor made the decision to proceed with components of the Port's Master Plan, including expansion of the existing TN to the full 1,500 foot dimension previously discussed. The Port's expansion of the TN (to the authorized depth of -42 ft-MLLW) is independent of the Federal project and will become the "existing condition". Expansion of the SAC to the north and east of the TN, to accommodate vessel turning, as well as deepening the expanded TN to the NED project depth will remain components of the Federal project. This revised project component will be denoted "S_TN". Figure A- 36 and Figure A-37 show the "existing" and the final design layouts for the TN. Note that these figures indicate the navigation channel only and do not show the expansion of the berthing area. Prior to this study, there was no federally recognized berthing area within the TN.

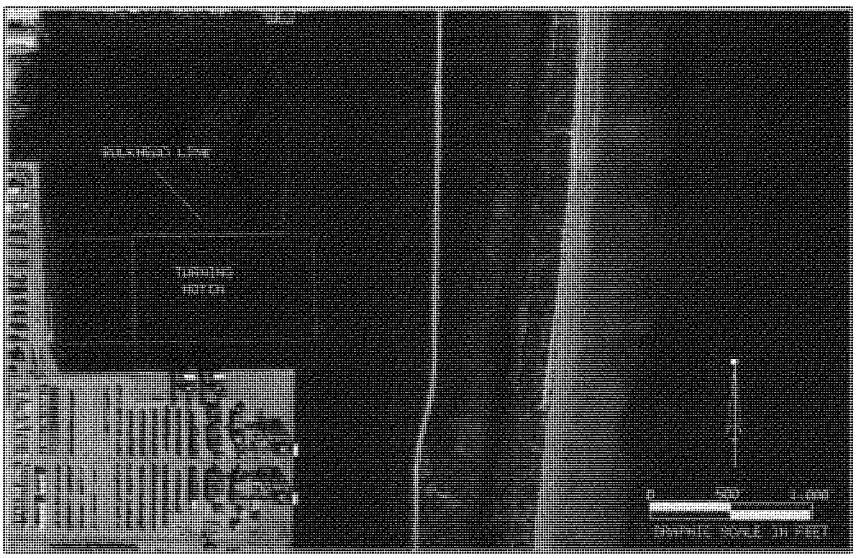


Figure A- 36. TN Projected "Existing" Layout

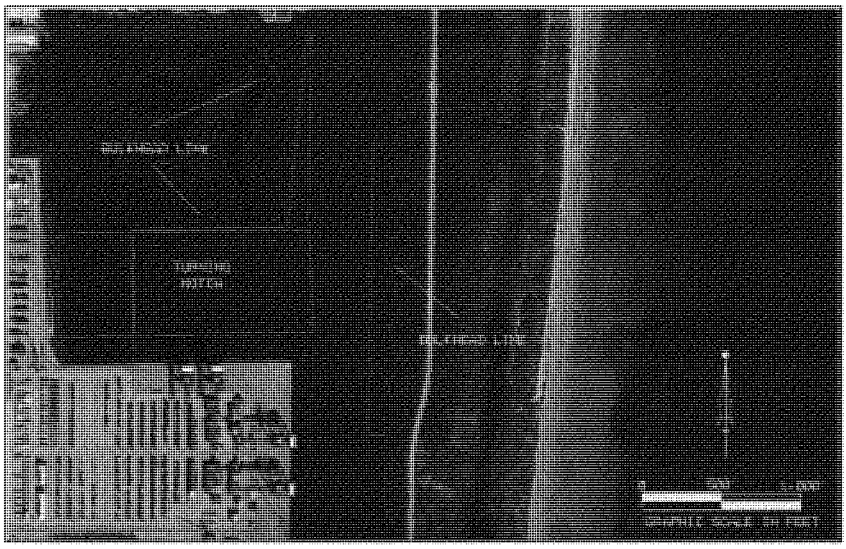


Figure A- 37. TN (S_TN) Project Component – Final Design

3.4.10 DANIA CUTOFF CANAL (DCC)

3.4.10.1 Existing Dimensions

134. The DCC is presently a small boat canal that intersects the Intracoastal Waterway and SAC at the southeast corner of the Port Everglades property (Figure A- 38). In the vicinity of the Port, it is approximately 200 feet wide with an average depth of -13 ft-MLLW.

3.4.10.2 Preliminary Design

135. In order to develop the southern extent of Port Everglades, it is necessary to accommodate commercial vessels in the DCC. Based on projections for the future fleet, the design vessel is the panamax class "Bellatrix".

136. The present width of the DCC combined with local boat traffic presents an obstacle to commercial vessels. The DCC is the location of several privately owned marinas. It is therefore unavoidable that pleasure craft will be present during the transit and berthing of cargo vessels. Also, the port intends to maintain multiple berths in the DCC, making it highly likely that the Bellatrix will pass other commercial vessels at berth as well as pleasure craft in the channel. For the purpose of design, the ship representing the berthed vessel shares the same dimensions as the Bellatrix. Pleasure craft are given a beam of 20 feet. The maximum project depth considered for

the DCC component is -34 ft-MLLW.

137. To accommodate the above requirements, the width of the DCC requires widening from 200 ft to 280 ft. In addition, a 90 foot wide, 2,125 foot long berthing area is created along the north side of the channel. This berthing area includes two roll on/roll off (ro/ro) vessel slips at the western edge. Initially four options were considered (1) widening to the north into Port property with a bulkhead stabilizing the southern channel edge, (2) widening to the north into Port property while allowing the southern edge of the channel to stabilize with a natural side slope, (3) widening to the south in Westlake Park with a bulkhead stabilizing the southern channel edge, and (4) widening to the south into Westlake Park while allowing the southern edge of the channel to stabilize with a natural side slope.

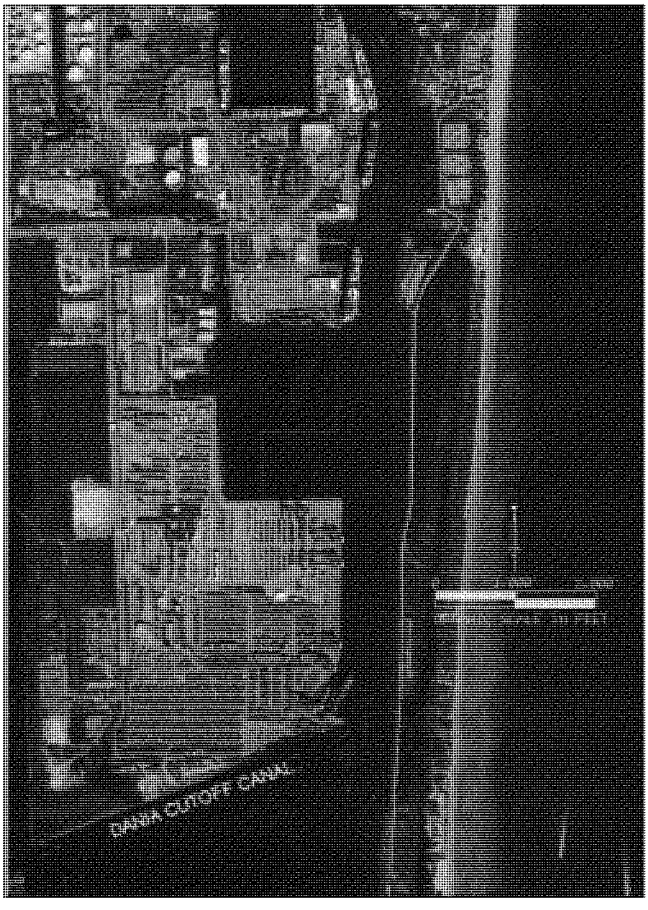


Figure A- 38. DCC Existing Layout

138. Options involving expansion to the south were eliminated during initial screening due to extensive environmental impacts to Westlake Park. Of the two remaining options, the northern expansion with a bulkhead along the southern edge was considered the most practical as it allows the channel to be pressed to the edge of Westlake Park (without impact), minimizing costly impacts to Port property. Natural side slopes to the south would require an additional excavation into Port property to avoid impacting parkland to the south. As this would increase impacts to existing container storage areas and effect operations, this alternative was eliminated.

3.4.10.3 Refinement of Design

3.4.10.3.1 Ship Simulation

139. Based on results from the ship simulation study (Sub-Appendix A), the following observations were recorded for the initial design of the DCC component:

- Design width of the DCC requires widening to 310 feet for safe transit of design vessel
- A turning basin is required at the intersection of the SAC and DCC to allow for safe transit of the Bellatrix to the DCC. The turning basin must include an eastward expansion of the SAC just north of the intersection and a southward expansion into the ICWW south of the intersection.

140. Due primarily to strong currents associated with the intersection of the DCC and SAC, initial channel limits of the DCC component were found to be unsuitable for transiting a Panamax vessel to berths located in the DCC. In order to remedy this, two primary modifications were made to the original channel layout. The first was to widen the proposed DCC channel from 280 feet to 310 feet allowing for increased vessel clearance and more maneuvering room when berthing. This was accomplished by expanding the channel 30 feet to the north. This increased the overall width of the channel to 310 feet while maintaining protection of Westlake Park to the south.

141. The second modification was inclusion of a turning basin at the intersection of the DCC and SAC. This was accomplished through the following: (1) addition of a 50 foot wide eastward expansion of the channel just north of the turning basin extending from the southern end of Berth 32 to the intersection of the DCC and SAC, (2) addition of a 300 foot by 375 foot extension of the turning basin extending to the south into the ICWW, and (3) widening of the northwest and southwest corners of the turning basin. Impacts to John U. Lloyd Park from the 50 foot expansion described in (1) are avoided through the use of a bulkhead.

142. Further modification of the DCC component was made at the request of the sponsor. The sponsor indicated a desire to omit proposed ro/ro ramps from the DCC design while at the same time extending the DCC channel 1,000 feet to the west and increasing the length of the northern berthing area from 2,250 feet to 3,600 feet.

3.4.10.4 DCC Project Component – Final Design

143. Figure A- 39 shows the final layout of the DCC project component. However, due to operational changes, the Port has asked that the DCC component be withdrawn from this study. While the DCC component remains feasible from an engineering standpoint, it will not be considered further.

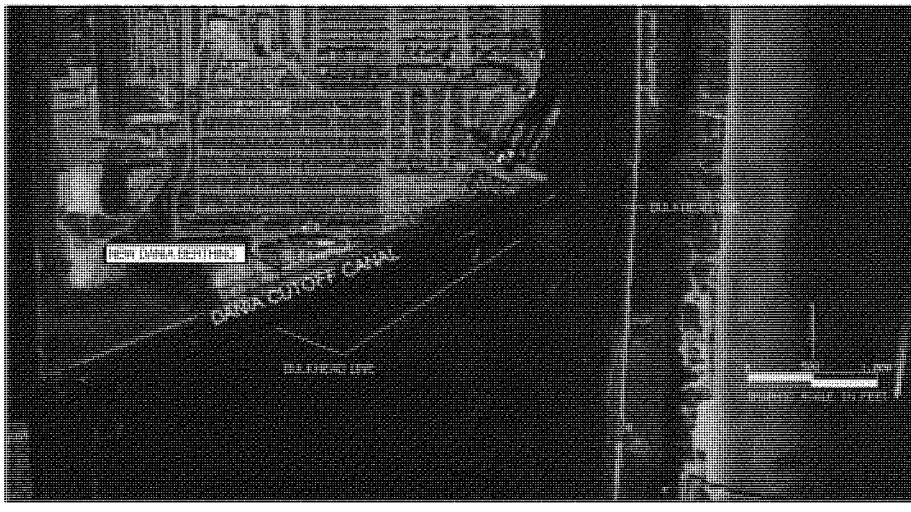


Figure A- 39. DCC Project Component – Final Design

3.4.11 UNDERKEEL CLEARANCE

144. Underkeel clearance is the distance between the keel of the vessel and the channel bottom that is required for safe maneuvering of the vessel in the harbor. When determining underkeel clearance, care must be taken that the design channel depths developed from the economic analysis are equal to the loaded draft of the design ship, plus an allowance for the following factors: the effect of fresh water, vertical motion due to wave action, ship squat, safety clearance, and dredging tolerances. These components of underkeel clearance are shown graphically in Figure A- 40.

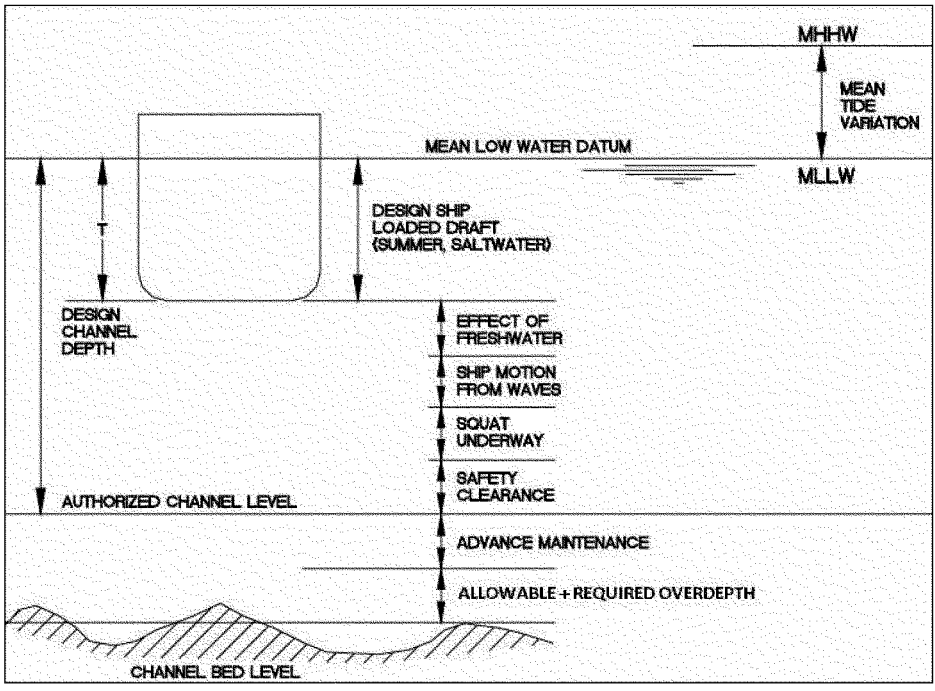


Figure A- 40. Underkeel Clearance Definition Sketch

3.4.11.1 Effects of Fresh Water

145. When ships enter fresh or brackish water, the ship draft will increase due to a decrease in the density of the water. At Port Everglades Harbor salinity levels within the port are consistent with those exterior or the harbor. Therefore, fresh water effects are not a design concern for this project.

3.4.11.2 Ship Motion from Waves

146. Ship response from waves is the movement of the ship bottom below the static water surface caused by waves. It is a vertical excursion that is composed primarily of motions in three response modes, heave, pitch, and roll (USACE, 2006). Because of the complex interrelationship between these three response modes, techniques for predicting maximum net vertical excursion due to waves tend to be highly variable and are often based upon approximations. In general, to account for wave influences, a gross underkeel clearance, of 10% to 20% of the maximum draft of the vessel is recommended. USACE Engineering Manual EM 1110-2-1613 (USACE, 2006) refers to recommendations made in 1981 by the International Association of Ports and Harbors (IAPH) Committee on Port Safety, Environment, and Construction in which the committee recommended gross underkeel clearance of 15% of the

maximum draft in regions exposed to strong and long swell. A gross underkeel wave clearance of 10% of the maximum draft was recommended for regions less exposed to swell. Due to sheltering effects of the Bahamas in the vicinity of the OEC, an underkeel clearance adjustment of 10% of the maximum allowable draft of the design vessel was considered to be sufficient.

147. Within the IEC and the remaining portions of the project located in the interior of the harbor, ship response from waves is less of a concern. Typically, wave effects are more pronounced and important in the design of the entrance channel or harbor fairway, which is open to ocean waves. Maximum ship response occurs with wavelengths equal to or nearly equal to the ship length. In these cases, the wave period resonates with the natural ship period. Conversely, typical commercial deep-draft design ships respond very weakly to wind waves with wave periods of less than 6 sec. In these cases, the wave period is considerably shorter than the natural ship period. In the exterior entrance channel, it is possible for swell to have wavelengths long enough to impact the vertical motion of the vessel. However, within the inner channels of the harbor, swell of significant wave lengths are not sustainable. Additionally, fetch limitations and sheltering limit the growth of the dominant wind waves. Wave lengths interior of the harbor jetties are significantly less than the length of the design vessel. Therefore, additional depth for wave motion was not applied to interior harbor channels.

3.4.11.3 Squat Underway

148. Squat underway is the vertical lowering of the vessel below the still water surface due to increased velocity past the ship causing the pressure on the ship hull to be decreased. This phenomenon occurs in deep, open-water situations and also in shallow waters. It is within shallow, restricted water such as canal- or trench-type open navigation channels (Figure A- 41) that the squat effect the most pronounced. The squat analysis conducted for Port Everglades is presented in Sub-Appendix C and summarized in the following paragraphs.

149. Methods for determining squat are generalized and varied. EM 1110-2-1613 discusses restricted channel squat under a variety of conditions and establishes a prediction method known as the Canal Theory (Blaauw and van der Knaap, 1983), in which squat and return velocity are obtained through an iterative analysis. Additional computational methods of determining squat are provided by the Permanent International Association of Navigation Congresses (PIANC, 1997). These include four methods applicable to restricted channels: Barrass (1979/1981), Eryuzlu et al. (1994), Huuska and Guliev (1976/1971), and Romisch (1989).

150. Based on evaluation of present Port Everglades transit procedures, a design speed of 10 knots was used for determining squat in the OEC. Though relatively high compared with OEC transit speeds at other harbors, this transit speed is at the lower end of the Port Everglades entrance speed range (10 to 12 knots) that is required to maintain vessel maneuverability under cross-current rotational forces prevalent in the vicinity of the OEC (see Section 2.3.6.2 – Offshore Currents), wind forces acting on the vessel's air draft, and natural hydraulic forces encountered in restricted waterways. The design vessel was the "S-Class" vessel, as its dimensions will result in the maximum squat condition for the design fleet.

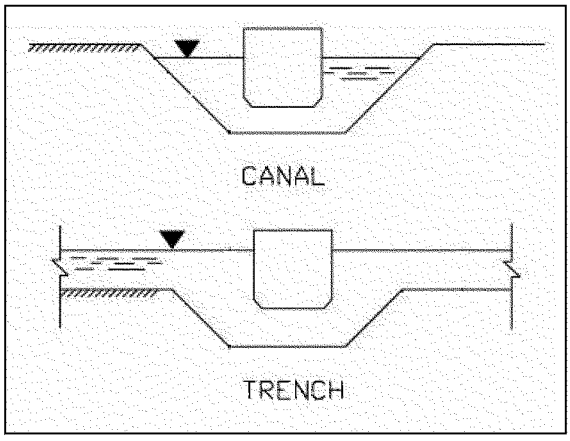


Figure A- 41. Restricted Channel Types

151. Of the five methods presented, the Canal Theory and Barrass methods result is the most conservative estimates of squat. The three remaining methods are less conservative, but show excellent agreement with one another for all vessel drafts considered. Because the Canal Theory is considered to be a first approximation for channel design and is open for refinement, it was not considered for the final determination of squat at Port Everglades. Of the remaining four methods, all are considered to be acceptable means of estimating squat. Therefore, it was decided that squat at Port Everglades would be determined as an average of the three methods that provided the most consistent results. Figure A- 42 shows squat as a function of vessel draft for each of the three determining methods (Eryuzlu et al., Huuska and Guliev, and Romisch). The Canal Theory and Barrass method are also shown (dashed lines) for comparison purposes. Final average squat for each incremental depth is provided in Table A- 11.

152. As vessels enter the IEC, forward speed is reduced drastically and the vessel is no longer subject to significant amounts of squat. Therefore, squat is not a factor in determining the project depths for the IEC or other interior channels.

153. The absence of additional depth for squat (and wave) effects in the interior channels will create a difference in design depths between the OEC and IEC. In order to minimize hydraulic effects that may result from an abrupt change in water depth, the bottom of the IEC channel will be sloped on 1V:3H gradient beginning just inside the harbor jetties at the point where the OEC becomes the IEC (Figure A- 43). This transition region will not only reduce hydraulic effects on transiting vessels, but will also provide an additional margin of safety for a project area where wave conditions, vessel speeds, and current conditions are also in transition.

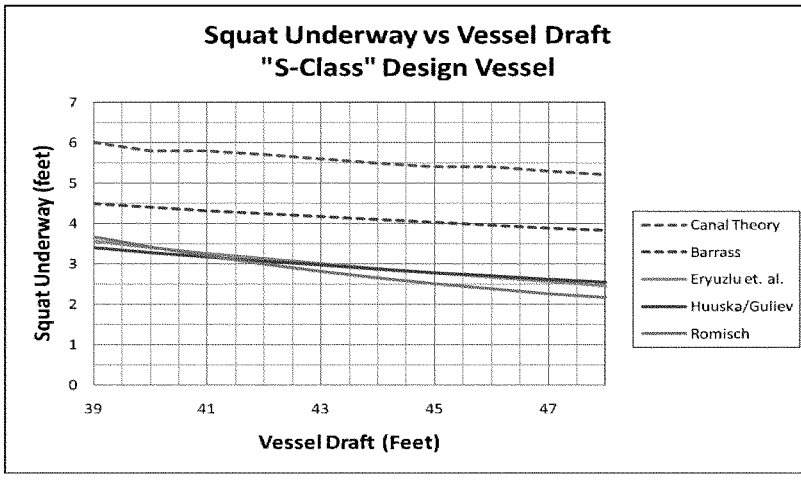


Figure A- 42. Squat Underway vs Vessel Draft: "S-Class" Design Vessel

3.4.11.4 Safety Clearance

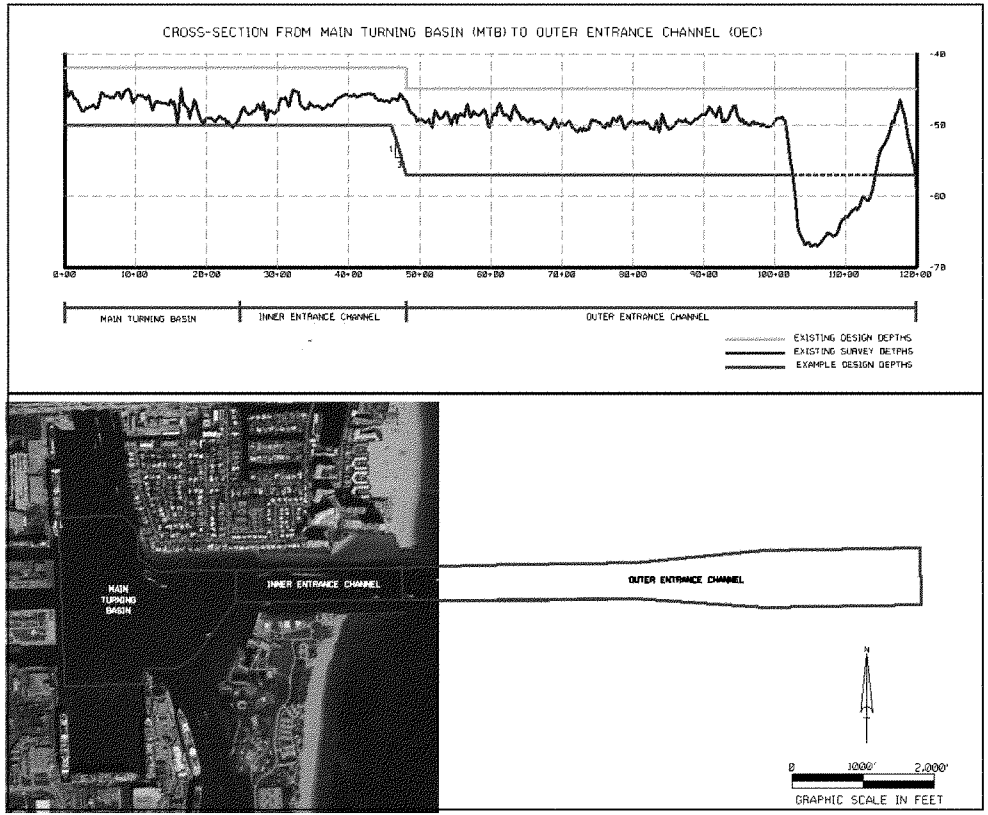
154. In the interest of safety, a clearance is provided between the bottom of the ship and the floor of the design channel to avoid damage to ship hull, propellers, and rudders from bottom irregularities and debris. A clearance of 2 feet is recommended when the bottom of the channel is soft material, such as sand. When the bottom of the channel is hard, consisting of rock, consolidated sand, or clay, the clearance should be increased to at least 3 feet (USACE, 2006). Due to the presence of rock and consolidated clay at Port Everglades, a safety clearance of 3 feet is specified.

3.4.11.5 Advance Maintenance and Overdepth

155. Advance maintenance, allowable overdepth, and required overdepth are additional depth increments for channel design that are associated with the dredging process. These increments were discussed previously in greater detail in the Section 3.3 Depth, and have the following values: 0 feet of advance maintenance, 1 foot allowable overdepth, and 1 foot required overdepth.

3.4.11.6 Total Underkeel Clearance

156. Combining effects due to fresh water, net vertical excursion due to wave action, the expected amount of squat, the safety clearance, and dredge related overdepths, results in the total underkeel clearance. Table A- 11 provides resulting project depths (not including dredge related overdepths) for all project components including the OEC. Design drafts range from 8 feet to 31 feet for the "Bellatrix" (DCC), from 31 feet to 42 feet for the STB Panamax vessel (STB), and from 39 feet to 48 feet for the "S-Class" vessel (OEC, IEC, MTB, Widener, SAC, and TN).



Fignre A- 43. Example Transition From OEC Depth to IEC Dept

Table A- 11. Underkeel Clearance and Project Depths for Outer and Inner Channels

Design Parameters				Outer Entrance Channel (OEC)				Interior Channels/Basins	
Vessel			Draft (ft)	Wave Clearance (ft)	Ave. Squat (ft)	Safety Clearance (ft)	Project Depth* (ft)	Safety Clearance (ft)	Project Depth* (ft)
"Bellatrix" (DCC)			8					3	11
			9					3	12
			10					3	13
			11					3	14
			12					3	15
			13					3	16
			14					3	17
			15					3	18
			16					3	19
			17					3	20
			18					3	21
			19					3	22
			20					3	23
			21					3	24
			22					3	25
			23					3	26
			24					3	27
			25					3	28
			26					3	29
			27					3	30
			28					3	31
			29					3	32
			30					3	33
	"STB Panamax" (STB)		31					3	34
			32					3	35
			33					3	36
			34					3	37
			35					3	38
			36					3	39
			37					3	40
			38					3	41
		"S-Class" (OEC, IEC, MTB,Wide, SAC, TN)	39	3.9	3.5	3.0	49	3	42
			40	4.0	3.4	3.0	50	3	43
			41	4.1	3.2	3.0	51	3	44
			42	4.2	3.1	3.0	52	3	45
			43	4.3	2.9	3.0	53	3	46
			44	4.4	2.8	3.0	54	3	47
			45	4.5	2.7	3.0	55	3	48
			46	4.6	2.6	3.0	56	3	49
			47	4.7	2.5	3.0	57	3	50
			48	4.8	2.4	3.0	58	3	51

*Project Depths do not include dredge related overdepths. Actual channel depths will include an additional 1 foot of allowable overdepth plus 1 foot of required overdepth.

3.5 DETERMINATION OF DESIGN PLANS

157. In order to meet project goals and generate an economically viable plan, the nine project components were arranged into six economic alternative plans (Plans 1 – 6) which were further divided into sixteen economically and logistically feasible alternatives based on the grouping of individual project components. Table A- 12 presents each Plan, itemizing associated project components and providing a brief description. Note that some alternatives are repetitive. This is for purposes of economic grouping and has no effect on the engineering or cost analyses. An asterisk denotes Plans that were dropped during the course of the study due to elimination of project components: STB, DCC, TN (Turning and Berthing), and TN (Turning Only).

3.6 HYDROLOGY AND HYDRAULICS

3.6.1 GENERAL

158. Port Everglades is a complex system of interconnecting channels and basins that vary in shape and depth. Deepening and widening such features can lead to localized hydrologic and hydraulic impacts. Among potential impacts at Port Everglades are changes to the nearshore wave climate, which can change shoreline erosion and accretion patterns, and changes to existing salinity levels, which can impact local ecosystems. The following summarizes evaluation of these potential impacts.

3.6.2 HYDROGRAPHIC AND TOPOGRAPHIC SURVEYS – EXISTING CONDITIONS

159. Three hydrographic surveys were utilized for the Port Everglades Feasibility Study. The first was a SHOALS (Scanning Hydrographic Operational Airborne Lidar Survey) survey conducted by U.S. Army Engineer Airborne Lidar Bathymetry Technical Center of Expertise in December 1997. This comprehensive survey was conducted to determine the existing condition of the Port Everglades Harbor navigational project and to establish the horizontal positions of navigational aids and existing jetties. The second hydrographic survey was a project condition survey completed by the U.S. Army Corps of Engineers Jacksonville District in June 2000, specifically for the Port Everglades Feasibility Study. The third survey was conducted June 2005 as part of the 2006 maintenance event. The horizontal datum for each survey is Florida East State Plane, NAD83, Transverse Mercator Projection. The vertical datum is Mean Lower Low Water (MLLW).

160. Two topographic surveys were conducted of Port Everglades by the Port Authority. The first, conducted in 1999 is a land survey. The second, conducted in August 2000 is an aerial survey covering John U Lloyd State Park from the south jetty at the Port Everglades entrance channel to the Dania Cutoff Canal as well as portions of port property located north of the Dania. The horizontal datum for both surveys is Florida East State Plane, NAD83.

161. Contours depicting coverage of the hydrographic (truncated north and south of the OEC) and topographic surveys of Port Everglades are displayed in Figure A- 44.

Table A- 12. Project Alternative Plans

Alternative Plan	Components	Description
Plan 1A	OEC, IEC, MTB	Widen (where applicable) and deepen to an economically determined depth
Plan 1B*	OEC, IEC, MTB, STB	
Plan 2A	OEC, IEC, MTB	Widen (where applicable) and deepen to an economically determined depth
Plan 2B	OEC, IEC, MTB, Widener, SAC	
Plan 2C*	OEC, IEC, MTB, Widener, SAC, TN (Turning & Berthing)	
Plan 2D*	OEC, IEC, MTB, Widener, SAC, TN (Turning Only)	
Plan 2E	OEC, IEC, MTB, Widener, SAC, TN (S_TN)	
Plan 3A*	DCC	Widen (where applicable) and deepen to an economically determined depth
Plan 4A*	STB	Widen (where applicable) and deepen to an economically determined depth
Plan 5A	OEC, IEC, MTB	Widen (where applicable) and deepen to an economically determined depth
Plan 5B*	OEC, IEC, MTB, STB	
Plan 5C*	OEC, IEC, MTB, STB, Widener, SAC	
Plan 5D*	OEC, IEC, MTB, STB, Widener, SAC, TN (Turning & Berthing)	
Plan 5E*	OEC, IEC, MTB, STB, Widener, SAC, TN (Turning & Berthing), DCC	
Plan 5F*	OEC, IEC, MTB, STB, Widener, SAC, TN (Turning Only)	
Plan 5G*	OEC, IEC, MTB, STB, Widener, SAC, TN (Turning Only), DCC	
Plan 6A	Widener	Widen (where applicable) and deepen only (with the exception of the DCC) to a project depth 42'. Widen and deepen DCC to an economically determined depth.
Plan 6B	Widener, SAC	
Plan 6C*	Widener, SAC, TN (Turning & Berthing)	
Plan 6D*	Widener, SAC, TN (Turning & Berthing), DCC	
Plan 6E*	Widener, SAC, TN (Turning Only)	
Plan 6F*	Widener, SAC, TN (Turning Only), DCC	
* Plans dropped due to the elimination of individual project components		

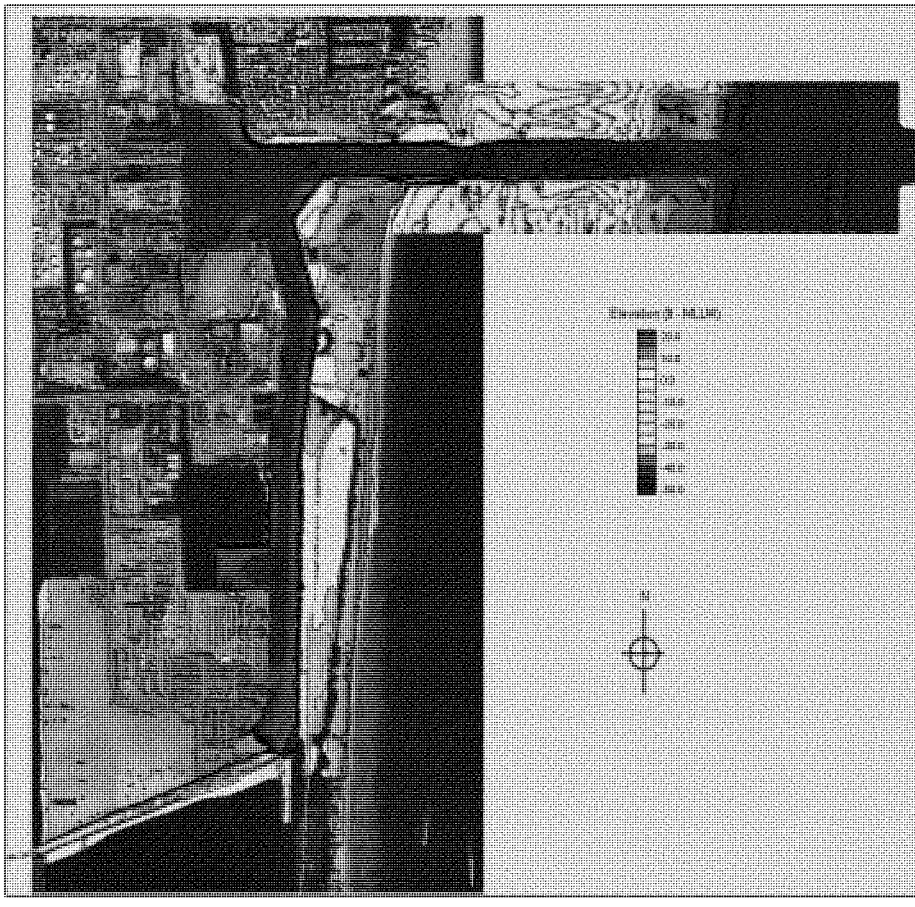


Figure A- 44. Coverage of Hydrographic and Topographic Surveys

162. It should be noted that the surveys detailed in previous paragraphs were the most currently available surveys at the time that the incremental benefit and cost analyses were initiated. Because Port Everglades is a slow shoaling harbor, maintenance surveys are not taken on a yearly basis, making timely updates during the analyses impossible. However, surveys conducted after completion of the Final Draft of this report will be incorporated into the PED phase of the study.

3.6.3 REGION 2D HYDRODYNAMIC MODELING

3.6.3.1 General

163. The proposed expansion of Port Everglades has the potential to alter the hydrodynamics in the vicinity of the Inlet and thus change sediment transport conditions in the nearshore areas to the north and south of the inlet.

164. As part of the Port Everglades Inlet Sand Management Phase I: Sand Bypassing Feasibility Study (Olsen Associates, Inc., 2004), the 2D nested hydrodynamic model MIKE 21 HD was setup to evaluate a series of bypassing alternatives. Within this study, the proposed expansion of the Port Everglades port facilities was also evaluated. The purpose of the addition of the port expansion to the bypass study was to "determine impact of port expansion on flow through Port Everglades Inlet, and to determine whether there will be any interaction between the proposed port expansion and the proposed bypassing scheme."

3.6.3.2 Impact on Inlet Discharge and Sediment Transport

165. Widening and deepening associated with the expansion project increases the water area in internal waterways and inlet channels. This has the potential to alter the discharge rates normally associated with the present harbor configuration and impact the sediment transport climate in the vicinity of the entrance channel. However Figure A- 45 (Olsen Associates, Inc., 2004), providing modeled discharge through the Port everglades inlet with and without port expansion elements, indicates that the net effect of the port expansion is an increase in the magnitude of discharge of only 1% to 3%. This small percentage of increase was determined to be negligible with respect to influencing the sediment transport conditions in the vicinity of the inlet.

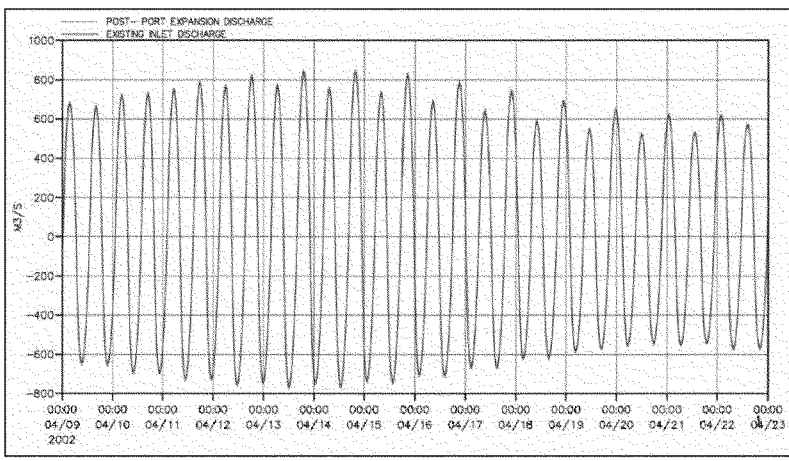


Figure A- 45. Inlet Discharge Rates, With and Without Port Expansion

166. Widening and deepening at Port Everglades , especially in the OEC, has the potential to impact the nearshore wave climate and therefore the longshore sediment transport patterns along the adjacent shorelines. However, further modeling proved that the effect of widening and deepening of the project elements on the longshore transport in the vicinity of Port Everglades was negligible. Figure A- 46 and Figure A- 47 (Olsen Associates, Inc., 2004) show examples of with and without expansion transport rates results.

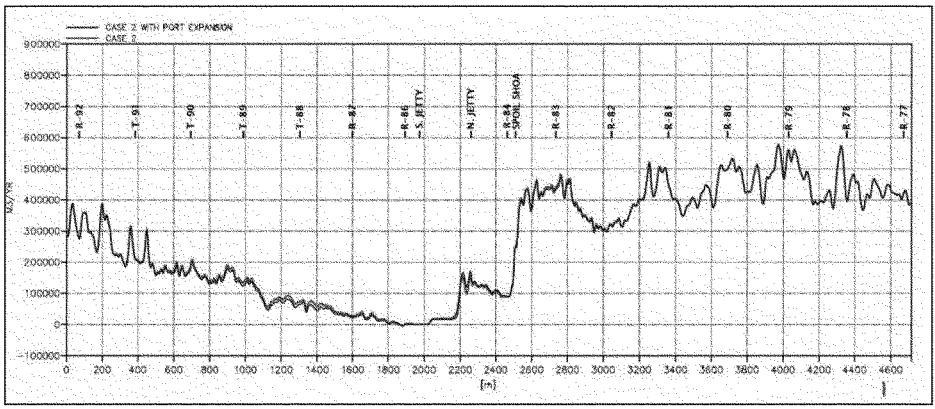


Figure A- 46. Sediment Transport Rates With and Without Port Expansion, Wave "Case 2"

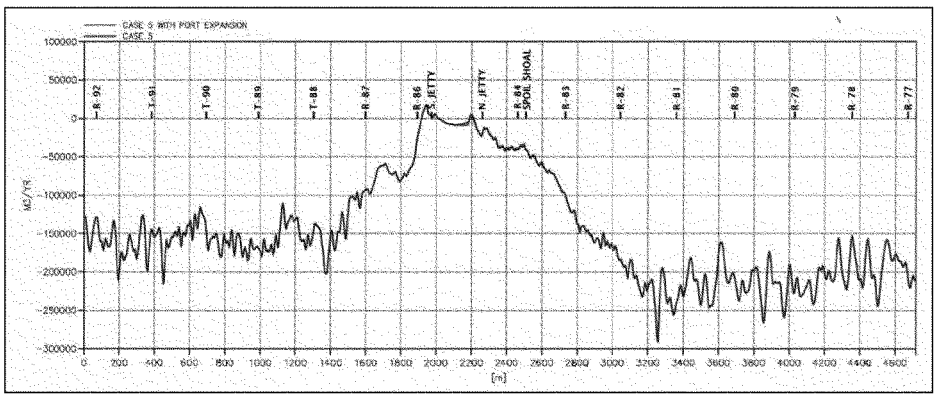


Figure A- 47. Sediment Transport Rates With and Without Port Expansion, Wave "Case 5"

3.6.3.3 Conclusions

167. The findings of Olsen indicate that widening and deepening associated with the expansion of Port Everglades will have negligible impact on sediment transport patterns along the shorelines to the north and south of the inlet.

3.6.4 RMA MODELING

168. In order to examine potential impacts to the salinity regime that could result from the proposed project, the numerical model RMA-2 was employed to analyze hydrodynamic changes in the study area. This modeling effort focused on plans that would most likely cause the largest impacts to the salinity regime (Plans 2 and 5). This RMA modeling effort is described in Sub-Appendix D.

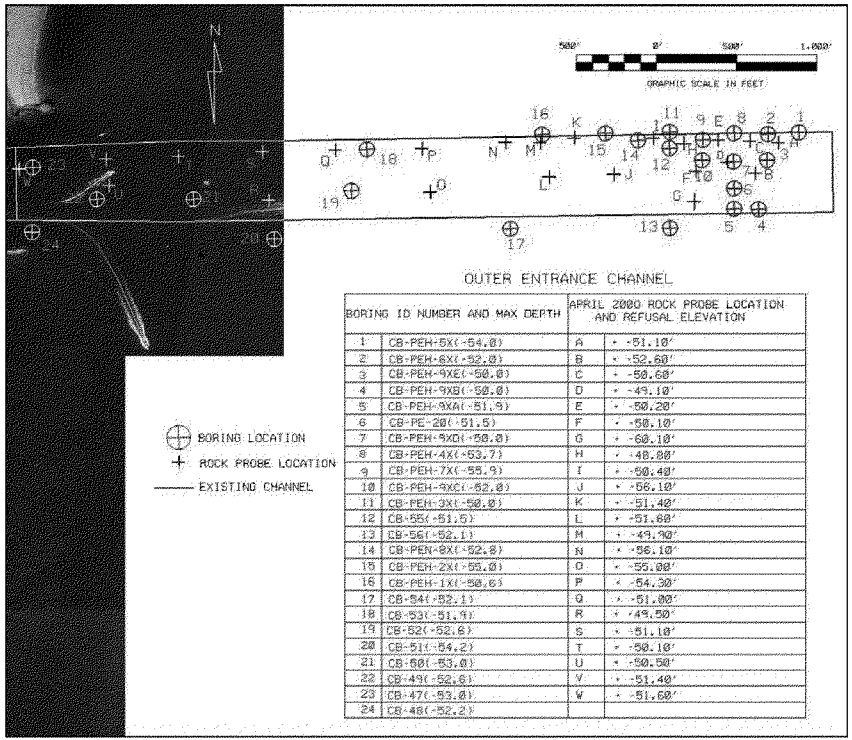
169. RMA-2 is a two-dimensional depth-averaged finite-element hydrodynamic model which computes water surface elevations and horizontal velocity components for subcritical, free-surface flow. RMA-2 provides a means for examining changes in tidal flushing which can be used as an indirect indicator of the magnitude of potential changes in the salinity regime of the study area.

170. A finite element mesh geometry was developed that allowed for the modeling of both the with- and without-project conditions. Transient head input data files were used to simulate forcing tides and steady-state volumetric inflows were included to simulate the fresh water discharge of rivers and canals. From resulting model output, computed average flows across selected channel locations were generated. Through comparison of with- and without-project flows, a relative percent change for each selected location was determined. Based on the 14 selected locations dispersed throughout the study area, differences in flow were found to be minimal, indicating that changes in tidal flushing and the existing salinity regime resulting from with-project channel configurations are not expected.

3.7 GEOTECHNICAL INVESTIGATIONS

3.7.1 CORE BORINGS

171. Hundreds of core borings have been drilled in and around Port Everglades Harbor. Figure A- 48 through Figure A- 56 illustrate core boring locations in the OEC, IEC, MTB, STB, Widener, SAC, TN, and DCC, respectively. Core borings were drilled by the Corps of Engineers, the Broward County Port Authority, and dredging contractors. The quality of the core borings is variable. The Corps of Engineers core borings can be relied upon to document the ground conditions. Other core borings vary in usefulness. Major problems observed on many of the core boring logs include poor recovery, uncertain locations, poor documentation of drilling data, and poor descriptions of materials.



BORING ID NUMBER AND MAX DEPTH		APRIL 2000 ROCK PROBE LOCATION AND REFUSAL ELEVATION	
1	CB-PEH-5X(-54.0)	A	+ -51.10'
2	CB-PEH-8X(-52.0)	B	+ -52.60'
3	CB-PEH-9XE(-50.0)	C	+ -50.60'
4	CB-PEH-9XB(-50.0)	D	+ -49.10'
5	CB-PEH-9XA(-51.9)	E	+ -50.20'
6	CB-PE-20(-51.5)	F	+ -50.10'
7	CB-PEH-9XD(-50.0)	G	+ -60.10'
8	CB-PEH-4X(-53.7)	H	+ -48.80'
9	CB-PEH-7X(-55.9)	I	+ -50.40'
10	CB-PEH-9XC(-52.0)	J	+ -56.10'
11	CB-PEH-3X(-50.0)	K	+ -51.40'
12	CB-55(-51.5)	L	+ -51.60'
13	CB-56(-52.1)	M	+ -49.90'
14	CB-PEN-8X(-52.8)	N	+ -56.10'
15	CB-PEH-2X(-55.0)	O	+ -55.00'
16	CB-PEH-1X(-50.6)	P	+ -54.30'
17	CB-54(-52.1)	Q	+ -51.00'
18	CB-53(-51.9)	R	+ -49.50'
19	CB-52(-52.6)	S	+ -51.10'
20	CB-51(-54.2)	T	+ -50.10'
21	CB-50(-53.0)	U	+ -50.50'
22	CB-49(-52.8)	V	+ -51.40'
23	CB-47(-53.0)	W	+ -51.60'
24	CB-48(-52.2)		

Figure A- 48. Core Borings - Outer Entrance Channel

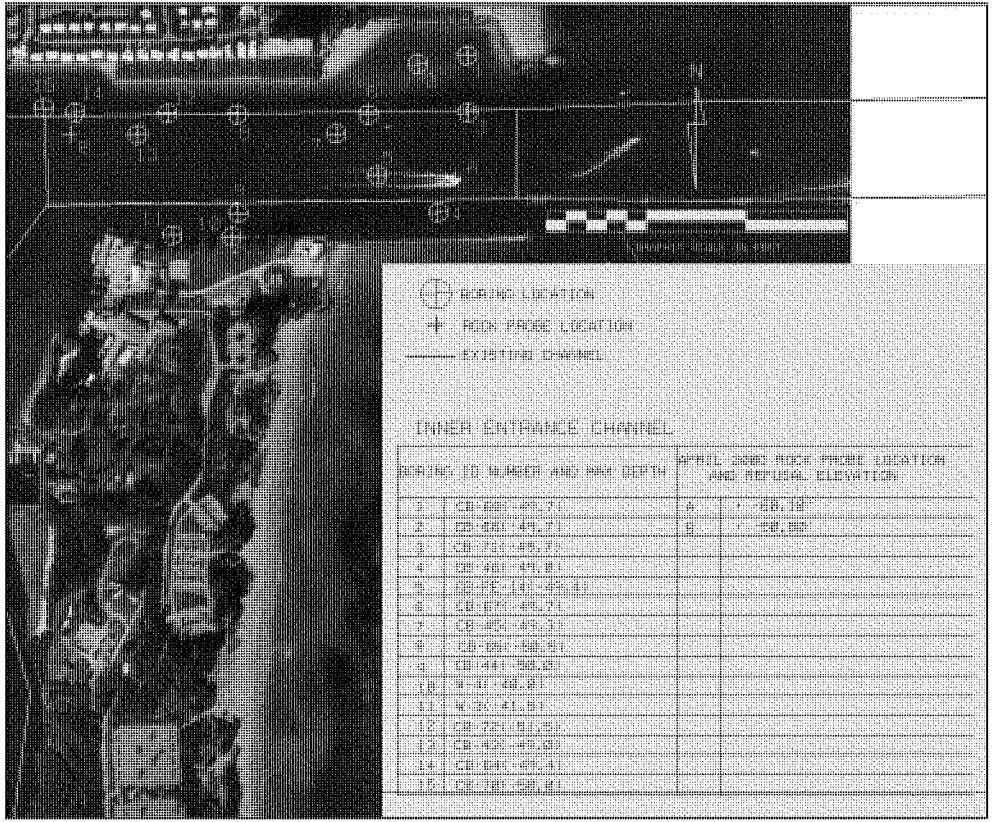


Figure A- 49. Core Borings - Inner Entrance Channel

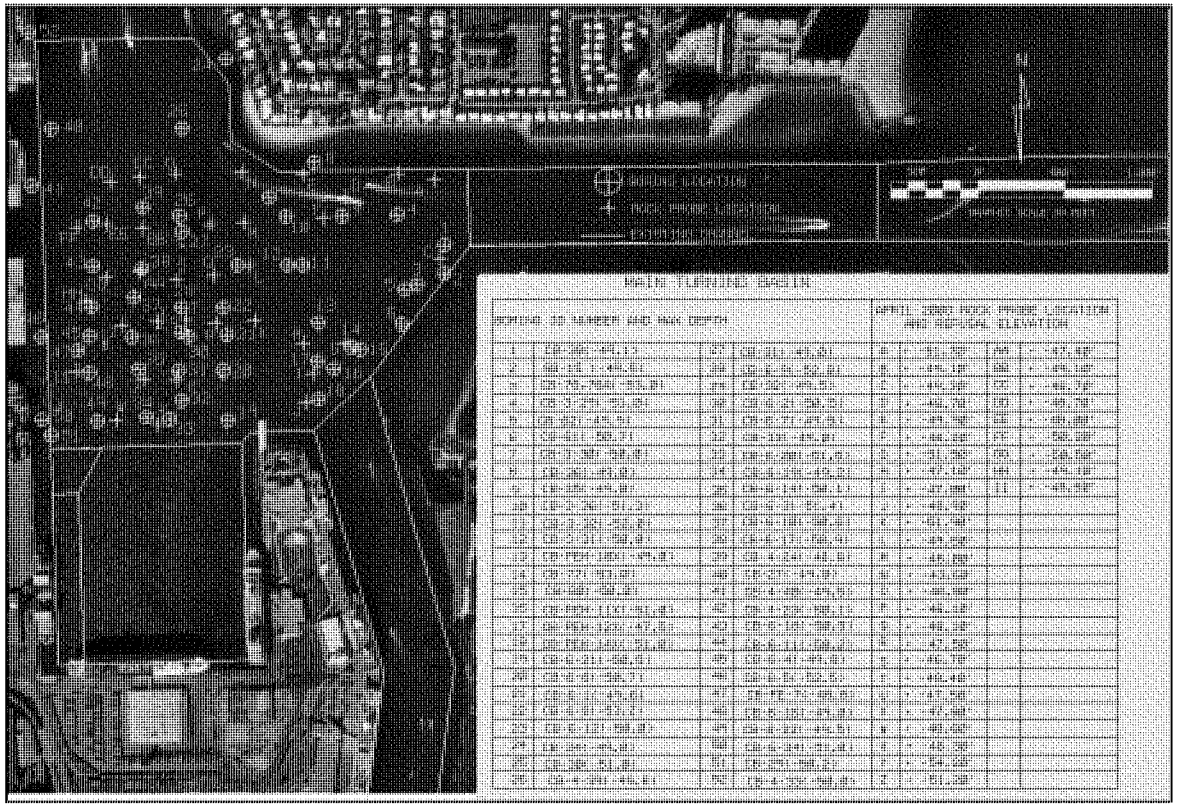


Figure A- 50. Core Borings - Main Turning Basin

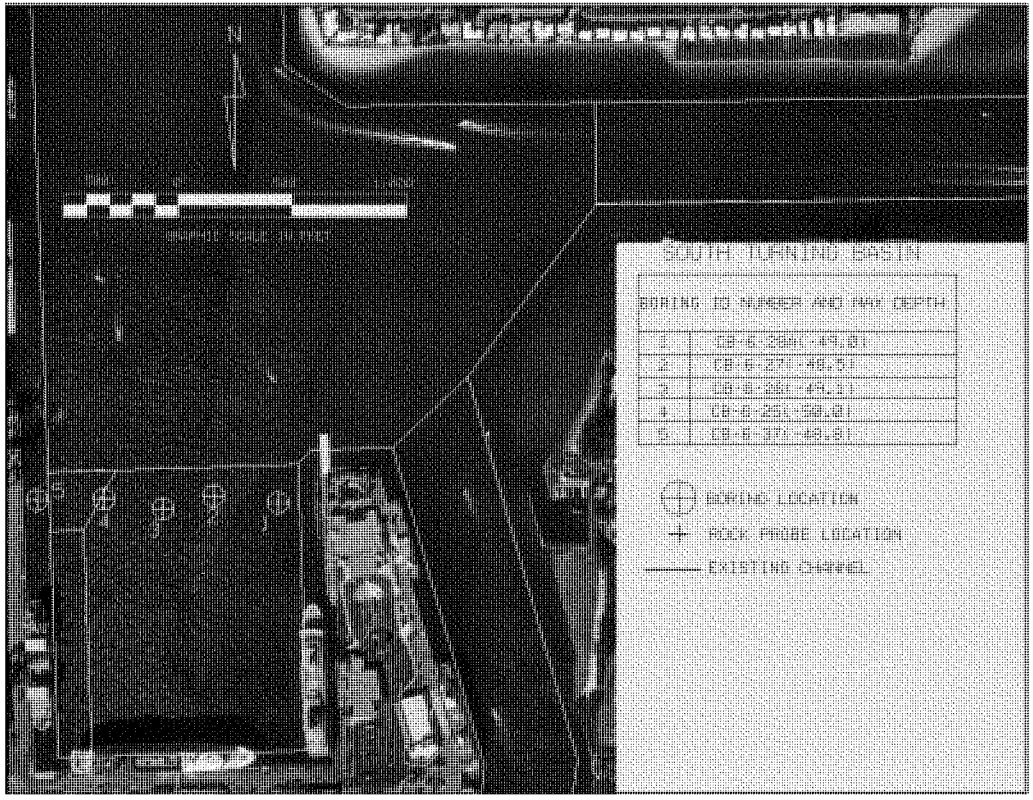


Figure A- 51. Core Borings - South Turning Basin

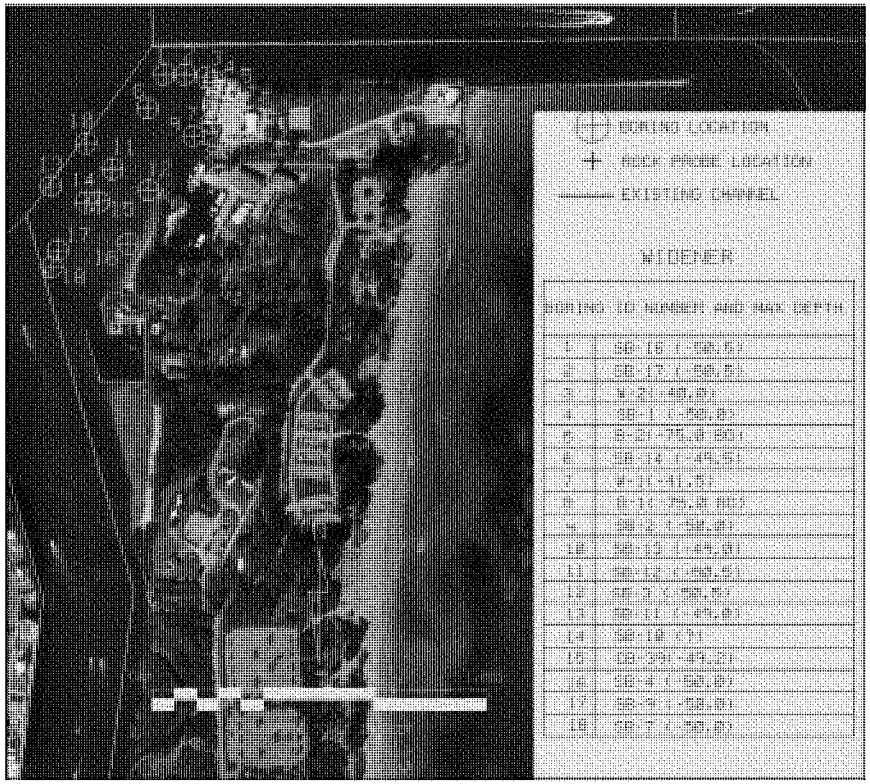


Figure A- 52. Core Borings - Widener

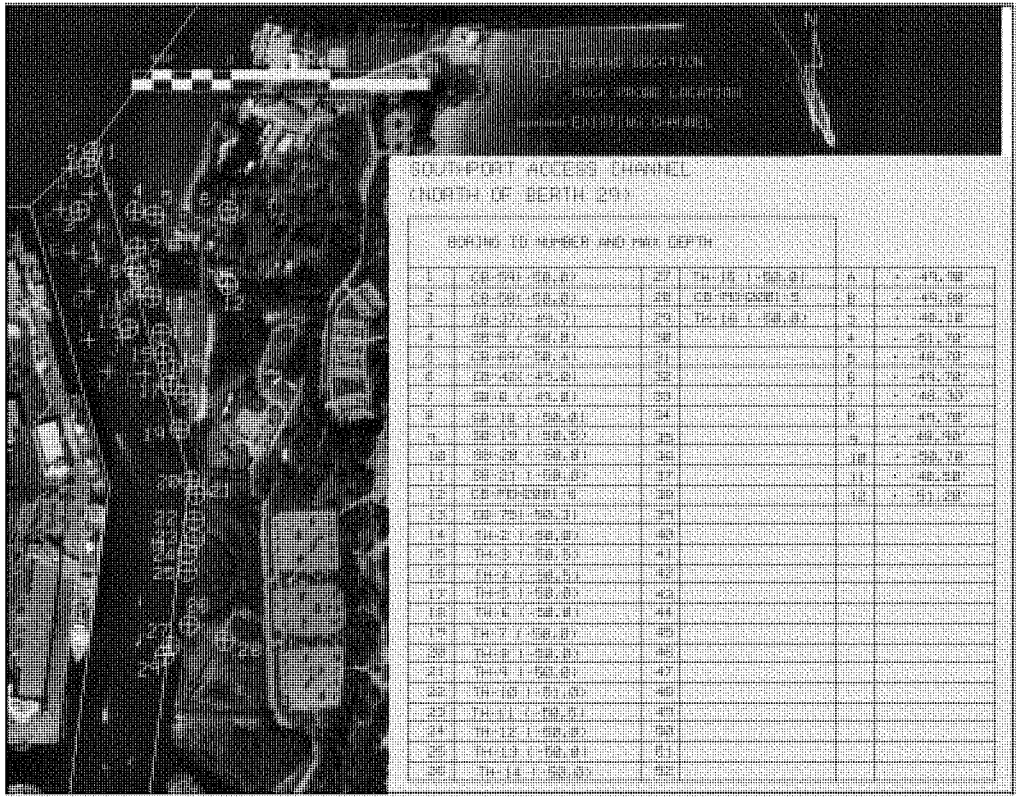


Figure A- 53. Core Borings - Southport Access Channel (North of Berth 29)

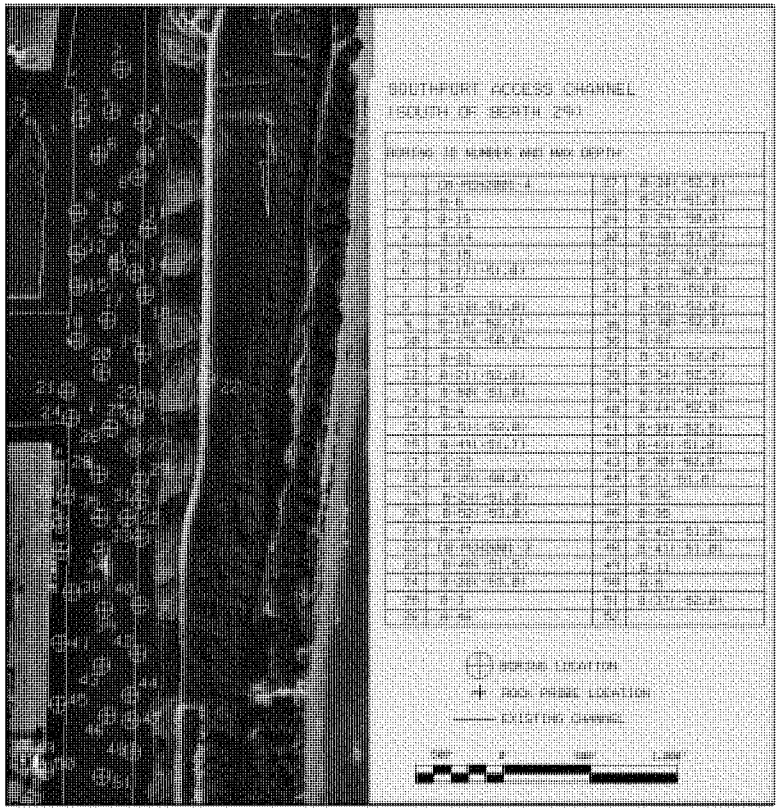


Figure A- 54. Core Borings - Southport Access Channel (South of Berth 29)

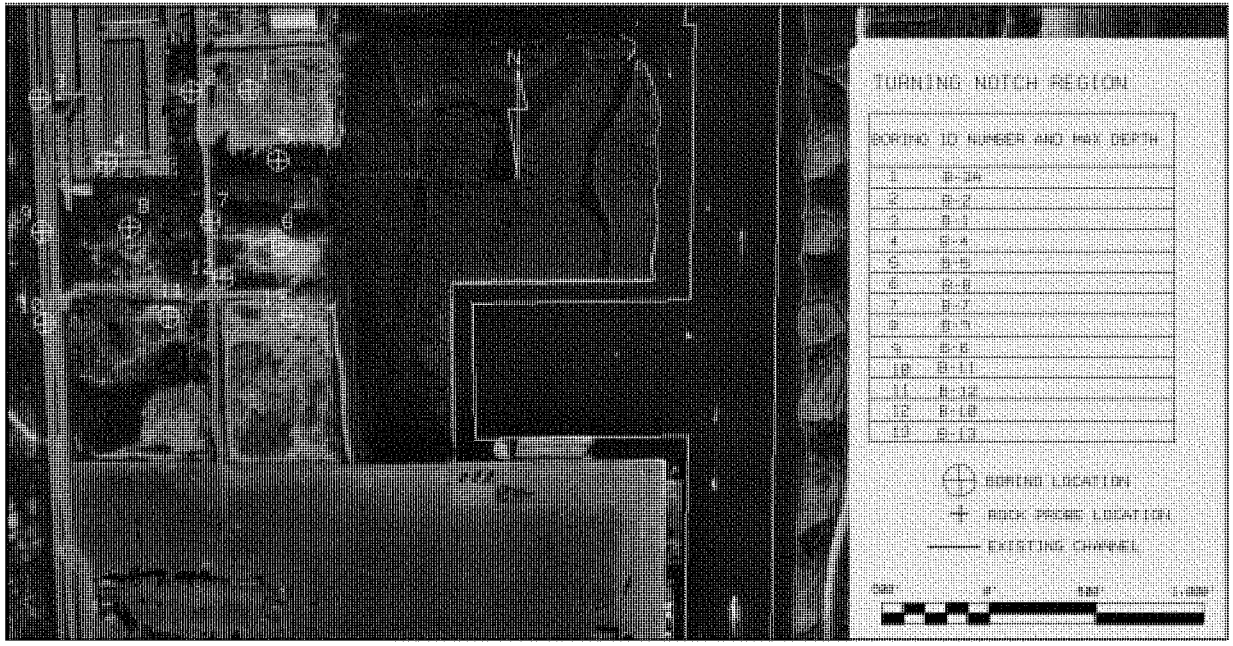


Figure A- 55. Core Borings - Turning Notch

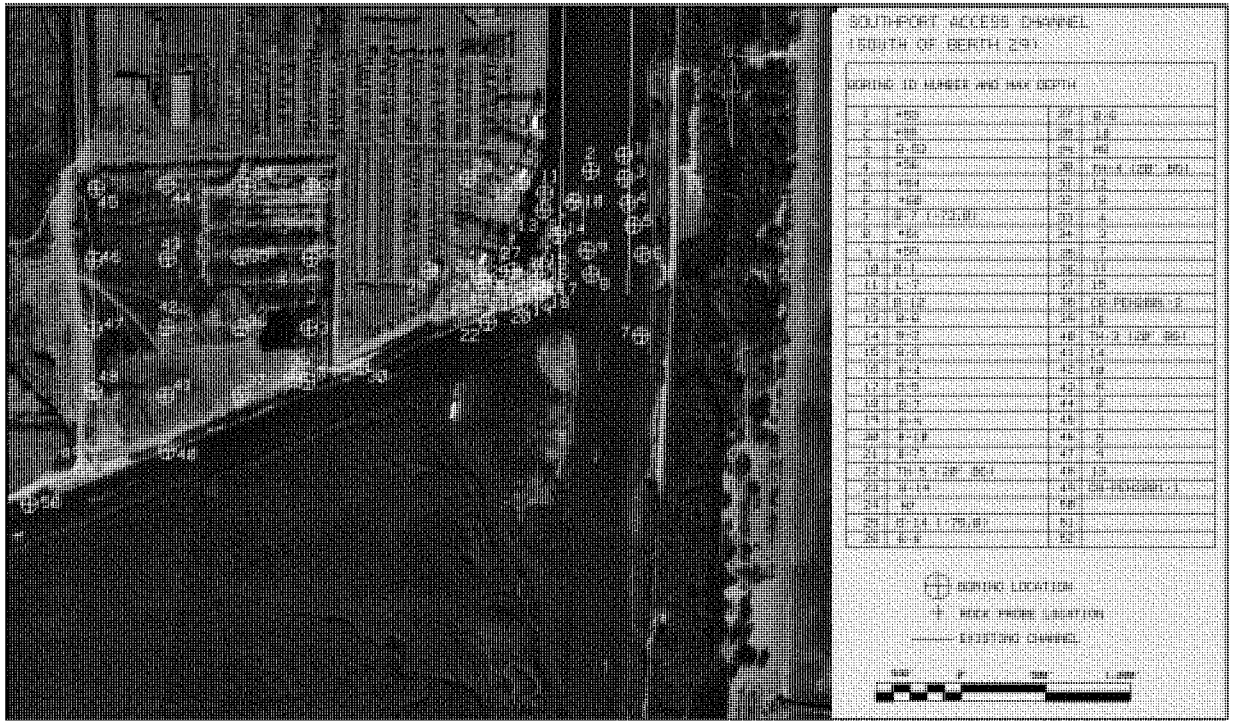


Figure A- 56. Core Borings - Dania Cutoff Canal

172. The sponsor (Broward County) has drilled two groups of core borings in support of the two widening portions of the project. The first group of 15 core borings (TH-2 through TH-16) was drilled in July-August 1997 by Ardaman & Associates Inc. These core borings were drilled to the east of the Intracoastal Waterway along an irregular alignment over a distance of 1,600 feet. The core borings were logged by a Professional Geologist. No gradations were run on the recovered samples.

173. The second group of 21 core borings (SB-1 through SB-21) was drilled in August 1998 by Geo Verse, Incorporated. These core borings were drilled just to the northeast of where the Intracoastal Waterway enters Port Everglades Harbor from the south. These core boring were drilled on a pattern to cover an area approximately 1,400 feet long by 400 feet wide. The core borings were logged by a Professional Engineer. Forty gradations were run on the recovered samples

174. Both groups of core borings were drilled using the standard split-spoon with 18-inch drives and continuous sampling. The borings were drilled to elevation -50 feet below "mean low water". They were drilled to a standard and quality that are acceptable to a Corps of Engineers project.

175. Materials generally encountered at Port Everglades are highly variable between core boring locations and elevations. Basic materials found in interbedded layers are peat, organic silts, sands, silty sands, gravelly sands, weakly cemented sands, moderately cemented sands, weakly cemented sandstones and limestones, occasional competent beds of sandstones and limestones and deposits of hard massive sandstone and limestone. The borings obtained during this study make up an extensive core boring library, too large for incorporation in this document. However, all core boring data are available upon request through USACE Jacksonville District.

3.7.2 MATERIAL TYPES

176. Geotechnical core borings and investigations determined that materials at Port Everglades were composed predominately of unconsolidated materials, "soft" rock (rock not requiring blasting for excavation), and "hard" rock (rock requiring blasting). Table A- 13 gives estimated percentages of materials based on project component. The delineation between hard rock, softer rock and unconsolidated material as presented in Table A-13 was derived from examination of the available individual core borings. Consideration was given to rock hardness, strength, fracturing, massiveness, vugs, solution cavities, RQD, N-values and area of influence. Often a rock is hard but it's thickness (<3'), fracturing and homogeneity determines if it needs to be blasted or can be removed with a large rock cutter. A majority of the borings were drilled at or just below the future project depth, thus requiring extrapolation and best professional judgment, when determining the percentage, if the rock was hard at or near project depth, it was considered to require blasting as the thickness could not be determined. This gives us reasonable reliability of the material to be removed and whether blasting may be required. Note that unconsolidated materials found in the project will include, for the most part, sands with varying amounts of fines, and silts, with varying amounts of organic materials mostly found on the Southport Access Channel and Turning Notch. The hardness of cohesive materials (silts and clays) is defined by

their "consistency" (very soft, soft, firm, hard, and very hard). Granular-non-cohesive unconsolidated materials including sands and gravels are defined by their "relative density" (very loose, loose, medium, dense, and very dense). Consolidated materials include sandstones and limestones with varying degrees of hardness, fracturing, weathering. Softer rock formations are usually associated more weathered materials. Harder rock formations are usually associated with unweathered and massive materials containing less jointed rock mass that will significantly resist excavation and will require blasting for economical removal.

177. A geotechnical analysis for beach quality sand potential at the Widener area was performed by the SAJ Geotechnical Branch in August 1999. The purpose of the analysis was to evaluate all available information gathered to date to determine and quantify the suitability of the excavated material for beach quality materials. The information gathered included subsurface investigations consisting of borings completed from about 1966 to 1977 for the 1981 dredging project; and recent borings completed in two areas for the current widening of the southeast harbor section and adjacent waterway. The 3 phases of drilling involved continuous sampling with the standard 18-inch splitspoon with coring operations in harder zones. The following were identified during the review and evaluation of the information to assist in the determination of the suitability of the proposed material for beach quality material.

Table A- 13. Distribution of Materials by Percentage

Location	Percentage of Unconsolidated Matierials (%)	Percentage of Soft Rock (%)	Percentage of Hard Rock (%)
Outer Entrance Channel	70.0	20.0	10.0
Inner Entrance Channel	40.0	55.0	5.0
Main Turning Basin	40.0	20.0	40.0
North Turning Basin	40.0	10.0	50.0
South Turning Basin	40.0	10.0	50.0
Widener	50.0	50.0	0.0
Southport Access Channel	50.0	50.0	0.0
Turning Notch	50.0	50.0	0.0
Dania Cutoff Canal	50.0	40.0	10.0

a) The processed materials will be primarily coarse to fine grained sand (SP & SP-SM) with lesser amounts of fine grained gravel.

b) Based on the Atterberg Limits, the processed material can be expected to be nonplastic making handling, blending and washing easier.

c) Based on the analysis, the information shows:

- Without processing, the excavated material would produce marginal quality beach fill.

- 35-percent of the as-excavated material would require processing. This material contains 5-percent gravel larger than 1-inch in size, 15-percent gravel up to 1-inch in size, and 15-percent fines (#200-sieve).
- Localized peat deposits can be separated and wasted to a designated spoil area.

d) A comparison of the samples to the geologic interpretation in the logs shows that overall:

- About 2/3 of the material (weathered limestone) is expected to be tan to gray sand.
- About 1/3 of the material (sand, cemented sand and sandstone) is expected to be tan or light brown and gray sand.
- This would result in a tan to gray, fine to coarse-grained sand with gravel.

e) The materials can be processed to produce beach quality sands:

- The material will have to be screened to remove gravel larger than 1-inch in size.
- The materials cannot be selectively mined to produce beach material without processing.
- Excessive silts will have to be removed. The silt concentration is variable ranging from a few percent to over 50 percent. Silt is defined as materials that pass the no. 200 sieve, are smaller than 75 micrometers, and plot below the A-line in the USCS Plasticity Chart.
- There is not an excessive amount of silt; but it would be difficult to get the as excavated material permitted for beach fill because the silt content of the excavation as a whole is 15 percent.

178. The following are recommendations concerning beach placement as a result of the review and evaluation of the project geotechnical data. These recommendations apply only if beach placement is part of the selected plan.

a) By volume, up to approximately 50-percent of the material could be used as beach material, but would require extensive processing to remove non-beach quality elements (gravels, silts).

b) A detailed QA/QC Plan needs to be prepared to control the manufacturing of the material to produce beach quality material.

c) The burden of responsibility to produce beach quality material should be placed on the Contractor to meet the required specifications and approved as a contract submittal.

d) The work may be receptive to a RFP.

3.7.3 EXCAVATION

3.7.3.1 General

179. The terms "top of rock" and "quantity of rock" have little meaning over much of the area as the majority of the materials encountered fall into a gray area of materials between the classic sand definition and the classic rock definition. For excavation purposes, materials at Port Everglades can be classified in two broad categories, softer material and harder material.

180. Softer materials on average will excavate as partially cemented sand with occasional thin (inches to a few feet) layers of competent rock. After excavation, a majority of the materials will appear as gravelly sand with occasional pockets of silt. Some boulders may result in regions of blasting. Although approximately 50 percent of the excavated material would be classified as sands, the gravelly component (broken rock), silt pockets, and the peat deposits make the material unsuitable, without processing, for beach disposal.

181. Softer materials may be excavated using a rock cutterhead dredge or other methods of excavation. The use of mechanical dredging may require a method to break up the occasional bed of resistant sandstone/limestone to aid in the excavation.

182. Harder materials are concentrations of hard massive rock that will significantly resist excavation. It is anticipated that hard rock encountered during the current project will require blasting for its economical removal.

183. The majority of hard massive rock at Port Everglades is located in the MTB and STB. However, additional hard massive rock may be found in the OEC, IEC, DCC, and in limited isolated deposits throughout the remainder of the project area.

184. Unconfined Compressive strength tests have been run on approximately 306 rock samples from the Port Everglades OEC, IEC, and MTB. Most of the samples are from the MTB. Figure A- 57 displays a chart showing the test results. The rocks strengths documented in Figure A- 57 indicate that while much of the rock is can be excavated with a rock cutterhead dredge, some of the rock would not and may require blasting. While this chart contains a significant quantity of data on the rock strengths at Port Everglades Harbor, it is important to note that much of this data came about as a result of a rock claim on this project. Because of the claim and the way the rock samples were selected for testing, the data over-represents the harder rock and under-represents data from the softer rock. In addition to a sampling bias for testing harder rock, the softer rock is less likely to be tested because it is difficult to obtain samples suitable for testing and it is difficult to physically test the softer rock.

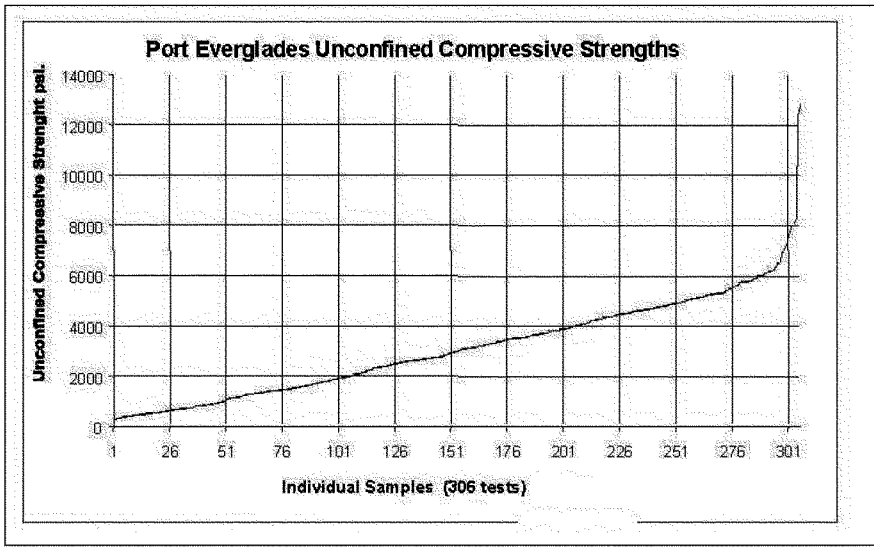


Figure A- 57. Unconfined Compressive Strengths

3.7.3.2 Previous Excavation

185. Deepening of Port Everglades Harbor in the early 1980's required rock excavation in the MTB and OEC. To aid in the rock excavation, a punch barge was employed. The procedure involved dropping a heavy steel beam/chisel to break hard rock formations into fragments that could then be excavated mechanically. The punch barge was used for 216 days in Port Everglades Harbor and proved to be prohibitively expensive and exorbitantly time consuming.

186. Records pinpoint locations where the punch barge was used. These records show areas of concentrated punch barge usage that indicate the locations of hard massive rock that proved difficult to excavate. Due to cost and environmental concerns the rock in these areas will likely have to be blasted in order to be excavated in the current deepening and widening plans.

187. During the same deepening event, sand and soft rock were excavated from the Widener and northern SAC. A combination of hydraulic, clam shell, and drag line dredges were employed with the hydraulic dredge providing the highest production rates (Table A- 14 and Table A- 15).

188. Based on Federal contract acquisition guidelines, the Corps of Engineers will, in general, not specify dredging methods, techniques, or specific types of dredging equipment. Rather the Corps of Engineers will specify performance results required by the dredging contract (i.e. a channel so many feet wide and so many feet deep). The contractor, being an expert in dredging technology, will determine the best and most cost effective type of dredging equipment required to do the job.

Table A- 14. Production Rates for Widener

Name of Dredge	Type of Dredge	Production cy/hr	Production cy
Cherokee	Hydraulic	307	30,000
Powel Brothers	Clam Shell	106	39,000
Michigan	Drag Line	127	193,000
Illinois	Drag Line	106	22,000
Moody Barge	Clam Shell	62	4,000
		Total Production cy	**288,000 est.**

Table A- 15. Production Rates for North SAC

Name of Dredge	Type of Dredge	Production cy/hr	Production cy
Clinton	Hydraulic	284	16,000
Cherokee	Hydraulic	228	90,000
Powel Brothers	Clam Shell	65	4,000
Michigan	Drag Line	153	110,000
Illinois	Drag Line	127	150,000
		Total Production cy	**370,000**

3.7.3.2.1 Port Everglades Side Slopes

189. When a channel or basin is deepened, its walls will attempt to stabilize by achieving a natural slope. The grade of the natural side slope depends on characteristics of the materials that comprise it and environmental factors such as wave and current conditions. Time also has an impact as all slopes will degrade to some degree over an extended lifetime.

190. There are three principal reasons side slopes must be identified. First, the side slope chosen must be flat enough to prevent excessive erosion or sloughing of the side slope that would cause shoaling to obstruct the navigation channel. Second, the effective side slope may undermine structures or affect land use. Third, sideslope determination is critical for defining the dredging prism; the fully defined dredging prism is a key element of the dredging quantity calculations.

191. It should be noted that a specified or design side slope does not always correspond to the natural or effective side slope. Often side slopes are specified for economic or environmental reasons. For the present study, however, design side slopes were specified based on the natural side slope as determined though investigation of the existing channels and basins. The exception occurs in areas with hard materials where a 0.5H:1V is specified as a "vertical" cut. Note that it is not practical to excavate a side slope to the specific dimensions of design template. Instead, the dredger performs a box cut into the side slopes to achieve the required grade along the edge of the channel. Typically, in order to achieve grade along the edge of a channel, the dredger must excavates outside the theoretical channel template allowing the material to slope downward.

192. The following are design side slopes for Port Everglades:

- **OEC, IEC, MTB, STB, and Widener:** These areas will maintain a 3 horizontal on 1 vertical side slope (3H:1V) except in reef and rock areas where a slope of 0.5H:1V is specified. The rock layer in the OEC and IEC is relatively uniform at an elevation of -48 ft-MLLW. Therefore slopes in the OEC and IEC are expected to transition from 0.5H:1V to 3H:1V at this interface.

- **SAC, TN:** 2H:1V side slopes are predicted based on previous excavations.

  Note: Theoretically the SAC can be designed based on 1.5H:1V side slopes if the dredger is prevented from excavating beyond the template. In practice, it would be virtually impossible to achieve grade along the edge of the channel without the excavation allowance.

- **DCC:** There is limited Geotechnical data available to determine a design slope along the DCC. It is anticipated that the geology along the DCC will be similar to the geology along the SAC. Therefore a design slope of 2H:1V can be considered. This slope is also considered appropriate as a transitional slope between the deeper depths within the project and the more shallow depths of the existing channel to the west of the project boundary. Variable flow within the DCC and potential head cutting up the canal was taken into account in reaching this conclusion.

3.7.3.3 Blasting

193. Areas requiring blasting can be identified as (1) areas documented by core borings to contain hard massive rock, (2) areas of high punch barge use during the 1980's deepening, and (3) areas of low production in the 1980's deepening.

194. Based on evaluations of the core boring logs, punch barge usage, and low production rates the following is an evaluation of the blasting requirements for the current project:

- **OEC and IEC:** The entrance channels can be excavated without blasting through the use of a rock cutting hydraulic dredge.

- **MTB, STB, and NTB:** A significant quantity of rock will require blasting in these main harbor areas. In general there is a wide ridge of hard massive rock that extends in a north-south direction from NTB, through the MTB, and through STB.

- **Widener, SAC, and TN:** 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 cutting hydraulic dredge. It is possible that harder more massive rock could be encountered at lower elevations that would require blasting for economical excavation.

- **DCC:** Although Geotechnical data is limited in the DCC, preliminary analysis indicates that materials can be dredged in the future deepening of the canal by using a rock cutting hydraulic dredge. It is possible that harder more massive rock could be encountered at lower elevations that would require blasting for economical excavation.

195. Several considerations must be taken into account during the blasting process. Core borings in areas where blasting may be anticipated will have to be carefully drilled and logged. The recovery, the RQD, and the drill time per foot must be documented. Maximizing the recovery in the rock mass is important. Voids, seams and/or layers of sediments or soft rock within the rock mass must be documented when possible. Borings within the rock mass must to be drilled at least 7 feet below the proposed grade. The reason for the above considerations is that blasting is extremely sensitive to weak or soft zones. The power of the blast can bleed off into the weak zones or sediment layers and prevent fragmentation of the rock mass. Although blasting techniques can be used to compensate for these conditions, their presence can significantly affect the cost of blasting.

196. Environmental considerations are also a factor that must be considered during the blasting process. Areas requiring blasting at Port Everglades have been designated as manatee refuge areas during the winter months from November 15 through March 31. Although few manatees are known to reside in Port Everglades during the summer months, a marine wildlife protection program is necessary to protect any manatees that might be in the area during underwater blasting. Further details are available in the Environmental Impact Statement (EIS).

197. The blasting program for the Port Everglades project shall include a Safety Blasting Plan and an Operational Blasting plan, to be reviewed by USACE.

198. In addition seasonal restrictions and business hours for blasting operations, the Blasting Program shall comply with all current county, local, state, and federal regulations. County regulations will govern and dictate maximum peak particle velocity and water borne overpressures.

199. The final limestone removal thickness will be determined based on data to be obtained from future geotechnical investigations, current hydrosurvey data, and current project depths for the channel. Project overdepth and allowable overdepth is 1-ft.

200. Rock blasting assessment for Port Everglades shall take into consideration core borings located within the proposed dredging area. Therefore, the proposed blasting operation shall be calibrated to actual geological conditions of the blasting areas defined based on the new geotechnical investigation and most current PED.

201. The Contractor shall obtain rights-of-entry to the pre-blast survey locations. The pre-blast survey shall become part of the operational blasting plan.

202. A test blast plan shall be a requirement in the specifications of the project and shall be incorporated into the Blasting Program. It shall be developed by the Contractor as part of the Blasting program and also include the planned test patterns and weights of explosives of each

test blast with anticipated peak particle velocities and pressures at structures most likely to receive damage from the test blast.

3.7.3.4 Disposal

203. Three disposal methods were initially considered for Port Everglades material: beach disposal, offshore disposal, and upland disposal.

204. Beach disposal consists of using excavated materials as beach fill. While approximately half of excavated materials at Port Everglades will be sand sized, these materials will contain gravel components, pockets of silt, and limited deposits of peat. In addition, excavation of hard massive rock areas will result in a mixture of sandy gravelly materials, cobbles, and boulders depending on the method of excavation employed. Individual material components cannot be selectively excavated and therefore require processing to be used as beach fill. Processing would consist of screening out any gravel (+1 inch) and removing all silts and peat deposits, resulting in slightly gravelly-fine to coarse-grained sand.

205. Offshore disposal consists of excavating materials, for instance using a clamshell dredge or cutter-suction dredge, placing it on barges, and towing the barges to a designated offshore dredged material disposal site (ODMDS). In 2004 an ODMDS site was designated 4 miles northeast of Port Everglades (Figure A- 58). Based on numerical modeling prior to designation, disposal capacity is limited to 500,000 cubic yards per event. As the volume of material for this project is expected to exceed this cap, efforts to expand the disposal site and redefine the capacity are underway and are expected to be complete before the final Feasibility Study is completed.

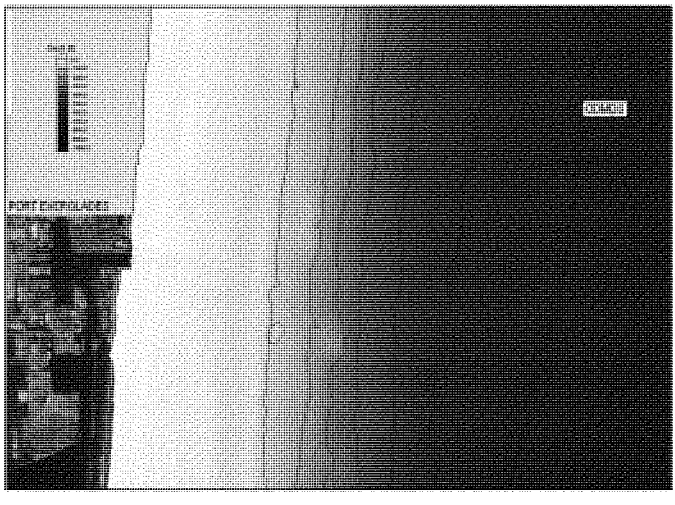


Figure A- 58. Port Everglades ODMDS Location

206. Upland disposal is a third option. This option consists of excavating material using a cutter suction dredge, clamshell dredge, or other type of dredge and transporting the material to a diked upland disposal site. Two upland sites were originally identified, just north of the Dania Cutoff Canal. Site 1 was a single use site located at the southwest corner of Port property. During the early stages of the study, Site 1 measured 62 acres offering approximately 1 million cubic yards of storage, but later evolved into 107 acres with a capacity of 3.2 million cubic yards (Figure A-59). Site 2 was a 64 acre site located on Airport property (Figure A- 60) expected to provide a capacity of approximately 1.6 million cubic yards. Although originally designated as a multiple use site, plans to expand the Airport's runway system made it necessary to designate Site 2 as a single use site.

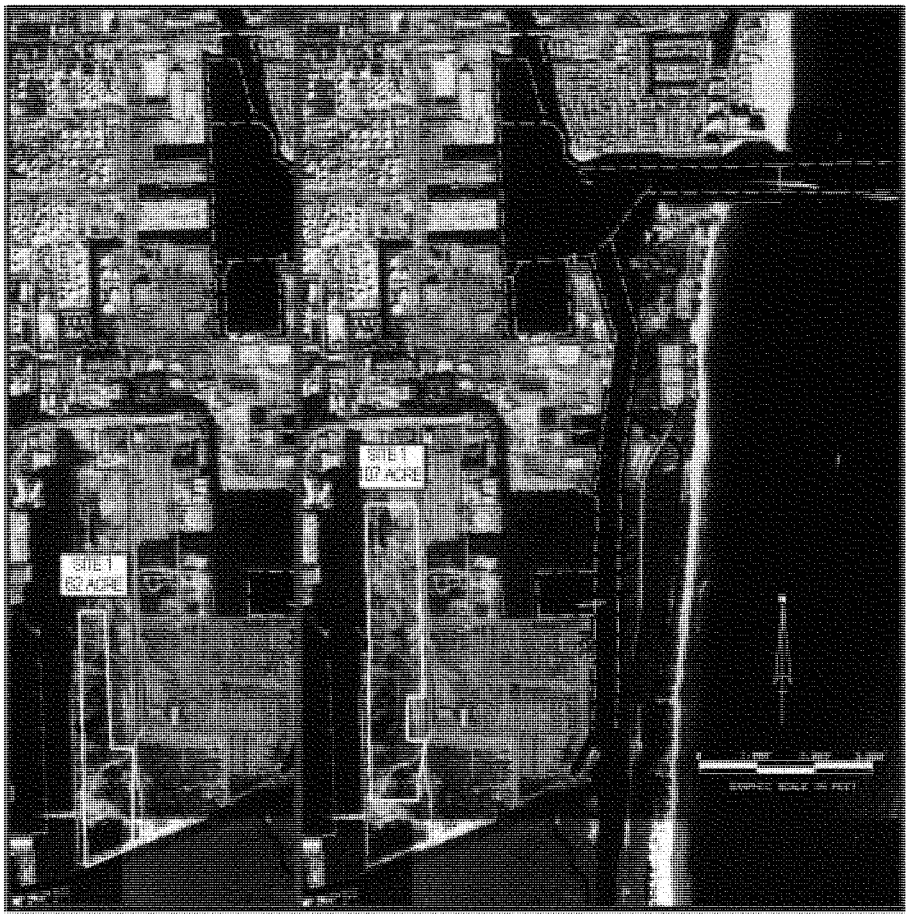


Figure A- 59. Disposal Site "Site 1" (2 Alternatives) Located at Port Everglades

Figure A- 60. Disposal Site "Site 2" Located at Fort Lauderdale Airport

207. 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 disposal sites. Therefore, Site 1 and Site 2 disposal areas have been removed from further consideration. Because there were no other viable upland alternatives in the heavily developed study region, upland disposal was removed entirely as a disposal option.

3.8 STRUCTURAL DESIGN AND CONSTRUCTION

3.8.1 GENERAL

208. In general, the Corps does not specify types of equipment and construction methods within its specifications. In general, the Corps does specify the result of the construction work though detailed plans and specifications. It is during the Request for Proposal (RFP) process, conducted prior to award of the construction contract, that an in-depth evaluation of a potential contractor's proposal will occur. This includes complete technical review of construction equipment and proposed methodologies. Therefore, for purposes of this report, only generic information will be provided as to the nature of construction and the types of equipment that may be employed. Additional discussion on potential construction techniques can also be found in the Environmental Impact Statement (EIS).

3.8.2 CHANNELS AND BASINS

3.8.2.1 Dredging and Disposal

209. As previously discussed, a majority of the material to be dredged can be removed without blasting. The specifications should limit the extent of blasting as much as possible through appropriate language. For environmental reasons, it is preferred that blasting occur only when excavation cannot be accomplished with hydraulic or mechanical dredging equipment. Such equipment may include a hydraulic pipeline dredge with a rock cutterhead or certain types of clamshell dredges that can effectively excavate the layered material. Use of small or inappropriate dredges may 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 and this possibility should be left open in the project specifications.

210. The type of dredge(s) used will affect methods used to convey the material to the disposal sites. For offshore disposal, split hull or similar barges will most likely be used.

211. It is almost certain that some material will require blasting. The EIS provides detailed information regarding blasting process. Included are items that will be incorporated into the project specifications. Additional core borings during PED will help further quantify specific areas of massive hardened materials prior to final design and construction.

3.8.2.2 Sideslope and Land Excavation

212. Based on evaluation of historical channel slopes, sideslopes excavated along John Lloyd Park (SAC) are expected to hold a slope of 2:1. To avoid further impacts to the Park, waterborne construction methods such as the use of a dredge (to cut the slope in a tiered fashion) will be employed. Excavated material will be placed into barges, pumped to the disposal sites, or placed in trucks. Although not likely, the use of cofferdams or shoring may be employed.

213. Excavation into areas with less restrictive access will employ land based construction

methods. Land based methods may include the use of truck mounted or crawler cranes with a clamshell attached, use of a Grade-all, use of loaders or dozers, or similar equipment. Primary landside removal activities include excavation of a new USCG basin and excavation of Port property for modification of the TN.

3.8.3 BULKHEADS

3.8.3.1 Port Bulkheads

214. Broward County Port Authority will be responsible for structural designs for all port toewall and bulkhead systems. Based on the most recent structural report (Halcrow Inc., 2010), it is assumed that any Port bulkhead that has exceeded its design life of 40 years will be replaced prior to construction of the Federal project. An exception to this is made in cases where the Port's Master Plan indicates relocation or modification of the impacted bulkhead. For these cases towalls will be constructed to accommodate the deeper project depth. Any deepening required to accommodate the project depth will be an element of the Federal project. In regions where bulkheads have not exceeded the 40 year design life, toewalls will be constructed to accommodate the deeper project depth. Table A- 16 provides a summary of potential bulkhead impacts due to the Federal project. It should be noted that although berths 24 through 29 fall within the Federal project they are not included in Table A- 16. Because these berths can already accommodate the design cruise ship draft, they will not be deepened beyond their existing depths. The 160 foot distance between the bulkhead and the channel at these locations prevents the existing bulkheads from being impacted by the proposed deepening.

Table A- 16. Port Bulkhead Impacts

Project Component	Impacted Bulkhead (by Berth)	Bulkhead Age		Required Action
		< 40 yrs	> 40 yrs	
OEC	---			---
IEC	---			No existing bulkheads
MTB	7 - 8		X	Bulkhead modification in Master Plan; Construct toewall to stabilize
	9 - 10		X	Bulkhead relocation in Master Plan; No Federal action
STB*	16 - 19		X	Bulkhead to be replaced prior to Federal Project; No Federal action
Widener	---			No existing bulkheads impacted
SAC	31 - 32	X		Construct toewall to stabilize bulkhead
TN	30	X		Bulkhead modification in Master Plan; No Federal action
DCC*	New			Construct new bulkhead
* Note that the STB and DCC project components were removed from consideration during the course of the study. Bulkhead information for these components is included here for completeness of project component documentation.				

3.8.3.2 Park Bulkheads

215. In order to minimize environmental impacts to sensitive species and habitats, an environmentally friendly sheet pile bulkhead (EFB) system (Figure A- 61) was developed. The proposed bulkhead system uses a toe wall bulkhead that eliminates the need for tie backs. This significantly reduces construction impacts to adjacent lands. The design also includes a sloped rubble cap to allow flushing into adjacent mangroves areas. This will aide in the establishment of a healthy habitat and enhance survival of newly planted growth and/or growth disturbed by channel improvements.

216. In order to construct the steel sheet pile bulkheads, pile driving equipment will be required. Bulkheads along the SAC and DCC 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-splitting of the rock will be required. Pre-splitting of rock will be accomplished through blasting.

217. The bulkheads shall be in place prior to the channel excavation. Land side construction equipment will not be used because there is no access to the site at these locations for such equipment.

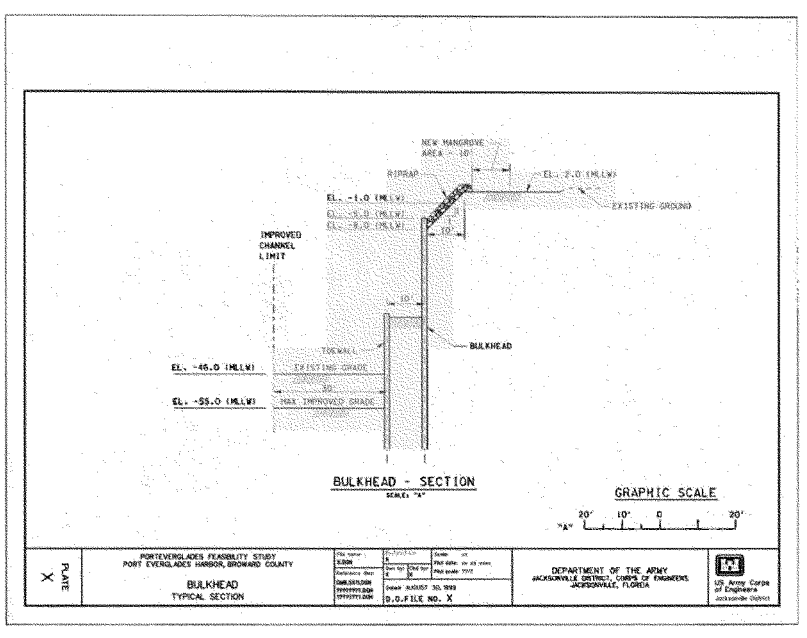


Figure A- 61. Initial Bulkhead Design

3.8.3.3 USCG Basin Bulkheads

218. The extent and type of bulkhead relocations required for the USCG basin were estimated based on the USCG reconfiguration plan presented in Sub-Appendix B. USCG Basin bulkheads 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. Further details for the USCG basin bulkheads are provided in Section 3.9 (Civil Design of USCG Facility Reconfiguration).

3.8.3.4 Staging Areas

219. It is the Contractor's responsibility to arrange for staging area(s). The staging area(s) will have to be defined early in the plan and specification preparation phase for each contract. The Contractor will need to secure sufficient land to: install construction trailers, park vehicles, stage dredging and construction equipment. The staging area will have to have navigable water access to allow the contractor to use work boats to shuttle the crew to the dredge(s). One or more mooring areas will need to be provided for the dredge(s).

3.8.4 UTILITY RELOCATIONS

Preliminary investigations indicate that Florida Power and Light (FPL) maintains a single cable crossings within the project area (Figure A- 62). The crossing occurs at the SAC running between Berth 27 and John U. Lloyd Park. Cable at this crossing is currently laid on the existing channel bottom. However, in the fall of 2014, FPL will relocate this crossing to a depth beyond the maximum channel depth of the project area. No additional relocation of this crossing will be required.

220. Utility relocations will also be required in conjunction with reconfiguration of the USCG basin. Utilities to be relocated include electric cables and service boxes, water lines, sewer systems, telephone lines, and fuel pumps. All utility relocations will be in accordance with USACE permit guidelines.

3.8.5 NAVIGATION AIDS

221. The U.S. Coast Guard 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 U.S. Coast Guard indicate that navigational aids may include, but are not limited to, 2 additional buoys in the OEC, 2 navigation lights in the Widener.

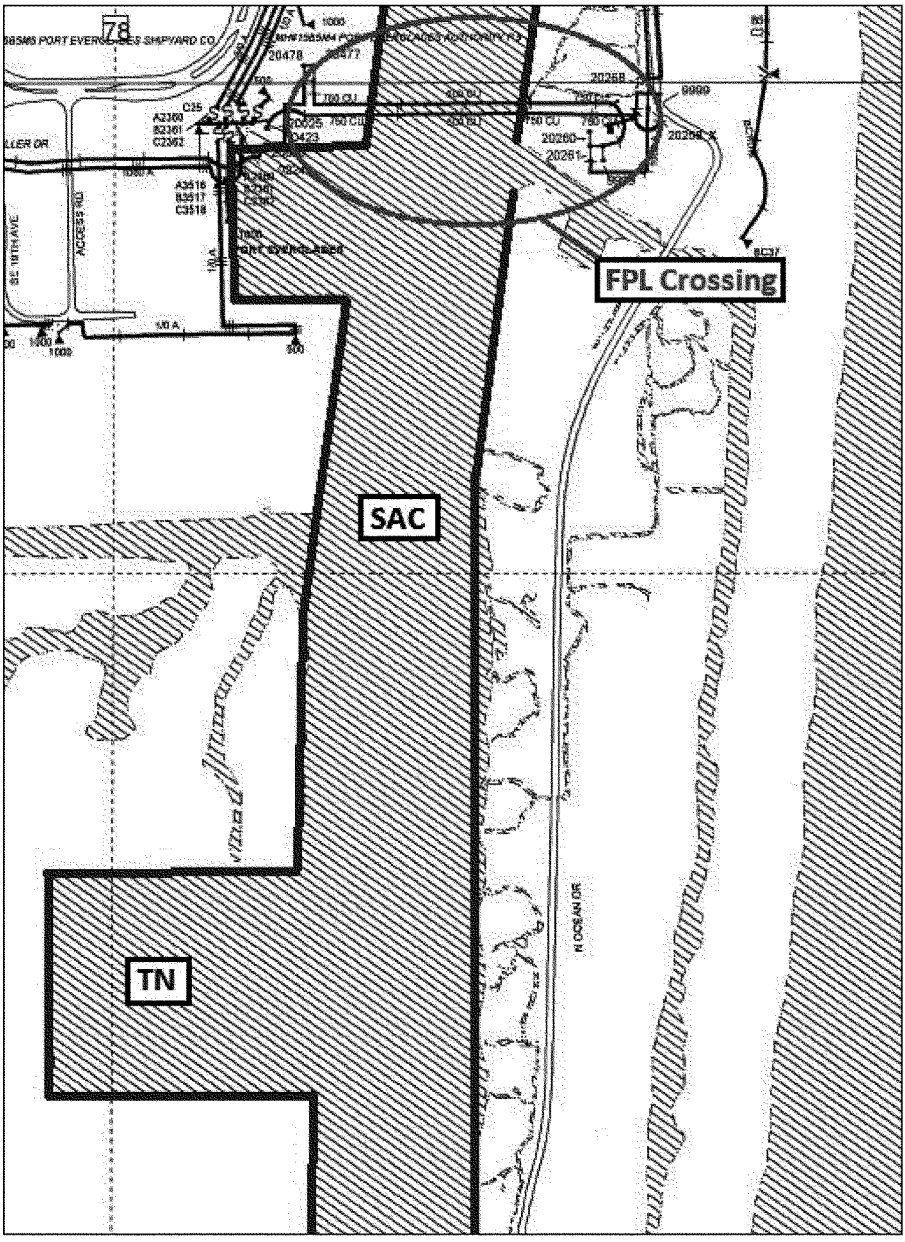


Figure A- 62. FPL Utilities

3.9 CIVIL DESIGN OF USCG FACILITY RECONFIGURATION

222. As previously discussed, the USCG boat basin at Port Everglades will require reconfiguration to the east on existing USCG property to allow for SAC improvements. The Preliminary design calls for the removal of existing USCG bulkheads and the excavation of approximately 1 acre of the existing USCG facility, presently occupied by boat maintenance sheds, the station's administration building, a multipurpose building which includes berthing, a heliopad, a fueling station, various parking areas, connecting roadways, and part of an open grassy field. All facilities are to be reconfigured to positions consistent with USCG operational requirements. All connecting roadways will be rerouted and new parking areas provided.

3.9.1 USCG BASIN

223. Based on existing bulkhead designs and proposed dimensioning, three bulkheads types were determined for the relocated USCG boat basin. The first (Figure A- 63) is a bulkhead/buttress combination developed for a maximum design water depth of –52 ft-MLLW. Surfacing on the bulkhead aides in the damping of wave energy, reducing reflection. This bulkhead, designated Typical Section 1, will be applied to the outer breakwater of relocated basin as well as the eastern interior wall the basin (adjusted for a project depth of -14 ft-MLLW). The second bulkhead (Figure A- 64) is a bulkhead/anchor wall combination capped with a slope of rubble wave absorber. This bulkhead, denoted Typical Section 2, was developed for a project depth of -14 ft-MLLW and will be placed at the northern/eastern interior of the entrance channel as well as the south side of the interior basin. The third bulkhead (Figure A- 65) is a solitary bulkhead developed for a project depth of –14 ft-MLLW. This bulkhead, designated Typical Section 3, will be placed along the north interior of the basin. Bulkhead locations along the proposed USCG basin are shown in Figure A- 66.

3.9.2 UNIT PRICE COST ESTIMATES

224. Incremental unit price cost estimates were preformed for all of the plans detailed previously in Table A- 12. Although it has previously been stated that some of these plans were eliminated, this occurred after the incremental cost analysis was completed. For completeness and consistency these plans will be included in the incremental cost analysis discussions.

225. Unit price cost estimates include the following: mobilization/demobilization, drilling and blasting, dredging and disposal, bank stabilization, lands and damages, environmental mitigation, aids to navigation, and associated general costs (bulkheads, revetments, utilities, and relocations). Planning, Engineering, and Design (PED), Supervision and Administration (of construction work) (S&A) costs, and contingencies were included. For the incremental cost analysis PED, S&A, and all contingencies were represented as percentages of the total project cost. Detailed itemized PED and S&A estimates are included in the final cost estimate for the Selected Plan.

226. Incremental costs are presented in the Cost Engineering Appendix.

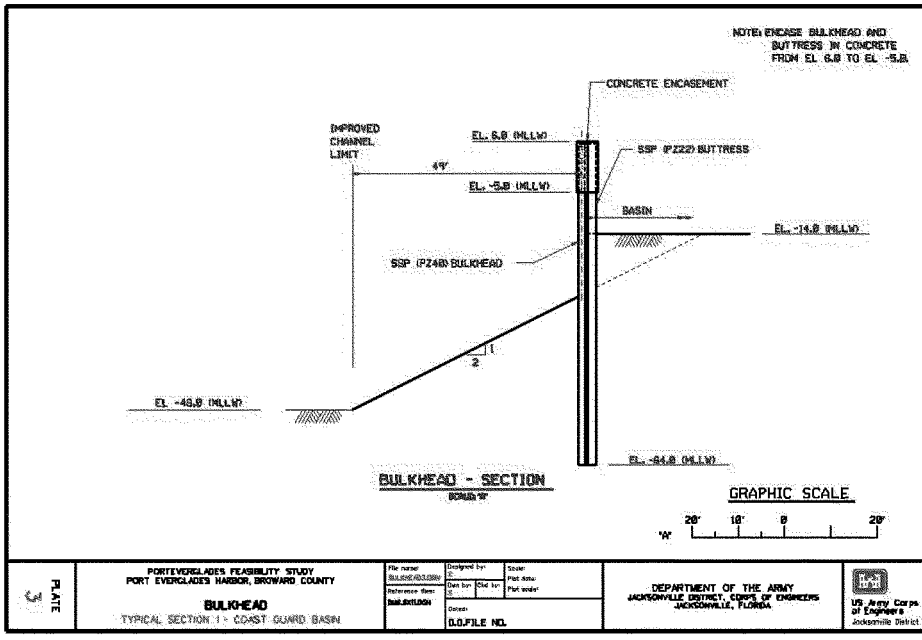


Figure A- 63. Preliminary USCG Wave Damping Bulkhead Design

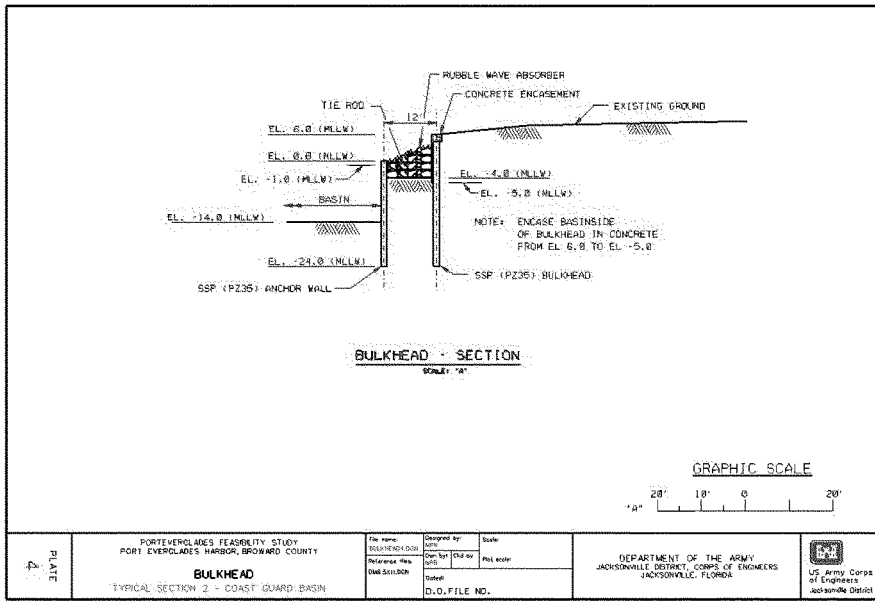


Figure A- 64. Preliminary USCG Wave Absorbing Bulkhead Design

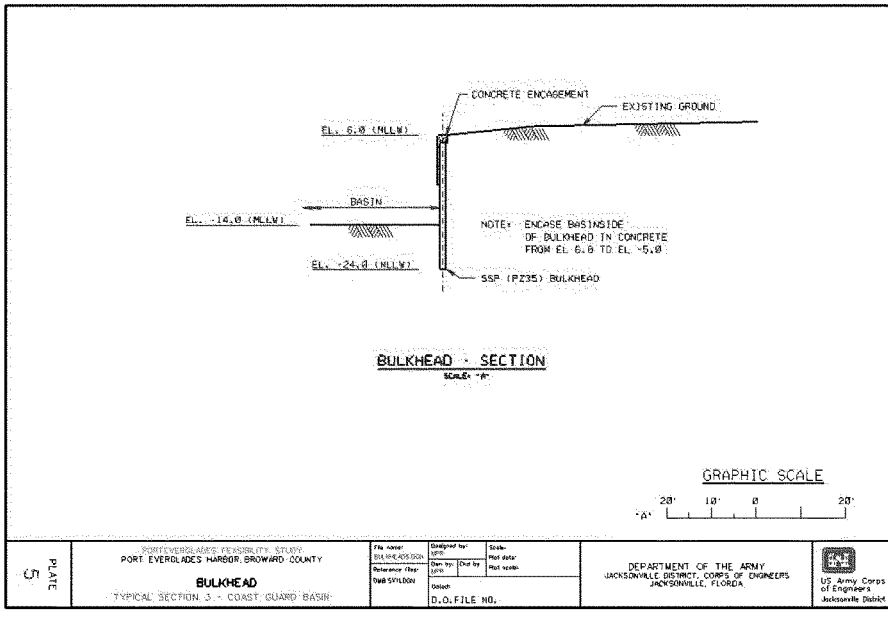


Figure A- 65. Preliminary USCG Interior Bulkhead Design

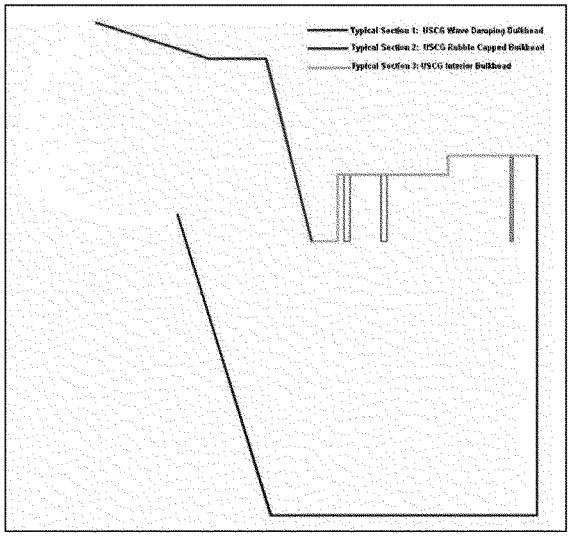


Figure A- 66. Locations of USCG Bulkhead Type

3.10 National Economic Development Plan

The National Economic Develop (NED) Plan maximizes net benefits while protecting the Nation's environment. Details of the NED Plan identification process can be found in Appendix B: Economics. Based on this analysis the NED Plan was identified as Plan 2E, which is described in Table A- 17.

Table A- 17. NED Plan - Summary

NED Plan Component	Description[1]
OEC	Extend OEC 2,200ft seaward, add an 800ft wide "flare", and deepen to -54 ft
IEC	Deepen IEC to -47 ft
MTB (Full)	Deepen MTB (existing Federal footprint) to -47 ft
Widener	Remove Widener shoal to –47 ft
SAC	Widen SAC in the vicinity of berths 23 to 26 and deepen to -47 ft
TN (S_TN)	Shave NE corner of the TN, widen SAC north and east of TN, and deepen to –47 ft
[1] All depths indicated are project depths. Add 1 foot for required overdepth and 1 foot for allowable overdepth.	

3.11 Selected Plan

227. The Port has indicated that they agree with all plan elements of the NED Plan with the exception of the design depth. The Port has indicated a locally preferred plan that increases the design depth throughout the project extents by an additional foot. Therefore, the Selected Plan that the Corps and Port will cost share in, seek permits for, and ultimately construct, reflects this additional depth (Table A- 18). The following section provides design details of the Selected Plan.

Table A- 18. Selected Plan - Summary

Selected Plan Component	Description[1]
OEC	Extend OEC 2,200ft seaward, add an 800ft wide "flare", and deepen to -55 ft
IEC	Deepen IEC to -48 ft
MTB (Full)	Deepen MTB (existing Federal footprint) to -48 ft
Widener	Remove Widener shoal to –48 ft
SAC	Widen SAC in the vicinity of berths 23 to 26 and deepen to -48 ft
TN (S_TN)	Shave NE corner of the TN, widen SAC north and east of TN, and deepen to –48 ft
[1] All depths indicated are project depths. Add 1 foot for required overdepth and 1 foot for allowable overdepth.	

4 BASIS FOR DESIGN OF SELECTED PLAN

4.1 TYPICAL CHANNEL CROSS-SECTIONS

228. The layout of the Selected plan is shown graphically in Figure A- 67and Figure A- 68. Figure A- 69 through Figure A- 71 shows typical channel cross-sections for the OEC, IEC, and SAC Project Components of the Selected Plan. Sections A-A and B-B depict deepening of the OEC, illustrating both the nearly vertical slopes that are predicted for reef and rock cuts and the natural side slopes expected to form in sand. Section C-C depicts a typical IEC cross-section. Section D-D depicts a typical cross section for expansion of the northern portion of the SAC, including the environmental bulkhead system along John U. Lloyd State Park. Section E-E depicts a typical cross-section for the southern portion of SAC, including natural side slopes to the east. All Port Bulkheads shown in these cross-sections are generic and are not to scale.

229. Figure A- 72 and Figure A- 73 provide the locations of typical cross-sections for the Widener Project Component. Section F-F (Figure A- 74) provides a sectional view of the proposed cut in the south portion of the Widener where landside slopes are unconfined by any existing bulkheads. Section G-G (Figure A- 75) provides a sectional view of the proposed cut in the north portion of the Widener where landside slopes are confined by existing bulkheads.

230. Figure A- 76 provides the location of a typical cross-section of the TN Project Componenet. Section H-H (Figure A- 77) provides a sectional view of the proposed cut in the TN from the EFB bulkhead to the north to the existing Port bulkhead to the south.

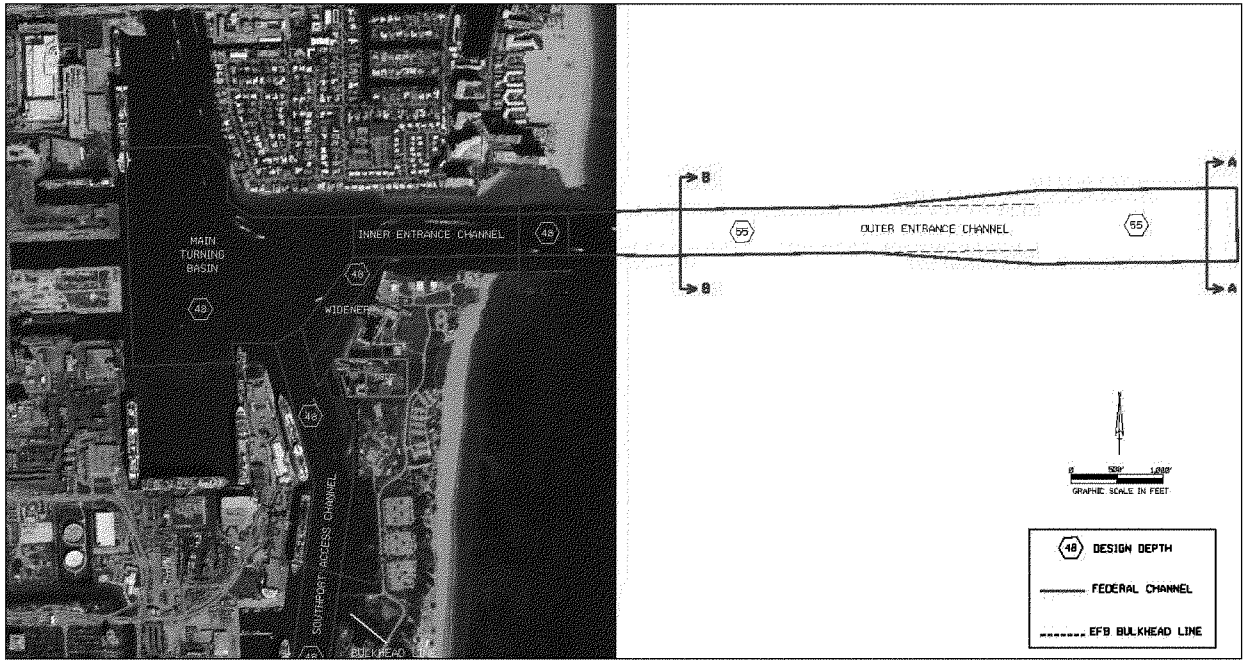


Figure A- 67. Port Everglades Selected Plan (North Portion)

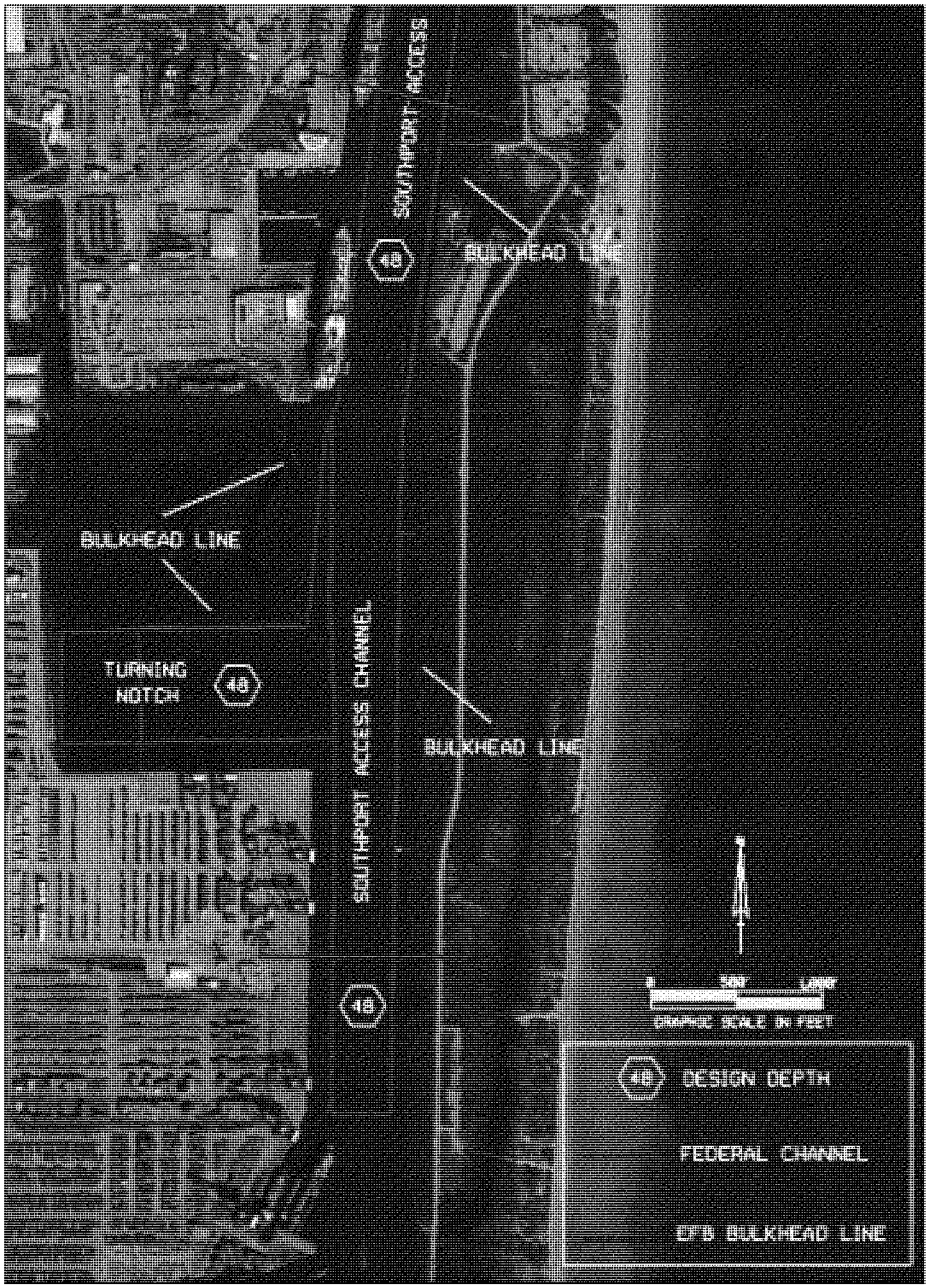


Figure A- 68. Port Everglades Selected Plan (South Portion)

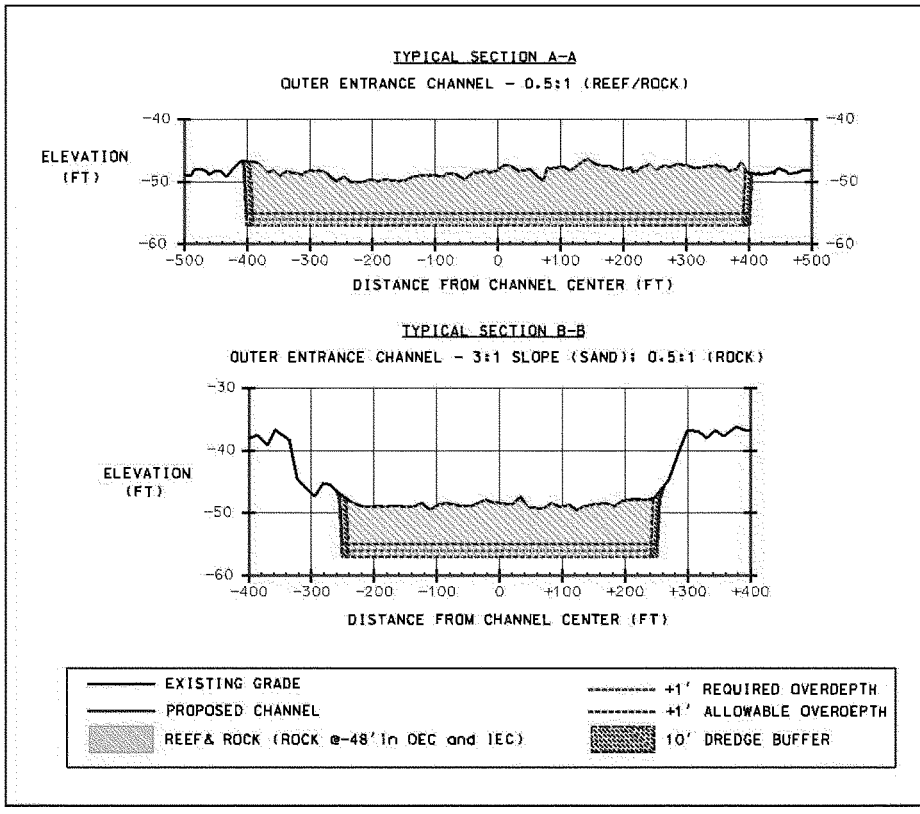


Figure A- 69. Typical Channel Cross-Sections: Outer Entrance Channels

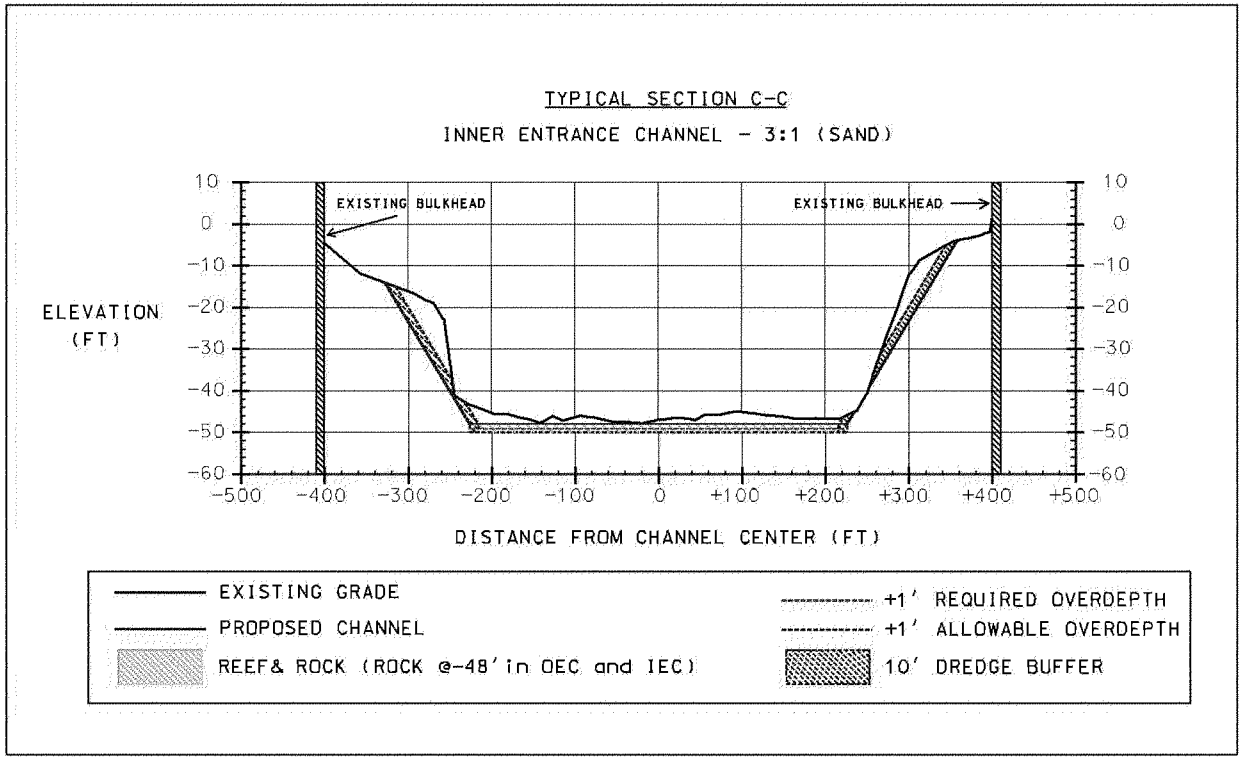


Figure A- 70. Typical Channel Cross-Sections: Inner Entrance Channel

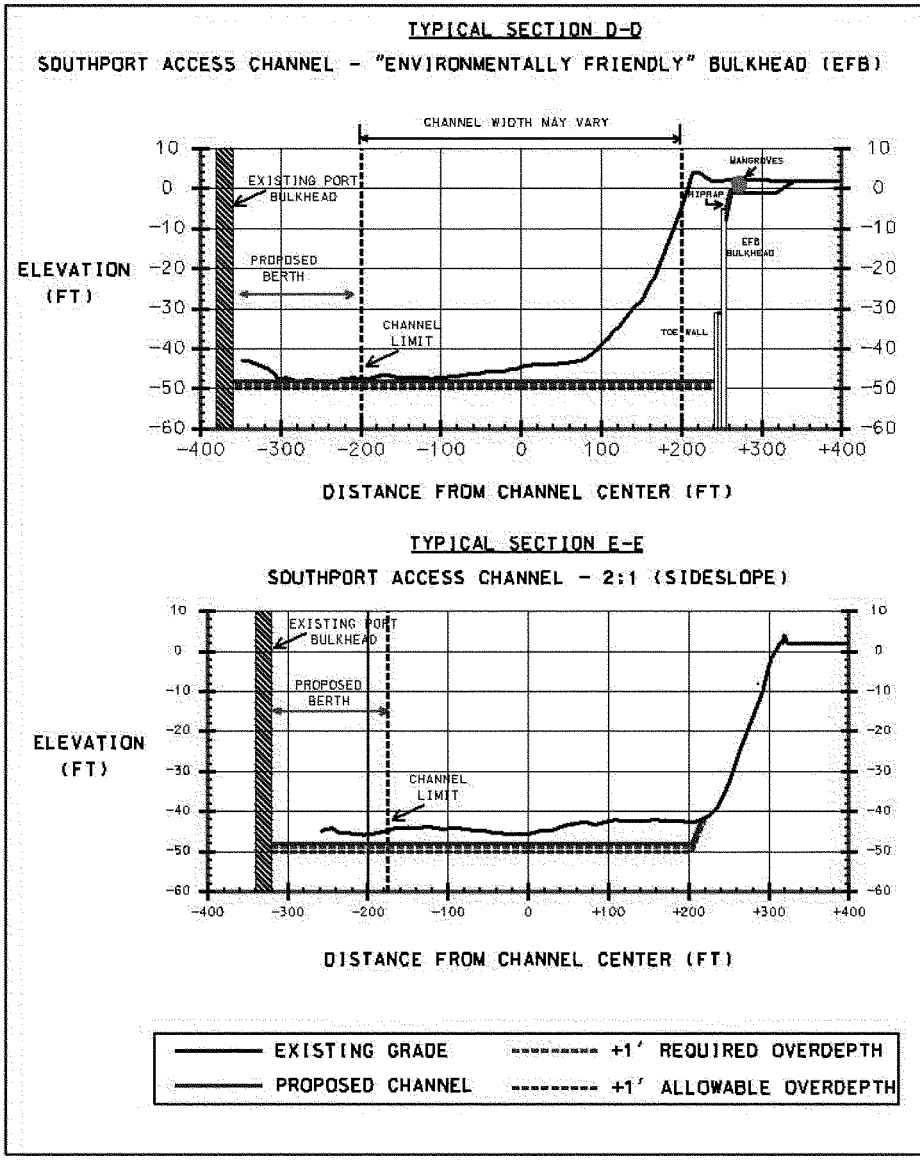


Figure A- 71. Typical Channel Cross-Sections: Southport Access Channel

Figure A- 72. Typical Cross-Section Location: Widener (Unconfined)

Figure A- 73. Typical Cross-Section Location: Widener (Confined)

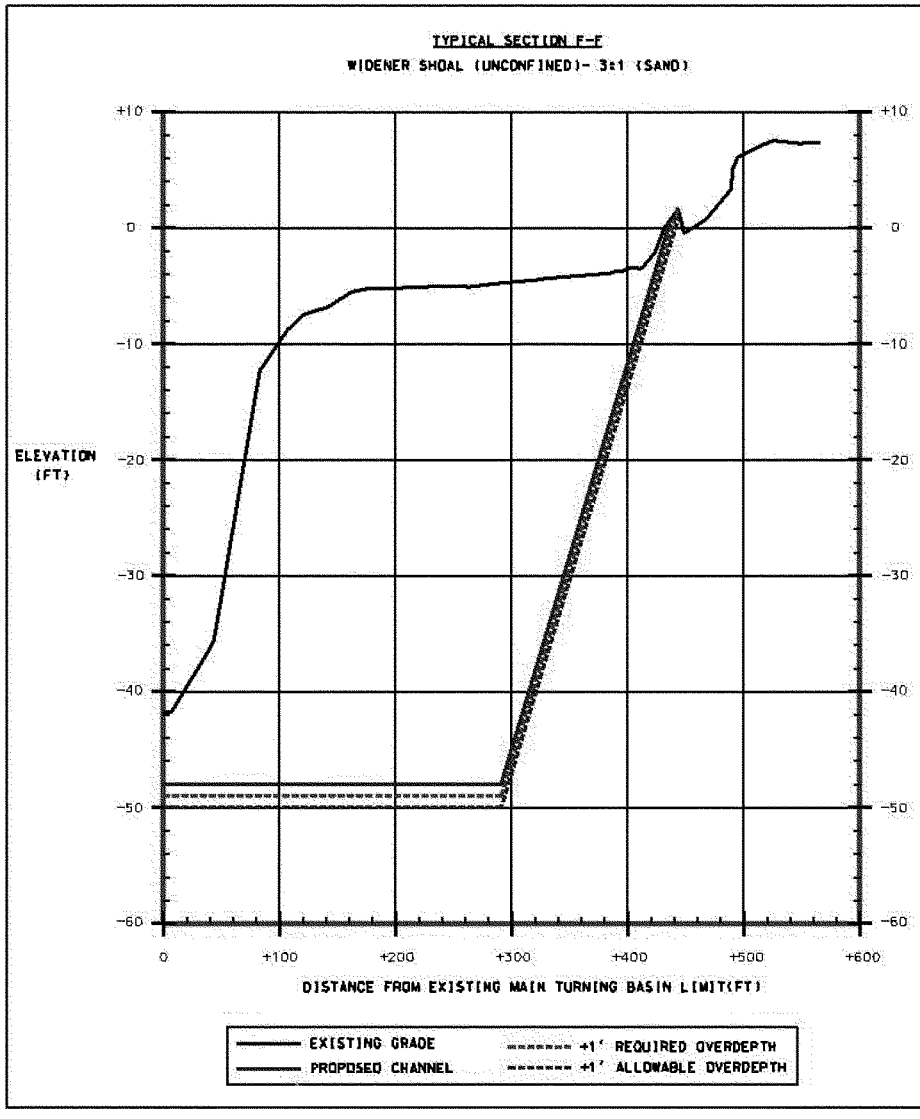


Figure A- 74. Typical Cross-Section: Widener (Unconfined)

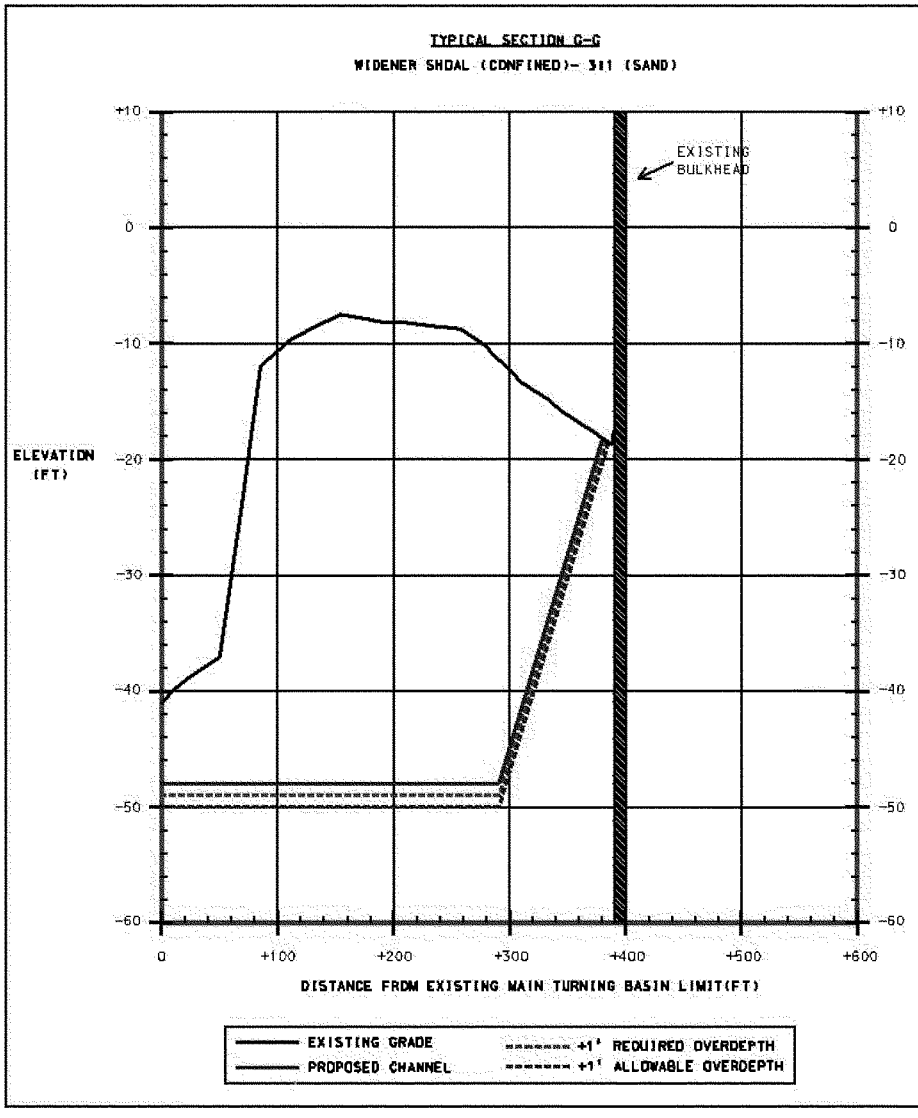


Figure A- 75. Typical Cross-Section: Widener (Confined)

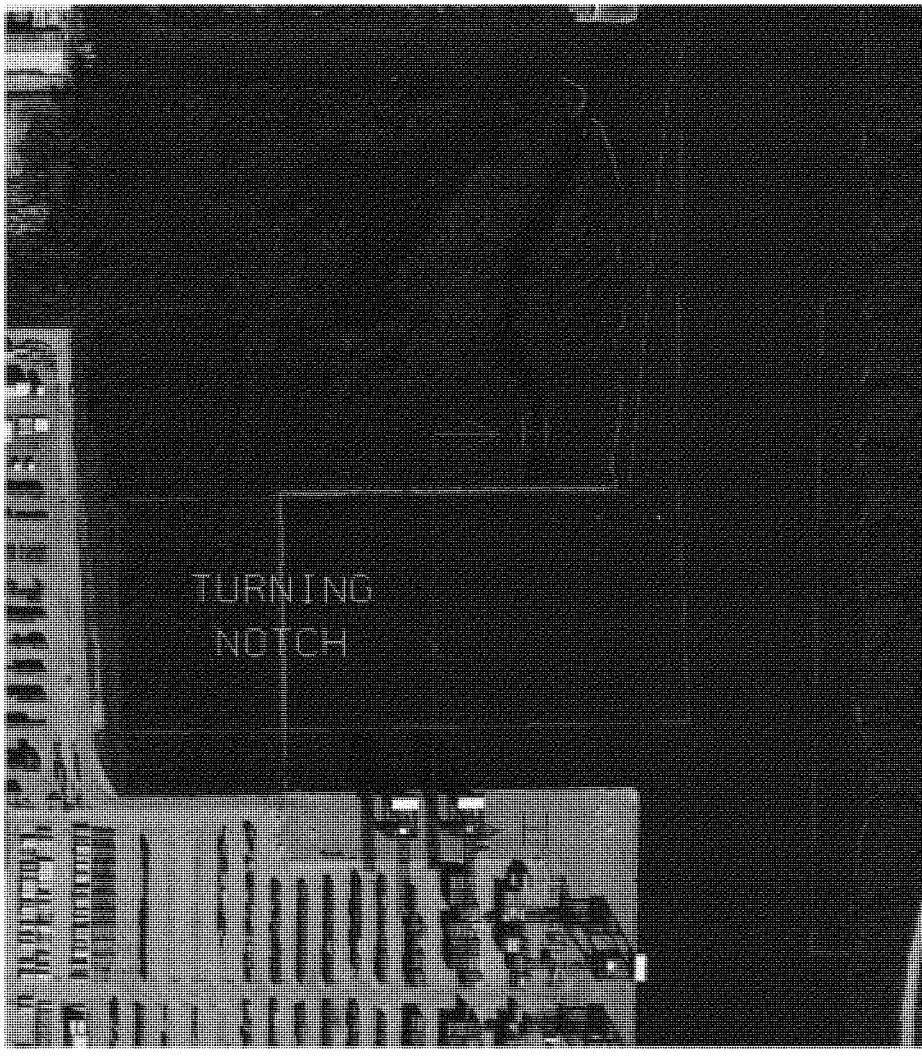


Figure A- 76. Typical Cross-Section Location: Turning Notch

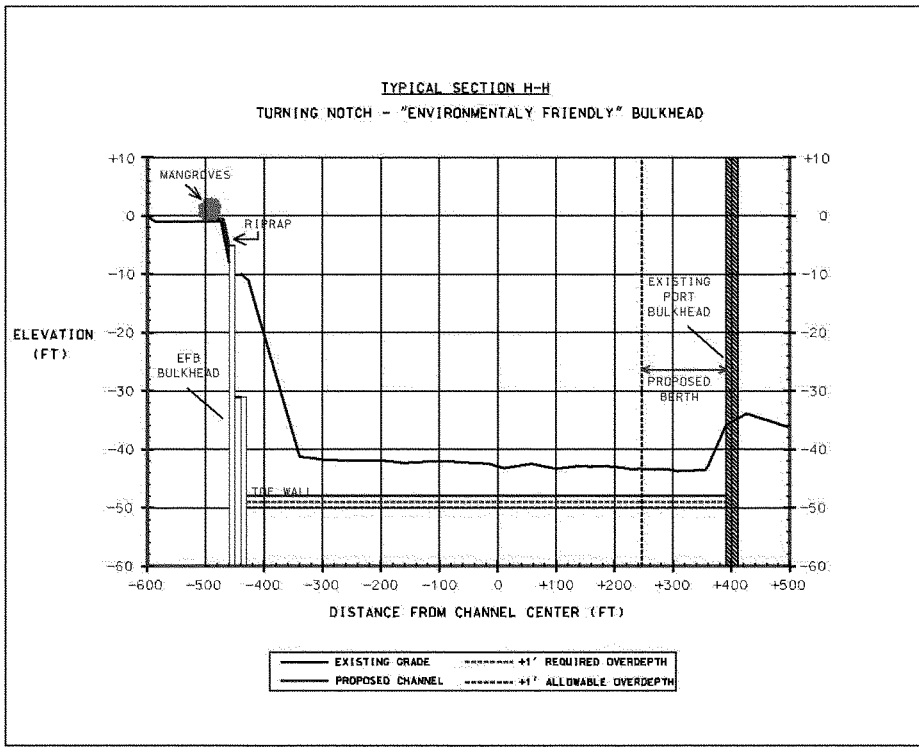


Figure A- 77. Typical Cross-Section: Turning Notch

4.2 STRUCTURAL DESIGN OF THE SELECTED PLAN

231. The Selected Plan requires the development of structural designs for the following bulkheads (by Project Component):

- MTB

  (a) Toewalls along Berths 7 and 8

- SAC

  (a) EFB bulkhead along eastern channel from USCG to John U. Lloyd Park, opposite of FP&L discharge canal (south end of Berth 29)
  (b) USCG bulkheads (USCG reconfiguration plan)
  (c) Toewalls along Berths 31 and 32

- TN

  (a) EFB bulkhead along north portion of TN (south side of conservation easement), west portion of SAC (east side of conservation easement), and east portion of SAC (John U. Lloyd Park, east of TN)

232. The conceptual location of all toewalls and EFBs are shown in Figure A- 78 and Figure A- 79. USCG bulkhead locations were provided previous in Figure A- 66. It is assumed that all toewall and bulkhead systems will be in place prior to dredging of the project channels. It is further assumed that existing channel access points (canals, creeks, marinas, etc.) will be taken into account during final bulkhead design and will remain accessible. Construction methodologies, equipment, and precise construction timeline for all toewalls and bulkheads will be the responsibility of the contractor.

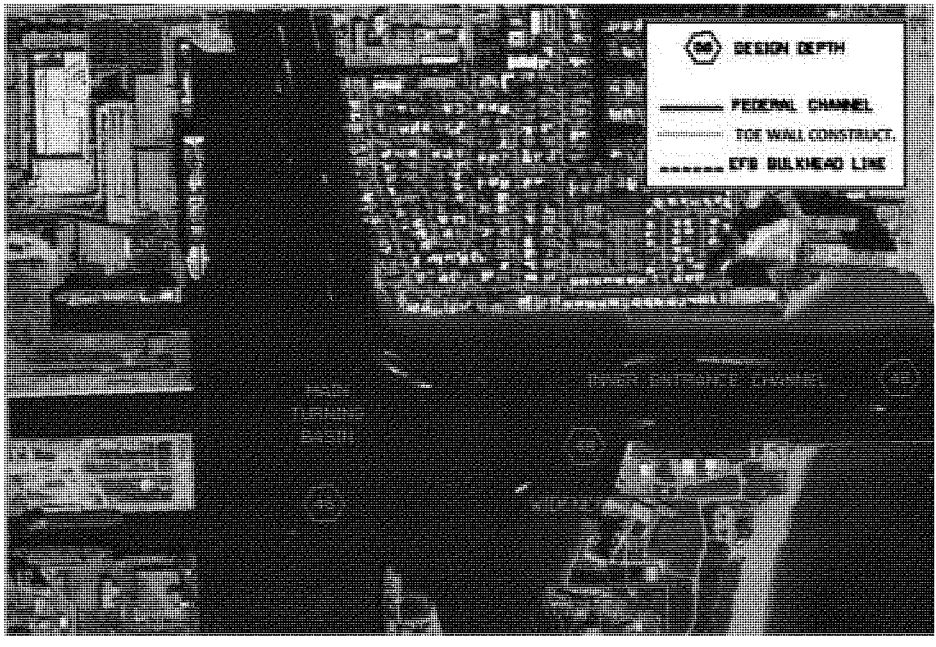


Figure A- 78. Toewall and EFB Locations (Conceptual) – North Selected Plan

Figure A- 79. Toewall and EFB Locations (Conceptual) – South Selected Plan

4.2.1 MAIN TURNING BASIN (MTB)

233. Broward County Port Authority will be responsible for structural designs for all port toewall and bulkhead systems.

4.2.2 SOUTHPORT ACCESS CHANNEL (SAC)

4.2.2.1 SAC - EFB Bulkheads

234. Expansion of the SAC in the vicinity of berths 24 through 29 requires a bulkhead along the eastern shore (John U. Lloyd Park) for slope stability. A single "environmentally friendly" bulkhead design (EFB) (Figure A- 80) was developed for this purpose. The following soil properties, provided by CESAJ-EN-GS, were used in the development of this design:

- Sand layer from top of ground to –60ft with a saturated unit weight of 125pcf and a friction angle (phi) of 30deg.
- Limestone from –60ft to –80ft with a saturated unit weight of 140pcf and a phi of 38deg
- Sand layer at –80ft and below with a saturated weight of 125pcf and phi of 34deg.

4.2.2.2 USCG – Bulkheads

235. Figure A- 63 through Figure A- 65 (previously shown in Section 3.9.1 USCG Basin) provide details of the three bulkhead designs to be incorporated into the USCG station reconfiguration. The following soil properties were used in the development of the USCG bulkhead designs:

- Sand layer from top of ground to –60ft with a saturated unit weight of 125pcf and a friction angle (phi) of 30deg.
- Limestone from –60ft to –80ft with a saturated unit weight of 140pcf and a phi of 38deg
- Sand layer at –80ft and below with a saturated weight of 125pcf and phi of 34deg.

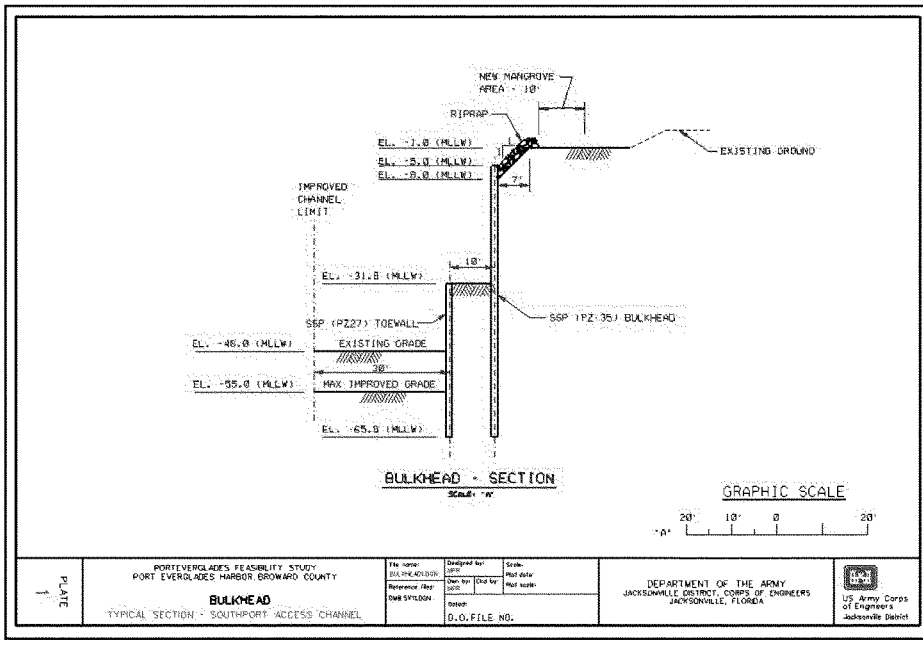


Figure A- 80. SAC – EFB Bulkhead Design

236. The following assumptions were also made during the development of the USCG basin bulkheads:

- No mooring directly at the bulkheads. Therefore, bulkheads were not designed for boat loadings.
- Soil profile on the channelside of exterior bulkhead was assumed to slope up from a depth of –48ft to a depth of –10ft on a 1 vertical on 2 horizontal (1V:2H) slope. The –10 ft basin represents the depth of the existing USCG basin which will not be raised with fill material after removal of present bulkheads.
- A 300psf construction surcharge loading was assumed for the installation of the USCG basin bulkheads along shore.

4.2.2.3 Port – Toewalls

237. Broward County Port Authority will be responsible for structural designs for all port toewall and bulkhead systems.

4.2.3 TURNING NOTCH (TN)

4.2.3.1 TN - EFB Bulkheads

238. Expansion of the TN and SAC (associated with the TN component) requires bulkheads along the north of the TN (south edge of the conservation easement), a western portion of the SAC (west edge of the conservation easement), and the western shore (John U. Lloyd Park) opposite the TN for slope stability. The "environmentally friendly" bulkhead design (EFB) (Figure A- 80) previously discussed for the SAC will be implemented as part of the TN component design as well. Design and construction of the segment of EFB along the northern portion of the TN is a future without project condition as is the responsibility of the Port Authority. The following soil properties, provided by CESAJ-EN-GS, were used in the development of bulkhead design:

- Sand layer from top of ground to –60ft with a saturated unit weight of 125pcf and a friction angle (phi) of 30deg.
- Limestone from –60ft to –80ft with a saturated unit weight of 140pcf and a phi of 38deg
- Sand layer at –80ft and below with a saturated weight of 125pcf and phi of 34deg.

4.2.3.2 Port – Toewalls

239. Broward County Port Authority will be responsible for structural designs for all port toewall and bulkhead systems.

4.3 CONSTRUCTION OF THE SELECTED PLAN

4.3.1 QUANTITY CALCULATIONS – SELECTED PLAN

240. A Triangulated Irregular Network (TIN) model was created for the study area using available hydrographic and topographic surveys (Section 3.6.2 Hydrographic and Topographic Surveys – Existing Conditions). TIN surfaces were created for the Selected Plan using INROADS software via wire frame and roadway modeler methods. INROADS was used via the triangle volume method to calculate dredge quantities. The quantity of material requiring blasting was estimated based on hard material mapping provided by CESAJ-EN-GG, which were converted to percentages (Section 3.7.2 Material Types).

4.3.2 PHASING OF CONSTRUCTION

241. The phasing, or number of contracts, required to complete this project will be contingent on the RFP process. Construction methodologies, equipment availability, and construction window compliance may result in multiple contracts being required. Additionally, due to the fact that total project cost exceeds $300,000,000, there is a strong possibility that construction will have to be phased into several contracts to meet Corps and Port funding constraints. Because

available data is insufficient at this time to determine the precise number of contracts that will be required, a single continuing contract is assumed. This will allow the contractor to group like items, to meet Port implementation schedules, and to reduce mobilization and demobilization costs. Bid items for setup/setdown can be placed as second year bid items within the continuing contracts. It should be noted that construction phasing and schedule may increase or decrease based on available resources and funding.

242. Table A- 19 provides information on the currently proposed construction order for the project components under a single contract. Note that this proposal assumes that dredging will be implemented consecutively, with excavation occurring in a single project component at a time. However, actual construction may include dredging of project components concurrently, reducing the overall construction timeline. Sequence of construction will be resolved during the RFP process. Additional details regarding project phasing will be presented in Section 4.5 (MCACES Estimates of the Selected Plan).

Table A- 19. Proposed Construction Phasing

Location	Depth	Channel Quantity[1] (cy)	Berth Quantity (cy)	Site	Start Year	Contract No.
ODMDS Designation	---	----	----	---	Year 1	1
Plans & Specifications	---	----	----	---	Year 2	1
Outer Entrance Channel	55	1,057,062	0	ODMDS	Year 3	1
Inner Entrance Channel	48	307,693	0	ODMDS	Year 4	1
Widener	48	996,245	0	ODMDS	Year 5	1
Main Turning Basin	48	700,734	146,286	ODMDS	Year 5	1
Southport Access Channel	48	1,571,500	40,004	ODMDS	Year 6	1
Turning Notch	48	608,528	42,497	ODMDS	Year 8	1
[1] Quantities include maintenance material and required and allowable overdepth						

4.4 MAINTENANCE

4.4.1 MAINTENANCE OF THE EXISTING PROJECT

243. The existing Federal navigation project at Port Everglades requires maintenance of existing channels and basins.

244. provides maintenance dredge quantities based upon the FY 2005 Corps hydrographic survey. The quantities were estimated assuming dredging to project depth +1 foot required overdepth and +1 foot allowable overdepth. The estimate is based on INROADS surface to surface calculations. This work could be accomplished in conjunction with the improvement dredging. A hydrographic survey and INROADS calculation will have to be performed prior to dredging in order to estimate the final maintenance quantities. This is necessary as maintenance dredging is funded with OM funds while the improvement work is funded with CG funds.

Table A- 20. Existing Project Federal Maintenance Quantities

Reach	Project Depth (ft)	Maintenance Quantity Avail. (cy)[1]
OEC	45/42	18,700
IEC	42	43,204
MTB	42	41,799
NTB	31	25,600
STB	31	0
SAC	42	362,100
TN	42	42,700
Total		534,100
[1] Quantities include +1ft required and +1ft allowable overdepth		

4.4.2 MAINTENANCE OF THE NED PLAN

245. Future maintenance of the channel and basin areas are expected in years 2027, 2037, 2047, and 2057. Table A- 21 provides the breakdown. Future maintenance material is expected to be placed in the Port Everglades ODMDS site

Table A- 21. Future Maintenance Quantities

Project Component	Estimated Future Shoaling Rate (cy/yr)	Estimated Future Maintenance Quantity (cy)			
		2027	2037	2047	2057
Federal Channels	27,440	274,400	274,400	274,400	274,400
Port Berthing Areas	2,000	20,000	20,000	20,000	20,000

246. Future Federal maintenance of Port Everglades Harbor was estimated using the history of Federal maintenance dredging previously discussed in this document. The history indicates a total volume of 1,538,500 cubic yards was dredged from the OEC, IEC, MTB, NTB, and STB between 1934 and 2005, yielding an average yearly shoaling rate of 21,700 cy/yr. This is approximately 0.003 cubic yards of shoaled material per square foot of channel. The widening/extension of the project will increase the channel by approximately 2,033,000 sq.ft., increasing the estimated annual shoaling rate for the increased project footprint by 5,740 cy/yr to total rate of 27,440 cy/yr.

247. The Port has reported that 30,000 cubic yards has been maintenance dredged from berthing areas in the last 15 years. This translates to a yearly berthing area maintenance dredge rate of 2,000 cy/yr. Maintaining berthing areas to project depths is the responsibility of the Broward County Port Authority.

4.5 MCACES ESTIMATES OF THE SELECTED PLAN

248. MCACES estimates were prepared for the Selected Plan. This estimate includes all project costs, contingency, PED, and S/A. MCACES estimates can be found in the Cost Engineering Appendix.

249. MCACES estimates for the Selected Plan were based on a single continuing construction contract and a phased project schedule. The project phasing schedule is presented graphically in Figure A- 81 and Figure A- 82. It should be noted that the timeline of the project phasing schedule presented here may change (increase or decrease) based on available resources and funding.

4.6 STUDIES/DATA REQUIRED DURING PED

4.6.1 SURVEYS REQUIRED DURING PED

250. While existing hydrographic and topographic surveys were sufficient for the feasibility phase of the Port Everglades study, additional data will be required before the project can progress to Plans and Specifications. The following information will need to be acquired:

- Controlled aerials with 1-foot contours including: the rock reef mitigation area, the entire port from the OEC through SAC and offshore from 4,000 feet offshore west to the limits of the Port property.

- A comprehensive hydrographic survey of the rock reef mitigation area and the port, including OEC, IEC, MTB, Widener, SAC, TN, all related berthing areas, and USCG station.

- Topographic surveys of all the USCG facility, impacted portions of John U. Lloyd Park, impacted portions of port property, and of mitigation areas.

4.6.2 GEOTECHNICAL INVESTIGATIONS REQUIRED DURING PED

251. The harbor has a history of dredging problems and claims involving rock excavations. A significant number of core borings were drilled in the past to document the materials present in the harbor Area. While the existing core boring program was adequate for planning purposes, many of the historic cores were not drilled deep enough to cover the elevations that currently need to be dredged. Additionally, most of the physical core samples of the sediments and rock have been discarded.

252. In order to fully document the rock conditions to be encountered in the current excavation plan, a significant number of core borings and rock probes (wash borings) will have to be drilled. Some gradation tests may also be needed for the TH-2 through TH-16 core borings.

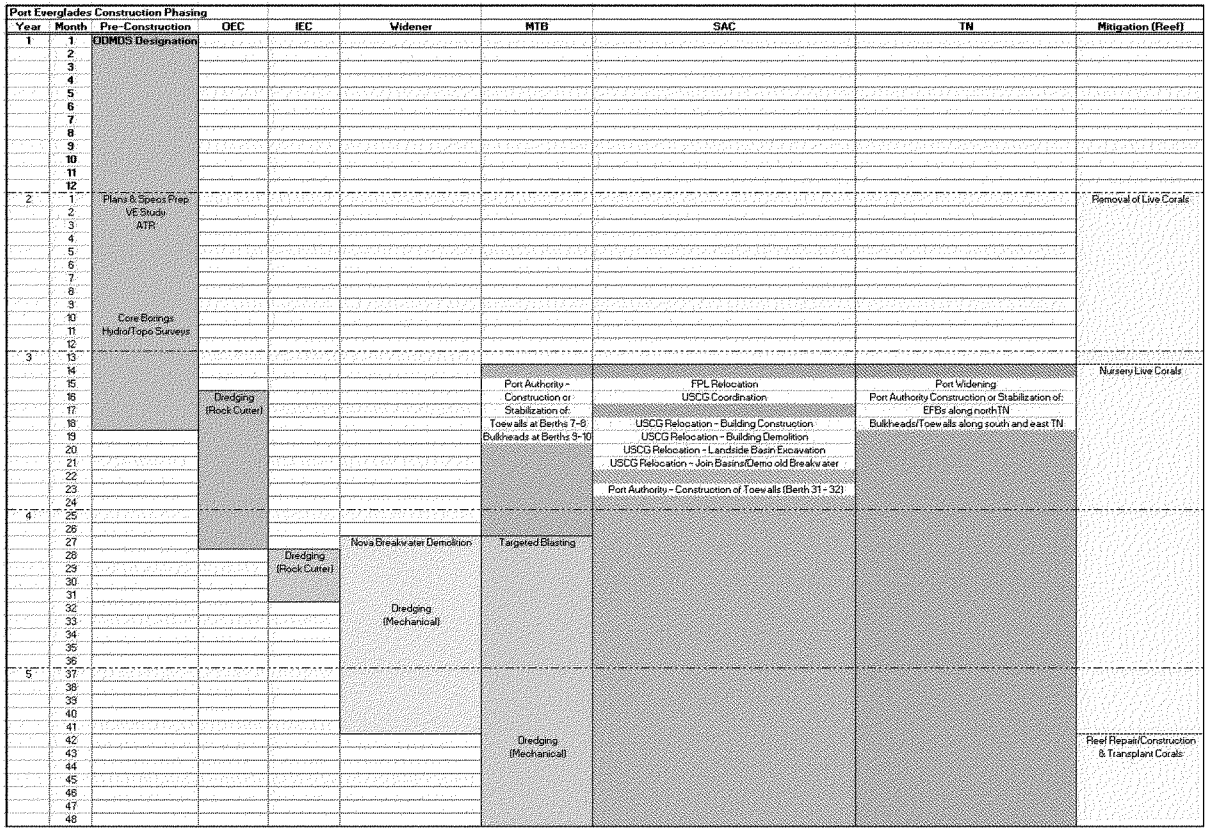
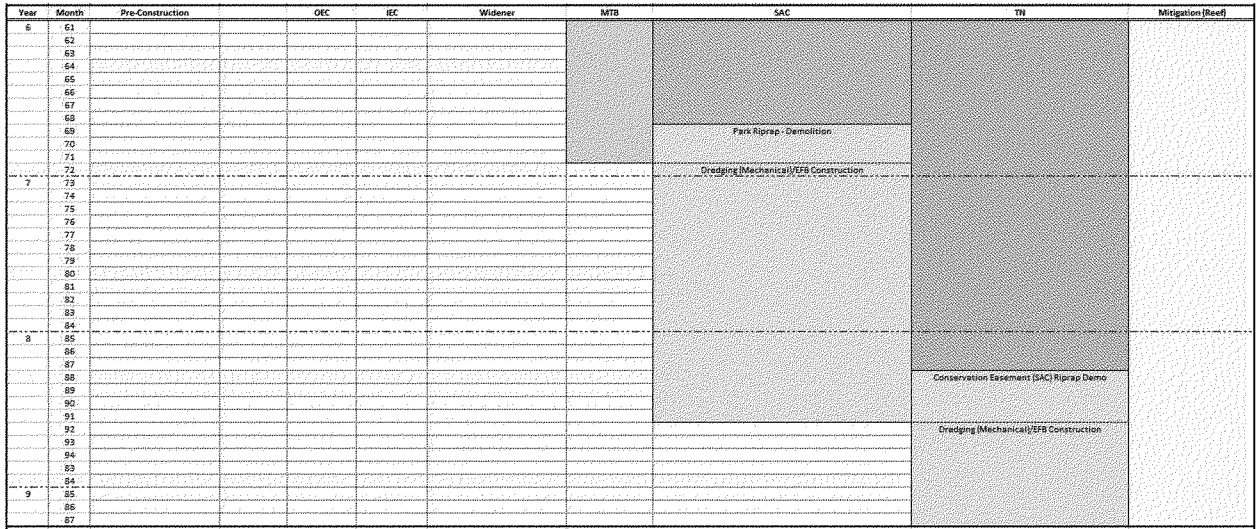


Figure A- 81. Port Everglades Project Phasing (Year 1 through Year 5)



Notes:

1. ODMDS designation is scheduled to be completed NLT the end of 2013. ODMDS will be available for use in 2014.
2. FP&L Utility relocations will be completed NLT than completion of Plans and Specs
3. All project elements will be completed under one continuous contract
4. "EFB" = Environmentally Friendly Bulkhead (Riprap topped bulkhead that allows for flushing of mangroves and access/shelter for juvenile fish)
5. U.S. Coast Guard Aides to Navigation will be relocated (if necessary) after completion and acceptance of each project element/component
6. Pre- and Post-Mitigation monitoring will occur concurrent with mitigation construction activities. Adaptive management will occur as necessary.

Cross-hatched areas indicate construction activities that will be completed by outside agencies (Florida Power & Light, U.S. Coast Guard, and Port Everglades Port Authority)

Figure A- 82. Port Everglades Project Phasing (Year 6 through Year 9)

610

253. Table A- 22 provides the PED drilling estimate and is established for plan/budget only. It is expected that the actual number of borings, the location of borings, and the depths of borings, may be revised as required during PED. Historic geotechnical data and borings obtained by the Port during feasibility should be used to aid in selecting actual drilling locations.

Table A- 22. Required Core Borings

Location	Number of Borings	Boring Location Type	Boring Depth (ft-MLLW)
OEC	13	Water	-69
IEC	5	Water	-62
MTB	5	Water	-62
Widener	2	Water	-62
USCG Facility	1	Land	-62
SAC - Channel	16	Water	-62
SAC – New Bulkheads	8	Water and Land	-62
TN	4	Water	-62

4.6.3 UTILITY RELOCATION INFORMATION REQUIRED

254. Detailed information regarding the location and specifications of all utilities to be relocated will need to be obtained early in the PED phase.

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PORT EVERGLADES HARBOR, FLORIDA

SUB-APPENDIX A

PORT EVERGLADES HARBOR, FLORIDA
SHIP SIMULATION STUDY

PORT EVERGLADES HARBOR
FORT LAUDERDALE, FLORIDA

SHIP SIMULATION STUDY

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SHIP SIMULATION CONDUCTED BY:

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Port Everglades Ship Simulation Study

Background

Port Everglades is located on the southeastern coastline of Florida, approximately 23 miles north of Miami and 48 miles south of West Palm Beach (figure 1). The port falls within the three cities of Dania, Fort Lauderdale, and Hollywood, as well as unincorporated Broward County. The full extent of the port covers over 448 acres of submerged land and 1,742 acres of upland territory. It is one of Florida's deepest ports

Access to Port Everglades begins at the sea buoy marking the outer limit of the port's entrance channel. The entrance channel itself is a 500 foot wide, 45 foot deep stretch that runs 1.7 miles due west, passing between north and south jetties at either side of the inlet entrance, and into the main turning basin. Mean lower low water depth in the basin is 42 feet. Beyond the main basin, Port Everglades is divided into three main regions, Northport, Midport, and Southport with a total of 33 active berths (figure 2).

As part of the US Army Corps of Engineer's (USACE) Port Everglades Harbor Feasibility Study, a series of harbor improvements have been proposed. In order to evaluate the navigation performance of the proposed modifications, US Army Engineer District Jacksonville (SAJ) and the Port Everglades Port Authority contracted with Raymond T. McKay Simulation, Training, Assessment & Research (RTM STAR) Center and the US Army Engineer Research & Development Center (ERDC) to perform a series of ship simulations. Study details, parameters and results are presented below.

Description of the Simulator

The RTM STAR Center, located in Dania Beach, Florida, is considered to be one of the most advanced facilities for maritime training and research in the world. A central component of this facility is a 360-degree-view training bridge. The bridge mockup includes realistic helm controls (figure 3) that allows pilots to command any vessel from the smallest tug to the largest super tanker under any conditions. The 360-degree-view screens display computer generated graphics that represent specific harbor and land features in sufficient detail to provide pilots with familiar visual cues. Figure 4 provides and example of the graphic display. As the simulation progresses in real-time, the visual scene is updated as the hydrodynamic portion of the simulator program computes a new ship's position and heading based on manual input from the pilot (rudder, engine throttle, bow and stern thrusters, and tug commands) and external forces (wind, waves, currents, banks, shallow water, ship/ship interaction, and tugboats). Operators in a separate control room control all of the simulated conditions, from the visual display to engine malfunctions and environmental hazards. Pilots are provided with simulated radar, water depth, relative ground and water speed of the vessel, magnitude of lateral vessel motions, relative windspeed and direction, and ship's heading.

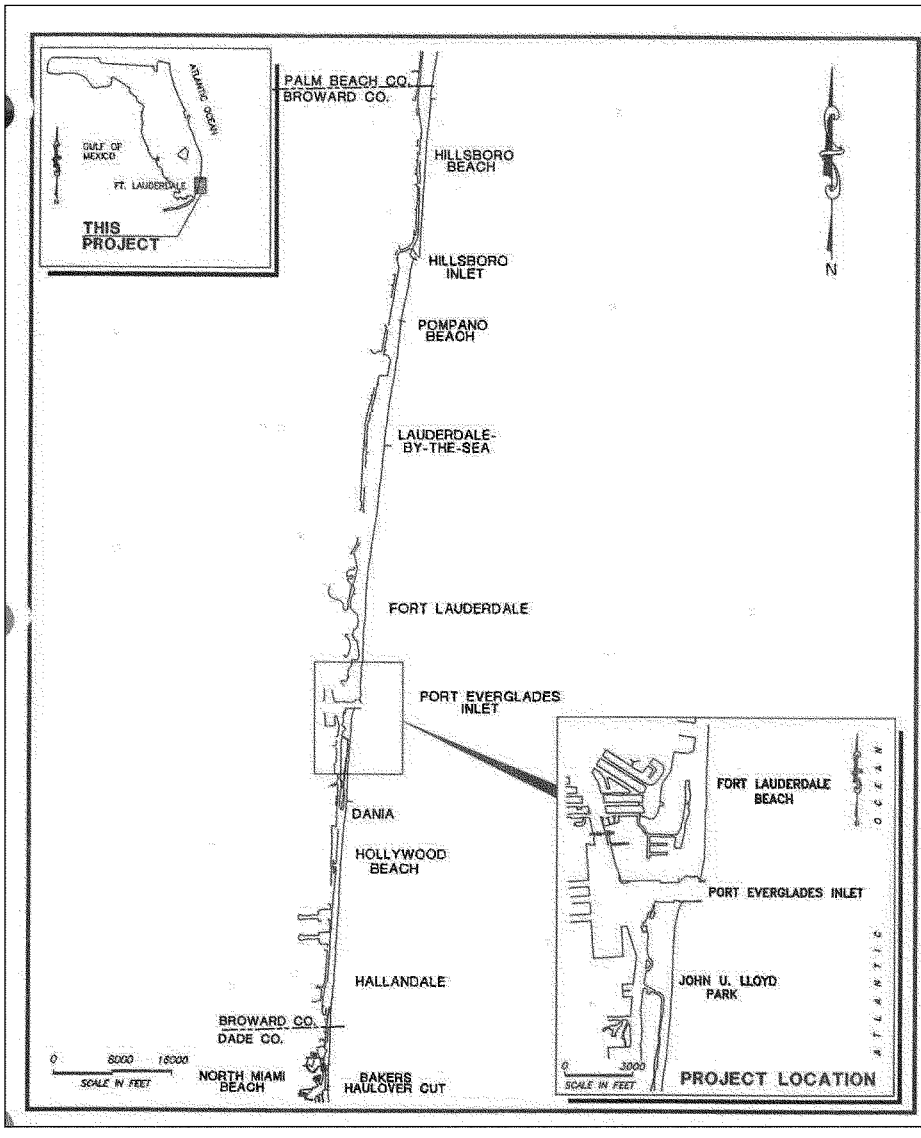


Figure 1. Location of Port Everglades Harbor

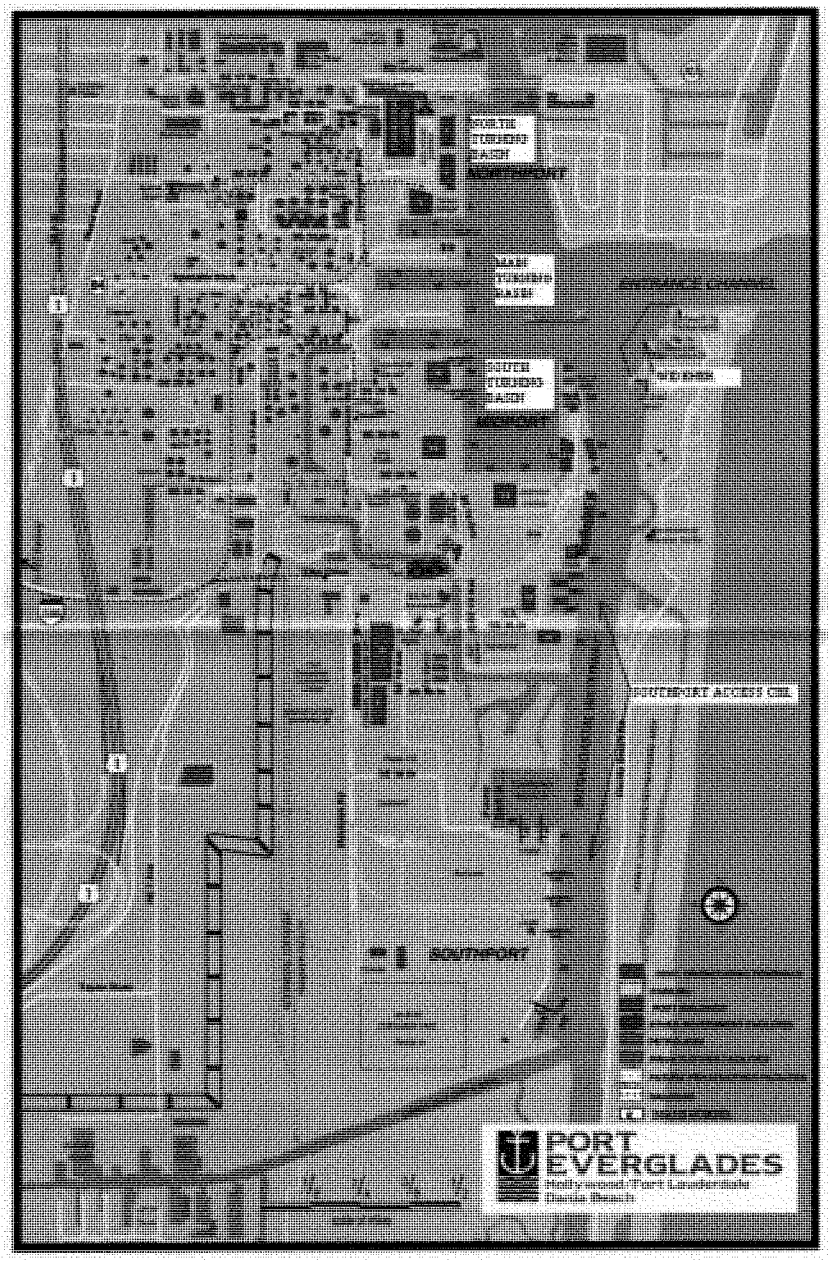


Figure 2. Layout of Port Everglades Harbor

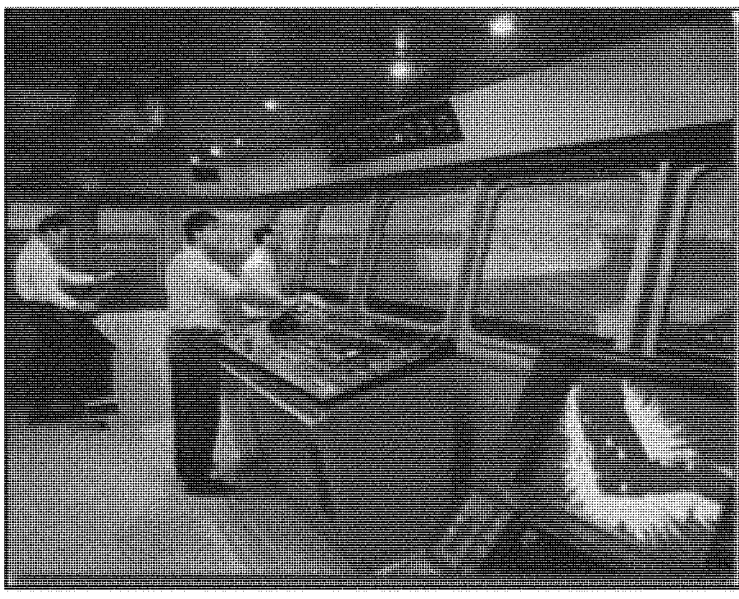


Figure 3. RTM STAR Center Training Bridge Helm

Figure 4. Example View from RTM STAR Center Training Bridge

Required Data

Data required for a simulation study includes channel geometry, bottom topography, channel currents for proposed and existing conditons, numerical models of design vessels, and visual data of the physical scene in the study area. RTM STAR had previously developed a geographic model for Port Everglades which accurately depicted existing channels, piers, shoreline, aids to navigation, and other distictive features. Details and allignments for proposed improvements to existing channels were provided by SAJ. Design vessels were taken from RTM STAR's existing model library and are considered to be good representations of both the design vessels referenced in the feasibility study and ships that presently utilize or are expected to utilize the docking facilities of Port Everglades. Data on channel currents as well as verification of visual data and other environmental condtions was provided by USACE and the Port Everglades Pilots Association.

Existing Project Conditions

For study purposes, Port Everglades Harbor can be divided into nine sub-areas referred to as project elements. Existing conditions for each project element can be described as follows:

- *Outer Entrance Channel (OEC)* – The OEC covers approximately 5,100ft of the Port Everglades Entrance Channel, extending from the open sea to the inlet's north and south jetties.

- *Inner Entrance Channel (IEC)* – The IEC covers approximately 2,300ft of the Port Everglades Entrance Channel, extending from the inlet jetties to the main basin of the harbor.

- *Main Turning Basin (MTB)* – The MTB covers the main turning area of the harbor, extending a maximum of 2,450ft from east to west and a maximum of 2,400ft from north to south.

- *North Turning Basin (NTB)* – The NTB is a northern expansion of the MTB that covers an area of approximately 1,100ft x 900ft.

- *South Turning Basin (STB)* – The STB is a southern expansion of the MTB that covers an area of approximately 1,200ft x 1,100ft.

- *Widener* – The Widener is a shoal area, measuring approximately 1,300ft x 400ft, located to the east of the MTB, just south of the intersection between the IEC and MTB.

- *Southport Access Channel (SAC)* – The SAC is the 400ft wide primary channel of the harbor. It extends 8,500ft north to south along the Intracoastal Waterway (ICWW) from the MTB to the intersection of the ICWW and the Dania Canal.

- *Turning Notch (TN)* – The TN is turning area south of the MTB. It measures approximately 1,000ft by 750ft and is located to the west of SAC approximately midway between the MTB and Dania Canal.

- *Dania Cutoff Canal (DCC)* – The DCC project element covers approximately 4,200ft of the Dania Canal, extending from the intersection of the Dania Canal and the ICWW.

Problem Identification

In order to accommodate projected growth in containerized cargo, cruise, liquid bulk, and general cargo traffic at Port Everglades Harbor, it was determined that regions of the harbor require deepening and expanding. In June 2000, representatives from the Broward County Port Authority, the Port Pilots Association, and the US Army Corps of Engineers identified several navigation problems within the harbor that resulted in the following design objectives:

- Create safer navigational conditions in the OEC and IEC.

- Accommodate deeper drafting bulk carriers to Berths 9-13 (adjacent to MTB).

- Accommodate transit of Post Panamax containerized cargo vessels to SAC Berths 30-33.

- Accommodate transit and berthing of mid size commercial vessels to the DCC.

- Accommodate new generation cruise ships into the NTB.

- Accommodate Panamax class container vessels into the STB.

- Accommodate berthing and turning of Panamax and Post Panamax class container vessels into the TN.

Design Vessels

The following vessels were the primary design vessels used in the evaluation of structural design plans for Port Everglades Harbor.

Susan Maersk. A Post Panamax Class Container vessel with a 141ft beam, 48ft draft, and a length of 1,139ft.

Voyager of the Seas. A future class of cruise ship with a beam of 156ft, a draft of 28ft, and a length of 1,020ft.

Bellatrix. A Panamax Container Class vessel with an 82ft beam, 29ft draft, and an overall length of 524ft.

Atlantic Class Container Ship. A generic cargo vessel, representative of a "larger" panamax containerized cargo vessel, with a 106ft beam, 38ft draft, and an overall length of 965ft.

Ambassador. A Ro/Ro vessel representative of a "short" Ro/Ro vessel to be berthed at Berth 33C. The Ambassador has a beam of 71ft, a draft of 29ft, and a length of 554ft.

Ro/Ro. A generic Ro/Ro vessel representative of a "long" vessel to be berthed at Berth 33C. This generic Ro/Ro has a beam of 90ft, a draft of 32ft, and a length of 755ft.

Jutlandia. A Panamax container vessel with a beam of 106ft, a draft of 42ft, and a length of 965ft.

SL Anchorage. A container ship with a beam of 78ft, a draft of 28ft, and a length of 710ft.

Pleasure Craft. To represent pleasure craft traffic in the design process, a generic 20ft beam vessel was selected.

Tugs. Tugs were available during each simulation exercise. The Fort Lauderdale Twin Screw is a 4200 HP tug with a beam of 32ft and a length of 90ft. The Everglades Single Screw is a 2145 HP tug with a beam of 25ft and a length of 88ft. During the runs the tugs on the plots were 118 feet long with 28ft beam. Thus, the tugs shown during the simulation were approximately 30ft longer than either real-world tug. It should be noted that this caused some runs to result in false groundings.

Series I Simulation

General

Series I ship simulation runs were conducted at the RTM STAR Center in October 2000. Six Port Everglades Pilots conducted the runs using three design vessels in both inbound and outbound scenarios. Wind conditions were represented by either a 15 knot wind from the East or a 15knot wind from the Northwest, depending on the scenario. The wind conditions were considered to be representative of the "worst case" situations. Except where specifically indicated to be otherwise, it was left up to the individual pilot's discretion to determine if a run would be made bow or stern first. During each simulation run, the pilot had full control over the vessel's rudder and engines. The pilot conned the vessel and operated steering and engine controls while operators provided tug assistance as requested.

Simulator output for each test run was processed and a ship track was generated. In addition, each pilot was asked to respond to items on a questionaire (detailed in the section entitled **Series I Pilot Evaluation Form** below) immediately following each completed simulation exercise. The questionnaire attempts to qualify the authenticity of each simulation and record additional comments that the pilot may have regarding the effectiveness of simulated alternatives.

Proposed Improvements to Existing Conditions

In order to address navigation concerns and to allow larger, deeper draft vessels to call at Port Everglades, SAJ proposed a combination of modifications. Modifications to the existing channel and basin dimensions are detailed below. It should be noted that channel and/or basin deeping, although a major part of the harbor improvement plan, is not a component of the ship simulation study.

Outer Entrance Channel (OEC)

Under conditions of strong, variable currents, the 500ft OEC presents a hazard to the existing and future design fleet. Presently, Pilots are required to line up with the channel early and bring vessels in at high speed to maintain a straight course. Rapid deceleration of the vessel is then required for safe negotiation of the entrance jetties. To alleviate the need for potentially dangerous maneuvering for the existing and future design fleet, the OEC was first flared to a maximum width of 800ft at its present outer most limit and then extended 2,200ft offshore past the third outer reef (figure 5). Channel depth must also be increased to accommodate design vessels.

Inner Entrance Channel (IEC), Main Turning Basin (MTB), and Widener

Presently the depths in the IEC and MTB restrict the size of bulk carriers able to transit to berth in the main harbor. The widener shoal restricts the amount of maneuvering room a vessel has when turning in the MTB in preparation for backing down the SAC (a common method of transit). The shoal also prohibits other traffic from transiting and exiting the SAC while another vessel is in the MTB. The IEC and OEC was deepened and the Widener shoal removaled to (1) allow transit of larger vessels, (2) turn the Post Panamax Container Vessels preparing to enter the SAC, and (3) allow for two-way traffic in the MTB.

North Turning Basin (NTB)

The present design depth of 31ft in the NTB is adequate to accommodate the full draft of an S Class cruise ship with aan accepted safety clearance of 3ft. However, recent surveys indicate 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 was made made along the western side of the basin providing a uniformly deepened area that is 250ft wide from the northern wall to the south where the NTB and MTB merge (figure 6).

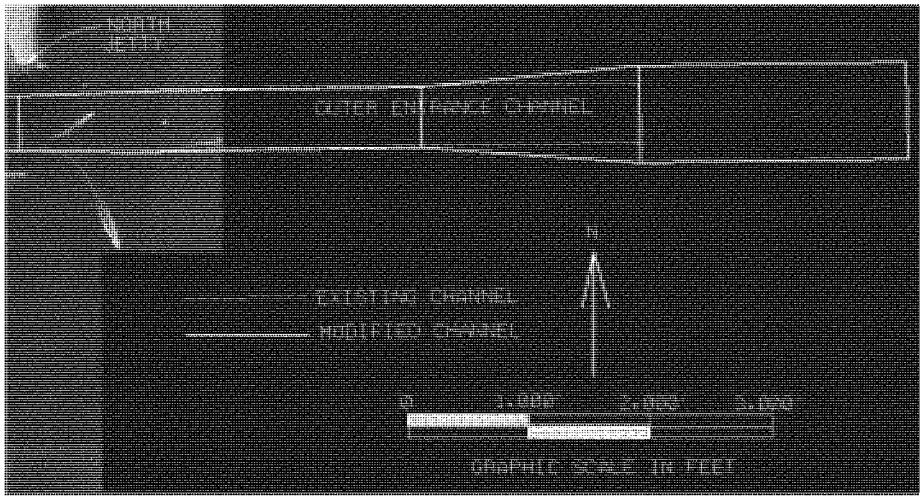


Figure 5. Modifications to Existing Outer Entrance Channel

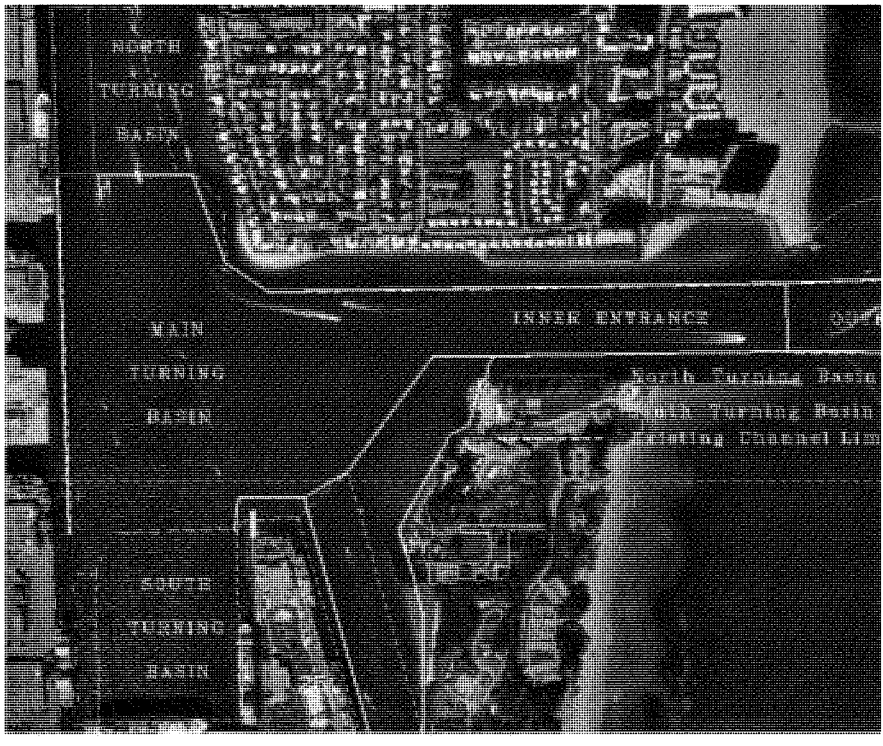


Figure 6. Modifications to Existing North and South Turning Basins

South Turning Basin (STB)

Due to the 39ft draft of the design vessel, it is necessary to deepen the STB from a present design depth of 31 ft to a depth of 42ft. Because the vessel will be berthed only at Berths 16 and 17, deepening is not required over the entire extent of the STB. Depth requirements are met with a cut across the western side basin from north to south. This provides a uniformly deepened area that is 260ft wide from the south wall of the basin to the north where the STB and MTB merge (figure 6).

Southport Access Channel

The width and configuration of the SAC, and the proximity of a US Coast Guard Station to the northeast portion of the channel present obstacles in transiting a Post Panamax Container Vessel past cruise ships at berth in the Knuckle (a "bend" in the SAC between Berths 24 and 27) to Berths 31 and 32. At the north end of the channel, the Knuckle area was expanded from a design width of 400ft to a width of 786ft. The width at the center of the Knuckle (juncture of Berths 25 and 26) was widened from 400 ft to 480ft. At the south end of the Knuckle, adjacent to Berth 27, the width of the channel was changed from 400ft to 575ft. Channel width was then tapered in a southerly direction over a distance of 3,030ft to a design width of 460ft. A constant width of 460ft was then maintained over the remainder of the channel until reaching berths 31 and 32 where it was decreased to a width of 315ft. SAC modifications are shown in figure 7.

Turning Notch

There are two primary obstacles to bringing a Post Panamax vessel such as the Susan Maersk into the TN, the present depth in the notch and its present dimensions. To alleviate these problems, the depth of the TN was first deepened to a uniform 51ft. The dimensions of the TN are currently 1,000ft from east to west and 750ft from north to south. Under these conditions, the east to west length of the notch is not adequate to allow berthing of the 1,139ft vessel even if depth limitations could be overcome with light-loading. The design plan expanded the TN to the west, extending the total width of the Notch from 1,000ft to 1,500ft (figure 8). This plan is intended to allow for both berthing and turning of the Susan Maersk.

Dania Cutoff Canal

Presently, depths in the IEC, OEC, MTB, SAC, and the TN are sufficient to accommodate commercial vessels comparable in size to the design vessel Bellatrix. The relatively shallow depth of the DCC, however, prohibits transit to that area. In order to bring the Bellatrix into the DCC, the present design depth must be increased to a depth that accommodates both vessel draft and safety clearance. The present width of the DCC also presents an obstacle to commercial vessels. To accommodate the design vessel passing another vessel at berth and a pleasure craft in the channel, the DCC requires widening from 200 ft to 280 ft. It was also necessary to add a 356,000-sq. ft. turning area at the intersection of SAC and the DCC to allow access to and from the SAC. In

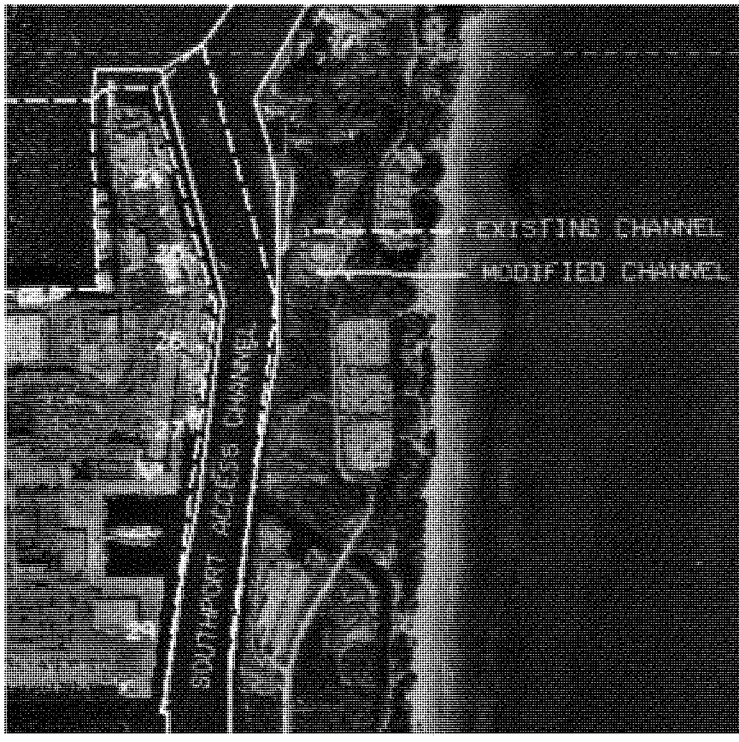


Figure 7. Modifications to Existing Southport Access Channel

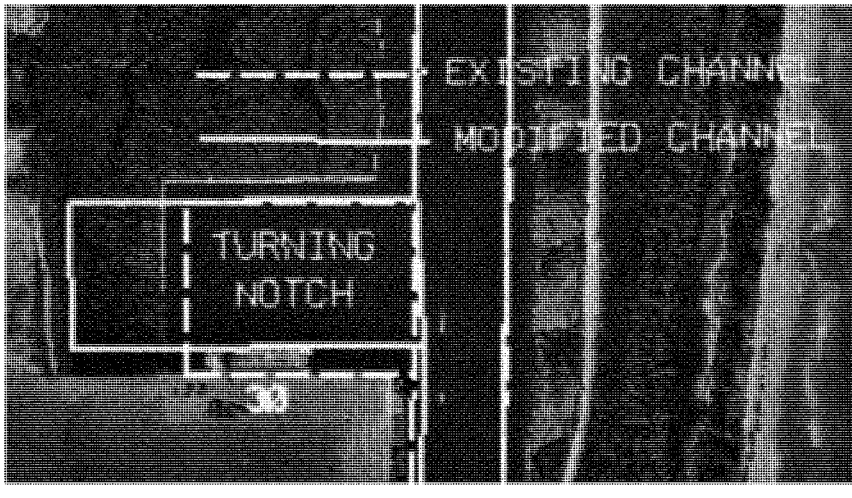


Figure 8. Modifications to Existing Turning Notch

addition, a 90ft wide berthing area and two ro/ro (roll on/roll off) ramps were created along the north side of the channel. Figure 9 illustrates modifications to the DCC.

Series I Testing Matrix

The testing matrix for the Series I Ship Simulation is provided in Table 1. Simulation runs consisted of both inbound and outbound scenarios under both flood and ebb tide conditions. Vessel orientation was specified only for DCC runs in order to better evaluate the difficult turning conditions at the intersection of the SAC and DCC. Winds were 15knots and originated from two directions, East and Northeast. Vessels at berth during transit are also specified. All scenarios, with the exception of E15 and E08 were run multiple times using different pilots. E15 and E08 were run only once.

Table 1. Series I Ship Simulation Testing Matrix

Run ID	Project Element(s)	Design Vessel	Direction	Bow/Stern[1]	Tide	Wind	Vessels At Berth Berth	Vessel
E01a	OEC, IEC, MTB, Widener, SAC (with breakwater)	Susan Maesk	Inbound		Flood	15knot - East	25 26	Cruise Cruise
E01	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Inbound		Flood	15knot - East	25 26	Cruise Cruise
E02	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Inbound		Ebb	15knot - East	25 26	Cruise Cruise
E09	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Outbound		Flood	15knot - East	25 26	Cruise Cruise
E10	OEC, IEC, MTB, Widener, SAC (with breakwater)	Susan Maersk	Outbound		Ebb	15knot - East	25 26	Cruise Cruise
E10	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Outbound		Ebb	15knot - East	25 26	Cruise Cruise
E03	DCC	Bellatrix	Inbound	Bow	Flood	15knot - Northwest		
E04	DCC	Bellatrix	Inbound	Bow	Ebb	15knot - Northwest		
E05	DCC	Bellatrix	Inbound	Stern	Flood	15knot - Northwest		
E06	DCC	Bellatrix	Inbound	Stern	Ebb	15knot - Northwest		
E11	DCC	Bellatrix	Outbound	Bow	Flood	15knot - Northwest		
E12	DCC	Bellatrix	Outbound	Bow	Ebb	15knot - Northwest		
E13	DCC	Bellatrix	Outbound	Stern	Flood	15knot - Northwest		
E14	DCC	Bellatrix	Outbound	Stern	Ebb	15knot - Northwest		
E15	NTB	Voyager	Outbound		Flood			
E08	STB	Voyager	Inbound		Ebb			

[1] Orientation was left to pilot discretion except for DCC simulation runs

Series I Pilot Evaluation Forms

Upon completion of each test run, pilot's were asked to fill out a pilot evaluation form. These forms provide a means by which to help qualify the authenticity of each simulation and provide the opportunity for pilot's to record additional comments that they may have regarding the effectiveness of the design plan. The evaluation form for Series I contained 12 questions, each requiring that the answer be given as a numerical rating. Three questions rated the vessel trackline, six rated vessel controllability, one rated overall safety of the maneuver, one rated task difficulty, and one rated the stress level of the maneuver. Questions and their associated rating systems for the Series I Simulation are provided in Table 2.

Table 2. Series I Simulation Evaluation Questions and Rating System

Port Everglades, Florida – Run Evaluation Form					
	Extremely Satisfactory	----------			Not at all Satisfactory
Vessel Trackline					
(1) Vessel position with regard to centerline	5	4	3	2	1
(2) CPA to channel boundaries and/or buoy at the entrance	5	4	3	2	1
(3) Vessel position with regard to ships at berth	5	4	3	2	1
Vessel Controllability					
(4) Engine reserve	5	4	3	2	1
(5) Rudder reserve	5	4	3	2	1
(6) Course control	5	4	3	2	1
(7) Speed control	5	4	3	2	1
(8) Use of tugs	5	4	3	2	1
(9) Thruster reserve	5	4	3	2	1
	Absolutely Safe	----------			Not at All Safe
(10) **Overall Safety**	5	4	3	2	1
	Extremely Difficult	----------			Not at All Difficult
(11) **Task Difficulty**	5	4	3	2	1
	Extremely High	----------			Not at All
(12) **Stress Level**	5	4	3	2	1

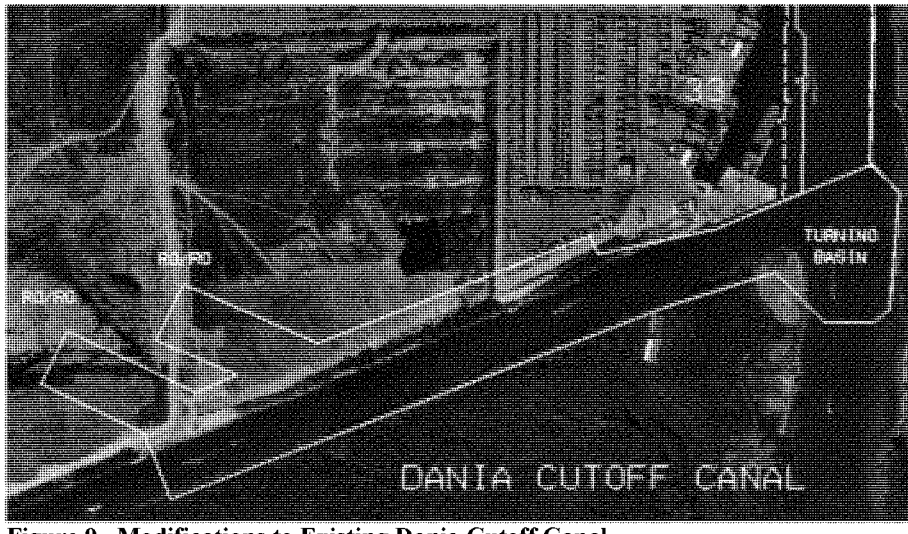


Figure 9. Modifications to Existing Dania Cutoff Canal

Series I Results

Plots showing average Pilot evaluation ratings for each run completed during the Series I simulation are shown in Attachment I. Actual composite tracks plots and pilot questionnaires will remain at USACE SAJ as these original documents are considered to be proprietary information belonging to the Port Everglades Pilots Association.

Susan Maersk, Inbound (OEC to Berth 31-32)

Flood Tide

Inbound, flood tide Susan Maersk runs consisted of one run with the USCG Station in its present location and four runs in which the USCG station breakwater was removed. None of the inbound vessels encounted significant problems in the OEC, IEC, or MTB. Upon entering the SAC, a single pilot lost control of his vessel, creating a collision with a cruise ship at Berth 25. This scenario was considered to be an abnormality and restarted. The pilots second attemp was completed without incident. None of the vessels came within 100ft of the proposed channel edge where it was widened on the east side of the channel. However, it was noted that no vessel was presently berthed at Berth 29. The inclusion of a cruise ship at this berth would cause transiting vessels to move further to the east. While pilots felt relocation of the USCG breakwater improved channel conditions, overall comments indicated that the constriction of the knuckle area still presents a significant problem. The average pilot rating for Overall Safety was 3 with the USCG breakwater in place and 3.5 with the breakwater removed.

Ebb Tide

All inbound, ebb tide Susan Maersk runs were made with the USCG Station breakwater removed from the channel. Pilots rated the ebb tide runs as easier than those conducted under flood tide. When vessels transit against the tidal currents, this increases the flow past the rudder, thus improving steerage. However, pilots continued to note that the knuckle area remained tight even without the USCG breakwater. The average pilot rating for Overall Safety was 4.3.

Susan Maersk, Outbound (Berth 31-32 to OEC)

Flood Tide

Outbound, flood tide runs with the Susan Maersk were all completed with the USCG breakwater removed from the channel. Four pilots participated in the runs. During outbound, flood tide runs, none of the vessels made use of the southern portion of the additional space created by widening the channel east of the knuckle. However, all of the vessels used the additional space near the USCG Station. Three of the runs left the channel near the USCG Station and one ship hit the station. Despite these incidents, Pilot comments indicate that moving the USCG breakwater was an improvement and the track plots showed that they used the extra room to avoid the docked ships. The average pilot rating for Overall Safety was 2.8.

Ebb Tide

Outbound, ebb tide Susan Maersk runs consisted off two runs made with the existing USCG Station configuration and three runs in which the USCG Station bulkhead was removed. Three pilots participated in these runs. While transiting outbound under an ebb tide, one ship ran aground due to excess speed. Upon rerunning the scenario, however, the run was completed successfully. The remainder of the runs, including those in which the USCG breakwater remained in its original location, were completed successfully. In runs were the breakwater was relocated, all of the pilots used the additional space provided. In all runs, none of the vessels left the existing channel limits while south of the knuckle. The average pilot rating for Overall Safety was 2 with the USCG breakwater in place and 3.3 with the breakwater removed.

Bellatrix, Inbound (Berth 31 to DCC Berth)

Flood Tide

Inbound, flood tide Bellatrix runs consisted of three bow first and five stern first transits. Three pilots participated in the bow first runs and each clipped the eastern edge of the channel as they approached the turning basin at the intersection of the SAC and DCC. One of the ships left the channel by approximately 40ft as it entered the turning basin. Two other vessels did not have adequate room for the tugs (ship's port side) as they made

the turn into the DCC. Pilot comments reflect that the entrance was tight at Berth 33C. The average pilot rating for Overall Safety was 3.5.

Four pilots participated in stern first inbound scenarios. One pilot began his run as if he had turned his ship prior to leaving the SAC. The other three pilots turned their vessels in the turning basin provided at the intersection of the SAC and DCC. In all three runs, the vessel left the turning basin at the southern limit. None of the four runs had enough room for tug assistance as they entered the DCC. Pilots again commented on the tightness of the channel near Berth 33C. The average pilot rating for Overall Safety was 2.7.

Ebb Tide

Inbound, ebb tide Bellatrix runs consisted of three bow first and four stem first transits. A single pilot conducted the ebb tide runs. Evaluations indicated that this was a fairly easy scenario to complete. However, the assist tug of one vessel ran aground in the DCC and it was noted in pilot comments that the channel and turning basin were tight around Berth 33C. The average pilot rating for Overall Safety was 3.7.

Four pilots participated the stem first scenarios. Three of the four runs in the widened channel were able to stay within the provided turning basin. The additional run left the turning basin at the southern limit. The improved success (compared with flood tide runs) was due to the fact that the ebb tide keeps the ship further north. However, two of the runs had instances of the port side assist tug running aground on the south side of the DCC. All pilots commented that the turning basin was tight for this maneuver. The average pilot rating for Overall Safety was 2.8.

Bellatrix, Outbound (DCC Berth to Berth 31)

Flood Tide

Outbound, flood tide Bellatrix runs consisted of three bow first and four stern first transits. Three pilots participated in the bow first cases. Two of the pilots were unable to make the turn to the north without leaving the channel on the east. The other was able to remain in the channel. In all of the runs, the assist tug (starboard side) for all runs ran aground. Two ran aground in the DCC and the other ran aground in turning area. The tightness of the turning basin was again expressed in the pilot's comments. The average pilot rating for Overall Safety was 3.0.

Three pilots participated in the stern first runs. All of the runs went too far south into the turning basin and left the authorized channel. In addition, all runs had instances of the assist tug running aground. Comments again focused on the tightness of the turning basin. The average pilot rating for Overall Safety was 2.7.

Ebb Tide

Outbound, ebb tide Bellatrix runs consisted of three bow first and four stern first transits. Three pilots participated in the bow first cases. In all cases, the vessel remained within the channel limits. The ebb tide helped the ships make the turn from the DCC. This is opposite the flood tide runs, in which the current pushed against the turning ship. However, during the three runs the assist tug ran aground. It was commented that the northbound turn under ebb tide conditions increased the difficulty of the maneuver. The average pilot rating for Overall Safety was 2.5.

Four pilots participated in the stern first runs. Three of the runs left the southern end of the turning area. The forth run stayed within the southern limits, but had inadequate room for tugs to maneuver. Comments again focused on the tightness of the turning basin, particularly under less than ideal ebb tide conditions. The average pilot rating for Overall Safety was 2.3.

Eagle, Inbound (OEC to Berth 17-18)

A single inbound run with the Eagle was conducted. Prior to the simulation run, the pilots, based on experience, recommended modification of the STB dimensions. As a result of visual inspection it was determined that the proposed STB cut would allow inadequate maneuvering room for vessels transiting to Berths 17 and 18. In order to provide more room, the original north to south straight cut along the western side of the STB was replaced by a diagonal cut that provides a uniformly deepened area measuring 260ft wide at the south and 1,100ft wide to the north where the STB and MTB merge. Using the new STB configuration, the pilot easily completed the exercise and no addition runs were required. The average pilot rating for Overall Safety was 5.

Eagle, Outbound (Berth 1-2 to OEC)

A single outbound run with the Eagle was conducted. As with the STB, it was recommended prior to simulation that the NTB dimensions be modified to allow more maneuvering room. It was also determined during this time frame that the NTB element was being removed from the project. A similar diagonal cut was added to the NTB and the simulation was run as planned. The pilot easily completed the exercise. No further NTB runs were made. The average pilot rating for Overall Safety was 5.

Series I Conclusions and Recommendations

Examination of ships tracks and pilot evaluations for inbound and outbound Susan Maersk runs leads to three primary conclusions in regard to transiting Post-Panamax vessels to Berths 31 and 32, (1) the Widener shoal must be removed from the southeast portion of the main harbor to successfully turn a Post-Panamax vessel in the MTB, (2) the USCG Station is a significant limiting factor for navigation for vessels traveling in and out of the SAC even with the USCG breakwater relocated, and (3) proposed SAC dimensions south of Berth 29 are adequate to accommodate the design vessel. It is

therefore recommended that at the very least, the Widener shoal be removed and the USCG breakwater be relocated to the east. However, total relocation of the entire USCG basin should also be considered. If removal of the shoal and total relocation of the basin occurs it will also be possible to reduce the eastward expansion of the SAC (and therefore environmental impacts) south of the basin by 50ft to 100ft (figure 10).

During the Susan Maersk transits into the SAC, it became evident that the dimensions of the proposed TN modifications were not sufficient to allow for either turning or berthing of a Post-Panamax vessel. In light of this, no simulation runs were conducted that involved use of the TN. It is therefore recommended that the TN dimensions be revisited to allow for berthing and turning of a vessel the size of the Susan Maersk. TN runs should be added to the next series of simulations to ensure that adequate maneuvering room has been provided.

After evaluating ships tracks and pilot questionnaires for the Bellatrix runs, it was determined that several modifications to the proposed DCC design plan were required. Numerous simulations included vessels which left the southern end of the proposed turning area. Additionally, two of the vessels left the turning basin on the northeast. A majority, however, did not come close to the eastern side. In order to alleviate maneuvering difficulties in the DCC turning area, it is recommended that the southern limits of the area be extended an additional 50ft to the south. At the same time, it is possible to move the eastern edge to the west by 25ft. The final result is a slightly elongated turning basin (figure 11). Given the additional room to the south, vessels should no longer encroach on the northwest limits of the turning area. It is also recommended that the main channel of the DCC be widened from 280ft to 310ft to provide more room for vessels entering and leaving berths under high current conditions. These recommended changes are significantly different from the original plan. Therefore, it is advisable that the new turning basin and channel configuration be simulated to ensure that it provides adequate clearance for ships entering and leaving the DCC.

Series II Simulation

General

Series II ship simulation runs were conducted at the RTM STAR Center between July 2002 and August 2002. Five Port Everglades Pilots conducted simulator runs that employed three design vessels. Simulations included, inbound, outbound, and turning scenarios under both flood tide and ebb tide conditions. Simulations took place using channel dimensions which were modified based upon Series I recommendations and changes made by the project sponsor.

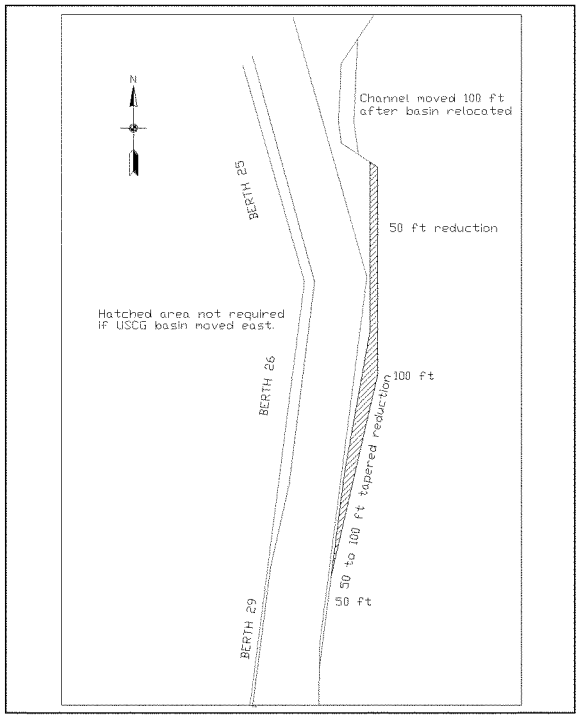


Figure 10. Recommended Reduction of SAC Design Channel Limits

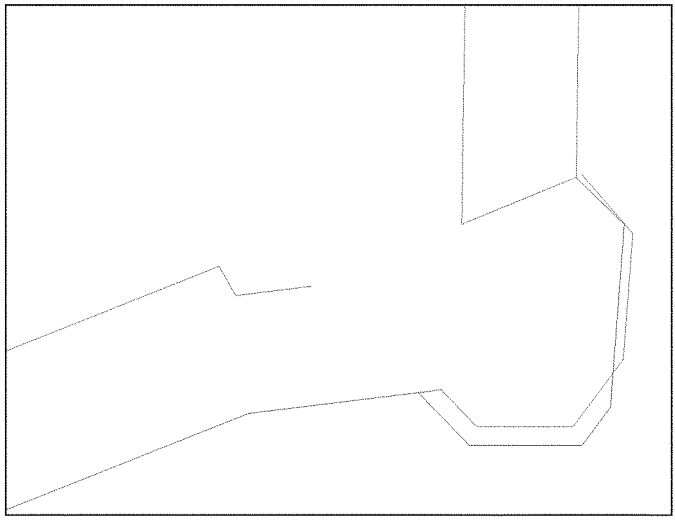


Figure 11. Recommended Modifications (blue) to DCC Design Turning Basin (red)

Series II simulations, like Series I simulations, were run with 15knot winds from the east and northwest. However, entrance channel crosscurrents varied in both magnitude and direction along the channel. The current magnitude decreased from west to east as the ships approached the harbor. Several current configurations were modeled. Pilots were not told current conditions prior to the simulations. This simulated real-life conditions where pilots occasionally don't know the predominant crosscurrent direction until the ship is affected by those currents.

Modifications Based on Series I Simulations

Series I ship simulation runs indicated that modifications were required if design plans were to meet the goals for which they were developed. In addition, the sponsor also indicated modifications that would help to further the Port's goals. Details of plan modifications for Series II simulation are provided below.

Outer Entrance Channel, Inner Entrance Channel, and Main Turning Basin

Series I simulations indicated that no additional modifactions were required to these project elements.

Widener and South Turning Basin

Series I simulation results confirmed that modification to the Widener shoal (i.e. removal of the shoal) were necessary for safe transit of Post-Panamax vessels into the SAC. Likewise, simulation results confirmed that proposed modifications to the STB were necessary and that dimensions provided for Series I simulations were adequate to allow safe transit of the design vessel to Berth 18. No further simulation was deemed necessary for either project element.

North Turning Basin

During the course of project development, the NTB project element was dropped from the study. No further testing of this element was conducted.

Southport Access Channel

Following the recommendations made based on Series I simulation results several modifications were made to the SAC design plan. In order to alleviate constriction at the entrance of the SAC, the USCG Station facilities and boat basin were relocated to a position 100ft east of the proposed channel limits (figure 12). Previously proposed widening south of the basin was then reduced approximately 50ft between Berths 25 and 26 and 50ft to 100ft between Berths 26 and 29 (see figure 10).

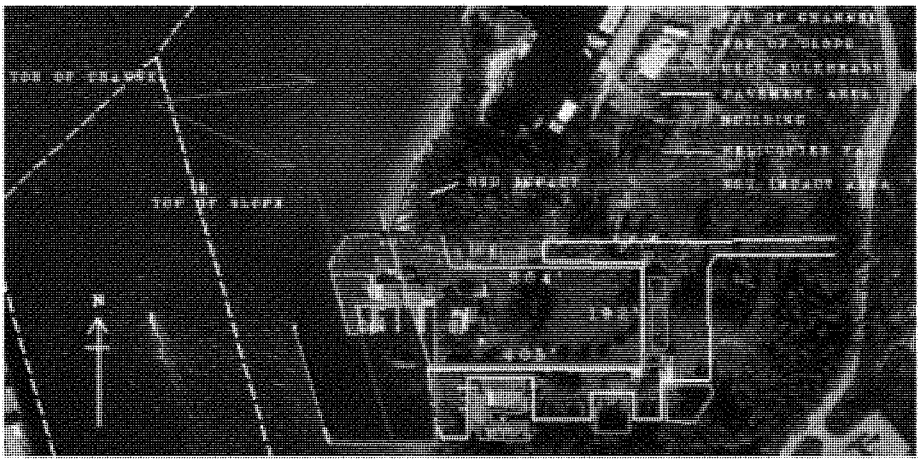


Figure 12. USCG Basin Relocation Plan

Turning Notch

Two modifications were made to the TN design plan. The first modification resulted from recommendations of the Series I simulation. Due to a lack of room to turn or berth the Post-Panamax design vessel, the TN was expanded 50ft to the north to allow for additional clearance. The second modification resulted from changes made by the project sponsor. Port plans to add a dock area along the western edge of the TN required the federal channel limits to be moved 180ft to the east. In addition, berths at the south of the TN were widened from 110ft to 145ft. Figure 13 shows TN modifications.

Dania Cutoff Canal

Based on recommendations made following the analysis of Series I results, the DCC dimensions were modified to allow for better vessel access. In order to alleviate maneuvering difficulties in the DCC turning area, the southern limits were extended an addition 50ft to the south and the eastern edge was moved 25ft to the west. To accommodate vessels in the main portion of the channel, the width of the channel was expanded from 280ft to 310ft. Two additional modifications were made at the request of the project sponsor: (1) Extension of the main DCC channel from 3,200ft to 4,200ft and (2) Removal of ro/ro ramps at the western end of the DCC, replaced by an extension of the northern berthing. Figure 14 shows DCC modifications.

Series II Testing Matrix

The testing matrix for the Series II Ship Simulation is provided in Table 3. Simulation runs consisted of both inbound and outbound scenarios under both flood and ebb tide conditions. Vessel orientation was specified only for DCC and TN runs in order to better evaluate the difficult turning conditions at both locations. Winds were 15knots and

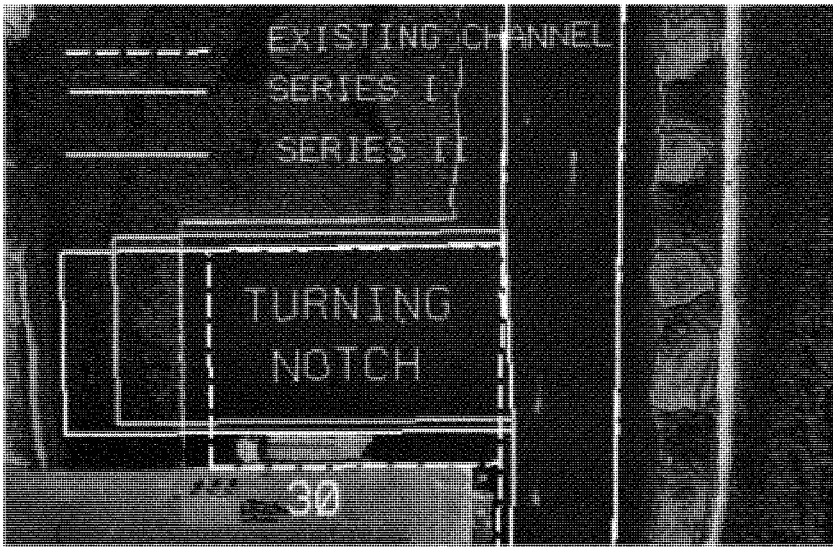


Figure 13. Turning Notch Modifications for Series II Simulation

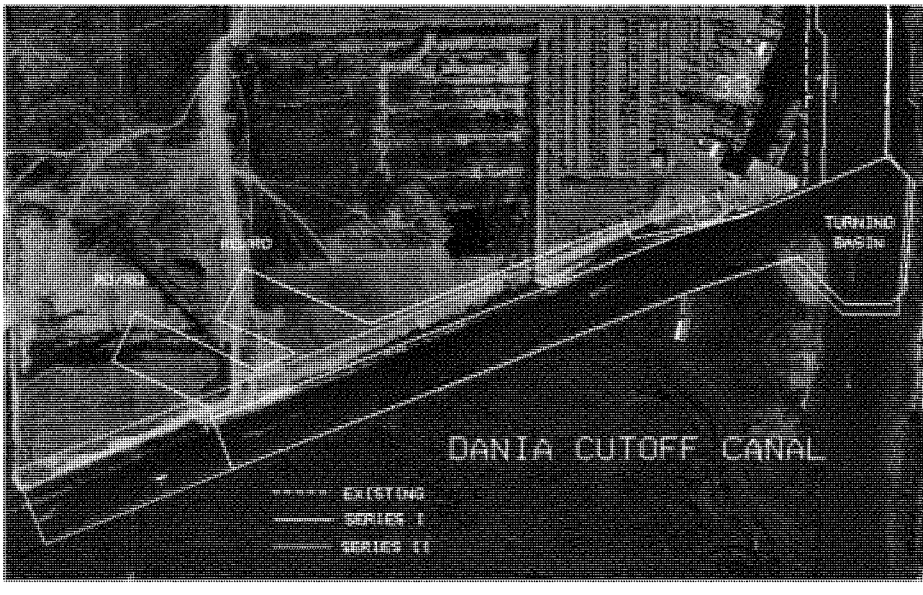


Figure 14. Dania Cutoff Canal Modifications for Series II Simulation

originated from two directions, East and Northeast. Vessels at berth during transit are also specified. All scenarios, with the exception of E13 through E16 were run multiple times using different pilots. E13 through E16 were each run once under flood tide and once under ebb tide conditions. All four of these runs were completed by the same pilot.

Series II Pilot Evaluation Forms

Upon completion of each test run, pilot's were asked to fill out a pilot evaluation form. These forms, including questions and rating systems were identical to the evaluation forms used during the Series I Simulation (Table 2).

Table 3. Series II Ship Simulation Testing Matrix

Run ID	Project Element(s)	Design Vessel	Direction	Orientation[1]	Tide	Wind	Vessels At Berth Berth	Vessel
E01	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Inbound		Flood	15knot - East	25 26 29	Cruise Cruise Cruise
E02	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Inbound		Ebb	15knot - East	25 26 29	Cruise Cruise Cruise
E07	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Outbound		Flood	15knot - East	25 26 29	Cruise Cruise Cruise
E08	OEC, IEC, MTB, Widener, SAC	Susan Maersk	Outbound		Ebb	15knot - East	25 26 29	Cruise Cruise Cruise
E13	TN	Susan Maersk	Turning	Bow	Flood	15knot-East		
E14	TN	Susan Maersk	Turning	Bow	Ebb	15knot-East		
E15	TN	Atlantic Class	Turning	Bow	Flood	15knot-East		
E16	TN	Atlantic Class	Turning	Bow	Ebb	15knot-East		
E03	DCC	Bellatrix	Inbound	Bow	Flood	15knot - Northwest	33C	Ro/Ro
E04	DCC	Bellatrix	Inbound	Bow	Ebb	15knot - Northwest	33C	Ro/Ro
E05	DCC	Bellatrix	Inbound	Stern	Flood	15knot - Northwest	33C	Ro/Ro
E06	DCC	Bellatrix	Inbound	Stern	Ebb	15knot - Northwest	33C	Ro/Ro
E09	DCC	Bellatrix	Outbound	Bow	Flood	15knot - Northwest	33C	Ro/Ro
E10	DCC	Bellatrix	Outbound	Bow	Ebb	15knot - Northwest	33C	Ro/Ro
E11	DCC	Bellatrix	Outbound	Stern	Flood	15knot - Northwest	33C	Ro/Ro
E12	DCC	Bellatrix	Outbound	Stern	Ebb	15knot - Northwest	33C	Ro/Ro

[1] Orientation was left to pilot discretion except for DCC and TN simulation runs

Series II Results

Plots showing average Pilot evaluation ratings for each run completed during the Series II simulation are shown in Attachment II. Actual composite tracks plots and pilot questionnaires will remain at USACE as these original documents are considered to be proprietary information belonging to the Port Everglades Pilots Association.

Susan Maersk, Inbound (OEC to Berth 31-32)

Flood Tide

Inbound, flood tide Susan Maersk runs were conducted by four pilots. Although most runs were without major incident, one pilot left the entrance channel by over 150ft on the north side of the channel. It should be noted, however, that the pilot felt that simulated currents were too strong compared to real-life. Vessels in all four of the runs stayed to the northern side of the entrance channel due to the presence of cross-currents, confirming the significant effect that these currents have at Port Everglades. Upon entering the SAC, two vessels left the west side of the channel approximately 25ft across from the former position of the USCG station. The two pilots that left the channel did not go as far west into the MTB before beginning to back down the SAC. It is likely that the flood tide, which pushed the stern of the ships south near the completion of the turning maneuver, was a factor in these two runs leaving the channel. The other pilots went over 600ft further west into the MTB before backing and were able to keep their vessels centered in the SAC. The SAC has a six-degree course change near Berth 29. One vessel came extremely close to the channel edge while making the turn. All of the vessels remained close to the west side of the SAC during the exercise due to the 15knot wind blowing from the east. Pilot comments indicated that the constriction at the knuckle, most like due to channel narrowing south of the USCG, remained a significant problem. The average pilot rating for Overall Safety was 3 for this scenario.

Ebb Tide

Four pilots participated in the inbound, ebb tide scenario. As in the flood tide scenario, the cross-currents in the entrance channel pushed the vessels to the northern side of the channel. One vessel left the channel by nearly 90ft. The other vessels were able to stay within the channel limits. All of the vessels in the ebb tide case successfully entered the northern end of the SAC after turning in the MTB. The ebb tide appears to help the pilots control the turning maneuver and keep their vessels further east. One pilot turned his vessel further north and left the north side of the channel before backing in the SAC. Another brought his vessel close to the curise ships docked at Berth 25 and 26. The same vessel left the channel south of Berth 29. All of the vessels remained close to the west side of the SAC during the exercise due to the 15knot wind blowing from the east. Again, pilot comments indicated that the knuckle area remains constricted, particulary south of the former USCG position and across from Berth 29. The average pilot rating for Overall Safety for this scenario was 2.9.

Susan Maersk, Outbound (Berth 31-32 to OEC)

Flood Tide

Outbound, flood tide Susan Maersk runs were conducted by four pilots. In each case, at the initial portion of the run (i.e. between Berth 31 and the southern end of Berth 25) the opposing flood tide appeared to assist the pilots in keeping the vessel in the center of the SAC. One pilot kept his vessel further east while heading north in the SAC and brought his vessel to the channel edge across from Berths 25 and 26 near the relocated USCG Station. None of the other vessels came within 100ft of the eastern channel limit. However, one vessel did cross the northwest channel corner across from the USCG due to beginning the turn too soon. Because outbound vessels are accelerating and are not as affected by the presence of cross-currents, the outbound runs ended once the vessel completed the turn into the entrance channel. Again pilots commented on the tightness of the knuckle area. The average pilot rating for Overal Safety was 3.4 for this scenario.

Ebb Tide

Four pilots participated in the outbound, ebb tide scenario. In all cases, the vessels transited in the same direction as the tidal currents and had more difficulty staying in the center of the channel between Berths 31 and 25. The wind appeared to keep these vessels along the west side of the channel. Although several runs came close to the channel's edge, only one run left the channel at any time during the simulations. One vessel crossed the northwest corner of the SAC by the USCG station by about 20ft. Another went further north than the other vessels before turning into the entrance channel, but the ship made the turn without any problem. According to pilots the constriction at the knuckle remained a problem. The average pilot rating for Overall Safety was 3 for this scenario.

Bellatrix, Inbound (Berth 31 to DCC Berth)

Flood Tide

Flood tide, inbound Bellatrix runs consisted of four bow first and four stern first transits. Four pilots participated in each of these scenarios. During the bow first runs, two of the pilots left the SAC north of the turning basin. Both of the vessels left the eastern side of the channel, one by about 30ft and the other by about 5ft. Another vessel cut the northwest corner of the intersection of the SAC and the canal. Although the flood tide helped the vessel make the turn, swinging the vessel's stern to the south while it was turning, comments indicated turning basin dimensions continued to provide inadequate manuevering room. The presence of a vessel at Berth 33C (absent during Series I cases also increased the difficulty of the maneuver. The average pilot rating for Overall Safety for this scenario was 3.1.

During the stern first runs, one vessel left the SAC twice by about 40ft each time. Both incidents occurred on the eastern side of the SAC across from Berth 33C, just north of the DCC turning area. One vessel also left the eastern side of the turning area by about 30ft and another cut the northwest corner of the intersection of the SAC and DCC. Again, the overall size and dimensions of the turning basin, particulary in the vicinity of Berth 33C, were a problem in conducting the manuever. The average pilot rating for Overall Safety was 1.8 for this scenario.

Ebb Tide

Inbound, ebb tide Bellatrix runs consisted of four bow first and four stern first transits. Four pilots participated in these scenarios. During the ebb tide, bow first runs, one pilot turned in the turning basin and backed his vessel in rather than pulling in bow first. The remainder of the runs were completed successfully using the proper vessel orientation. The only incident was a vessel cutting the northwest corner of the intersection of the SAC and the DCC. Pilot comments again mentioned the tightness in the vicinity of Berth 33C. The average pilot rating for Overall Safety was 2.8 for this scenario.

During the stern first runs, one pilot crossed into the SAC just north of the turning area. In general, however, the pilots were better able to stay in the SAC north of the DCC turning basin. Due to a miscommunication, one pilot conducted a bow first maneuver. The most significant incident occurred within the turning basin when one vesssel left the eastern edge by about 60ft. The presence of ebb currents tended to press vessels to the east. Again Berth 33C was considered a difficult area. The average pilot rating for Overall Safety was 3 for this scenario.

Bellatrix, Outbound (DCC Berth to Berth 31)

Flood Tide

Outbound, flood tide Bellatrix runs consisted of four bow first and four stern first transits. Four pilots participated in these scenarios. During the flood tide, bow first runs, one pilot left the southwest corner of the turning basin because he began his port turn too soon. Another vessel clipped the northwest corner of the intersection of the SAC and the canal. As the vessels left the DCC and entered the SAC, the flood tide pushed the vessel's bow to port, opposite the direction the pilots was trying to turn. Pilot comments again noted the tightness at Berth 33C, particulary in the presence of the tidal currents. The average pilot rating for Overall Safety was 2.6 for this scenario.

During stem first runs, several of the pilots cut across the northwest corner of the intersection of the SAC and the DCC in the vicinity of Berth 33C. The only significant incident occurred when one pilot failed to stop his vessel from swinging as he completed the turning maneuver and left the channel on the east side, just north of the turning basin. Again overall turning basin dimensions were considered to be tight. The average pilot rating for Overall Safety was 2.6 for this scenario.

Ebb Tide

Outbound, ebb tide Bellatrix runs consisted of four bow first and four stern first transits. Four pilots paticipated in these scenarios. During the ebb tide, bow first runs, two pilots crossed the channel limits as they turned north into the SAC, one on the east side of the channel and one on the west side. Overall, the ebb current helped the vessels make the turn from the DCC into the SAC. Tightness in the vicinity of Berth 33C was again mentioned in the pilot comments. The average pilot rating for Overall Safety for this scenario was 2.9.

During the stern first runs, one of the vessels clipped the northern edge of the channel in the northwest corner of the turning basin. All remaining runs were completed successfully and without incident. It was noted that the maneuver could use more space, particulary in the vicinity of Berth 33C. The average pilot rating for Overall Safety was 3 for this scenario.

Susan Maersk, Turning Notch

In order to evaluate the TN, two runs were made in which pilots attempted to turn the Susan Maersk design vessel in the TN. One run was under flood tide conditions and the other was under ebb tide conditions. Although the flood tide appeared to assist the ship during the maneuver by turning the vessel's stern to the south as the vessel backed out of the notch, the pilot was unable to complete the maneuver successfully. During the ebb tide run, the current had the opposite affect and the vessel was unable to counter the forces turning its stern north as the pilot tried to back out of the notch. The pilot was unable to complete either maneuver successfully. The average pilot rating for Overall Safety was 1 for both scenarios.

Atlantic Class Vessel, Turning Notch

In addition too the two runs made using the larger Susan Maersk design vessel, two runs were made using the Atlantic Class design vessel. One run was made under flood tide conditions and the other under ebb tide conditions. During the flood tide run, the pilot was able to turn, but left the western channel limit as it entered the TN. During the ebb tide run, the currents affected the Atlantic Class vessel in the much the same manner as they did the Susan Maersk. Neither run was completely successful. The average pilot rating for Overall Safety was 1 for both scenarios.

Series II Conclusions and Recommendations

Overall, the results of the Series II simulation were better than the results from the Series I simulation. However, several observations and recommendations can be made.

Inbound ships are subjected to a variety of cross-currents in the Port Everglades entrance channel. The ships are slowing down as they approach the jetties and are very much influenced by these currents. This has also been observed in real-life. The simulation

exercises show the pilots using the additional width in the OEC, particulary on the north side. Although several vessels left the north side of the channel, it appears that they may have been able to keep the vessels further south had the simulations started further east and the pilots given more time to set up for the entrance channel. It should also be noted that several of the pilots stated that they currents seemed too strong compared to real-life experience at the port. It is recommened that the OEC extension be widened by 150ft on both the north and south side of the channel as it was tested during Series II.

Moving the USCG Station and boat basin to the east, away from the navigation channel, is vital for the development of the port. It is recommended that the USCG basin be relocated as it was during the Series II simulation.

The width and alignment of the proposed SAC south of Berth 29 is adequate for the Susan Maersk design vessel. However, the region north of Berth 29 through the knuckle area remains tight despite relocation of the USCG basin. It is recommended that SAC be widened approximately 50ft to 60ft between the USCG basin and Berth 29.

Results of the DCC, particulary at the DCC turning basin do not show a significant improvement over those for the configuration tested in Series I. This is most likely due to the addition of a vessel at Berth 33C during the Series II cases. Also, it was general felt by the pilots that the design vessel in these cases was an extremely bad handling vessel. Based on overall results and comments, it can be seen that several areas consistently caused problems. It is recommended that the alignment of the turning basin be modified by extending southern and eastern limits of the basin and adding a 50ft eastern expansion in the vicinity of Berth 33C, just north of the intesection with the DCC.

Series III Simulation

General

Series III ship simulation runs were conducted at the RTM STAR Center between June 2003 and July 2003. Six Port Everglades Pilots conducted simulator runs that employed five design vessels. Runs included, inbound, outbound, and turning scenarios under both flood tide and ebb tide conditions. Winds coming at 15 knots from East and Northwest directions were considered to represent the "worst case" wind conditions. Simulations took place using channel dimensions that were modified based upon Series II recommendations.

Modifications Based on Series II Simulation

Southport Access Channel

The results of the Series II ship simulation study showed that the USCG station is a navigational hazard to Post-Panamax vessels and must be relocated. Series II results also indicated the need to increase the width of the SAC between berths 24 and 29. This was

accomplished by expanding the SAC channel to the east a maximum of 60ft (north of Berth 26) and a maximum of 50ft (south of Berth 26) (figure 15). No additional modifications were required for the OEC, IEC, MTB or Widener designs. It should be noted that the pilots remain concerned about the depth in the OEC channel. This issue will be addressed in the USACE feasibility report.

Turning Notch

Due to flood and tide current patterns in the SAC as well as the overall size of the design vessel, the TN design proved to provide inadequate maneuvering room to allow for either the berthing or turning of a post-panamax vessel. To accommodate berthing, it was necessary to first increase the interior dimensions of the TN and to modify the SAC to the north and east of the TN. This involved (1) expanding the limits of the TN to the north by 40ft, (2) gradually increasing the SAC channel width from 400ft to 530ft along the conservation easement beginning just south of berth 29 and ending at the TN, and (3) adding a 1,340ft long by 75ft wide expansion to the eastern SAC channel limits east of the TN. To incorporate turning of the design vessel, an additional 500ft by 75ft expansion cut was added to the eastern SAC limits south of the previous 1,340ft cut. Figure 16 illustrates TN modifications.

Dania Cutoff Canal

Due primarily to strong currents associated with the intersection of the DCC and SAC, channel limits of the DCC turning basin were found to be unsuitable for transiting a Panamax vessel to berths located in the DCC. In order to remedy this, an expansion of the DCC turning basin was developed. This was accomplished through the following: (1) addition of a 50ft wide eastward expansion of the channel just north of the turning basin extending from the southern end of Berth 32 to the intersection of the DCC and SAC, (2) addition of a 300ft by 375ft extension of the turning basin extending to the south into the ICWW, and (3) widening of the northwest and southwest corners of the turning basin. Remaining DCC dimensions were found to adequately meet safety standards. Figure 17 illustrates DCC modifications.

Series III Testing Matrix

The testing matrix for the Series III Ship Simulation is provided in Table 4. It should be noted that Susan Maersk and Voyager runs involving the SAC (E01 through E16) used both Series II and Series III layouts. Modifications to the SAC are considered vital to the development of the port and it was deemed important that the same pilots complete both plan layouts. Bellatrix to the DCC runs also used two design plans, one with only the southern expansion of the turning basin and the other with the southern, eastern, and northeastern expansions. TN runs were conducted with four vessels. Three vessels used a design plan which included all north and east expansions of the TN, while the forth used a design plan which did not include the eastern expansion. All simulation runs consisted of both inbound and outbound scenarios under both flood and ebb tide conditions. Vessel orientation was specified only for DCC and TN runs in order to better

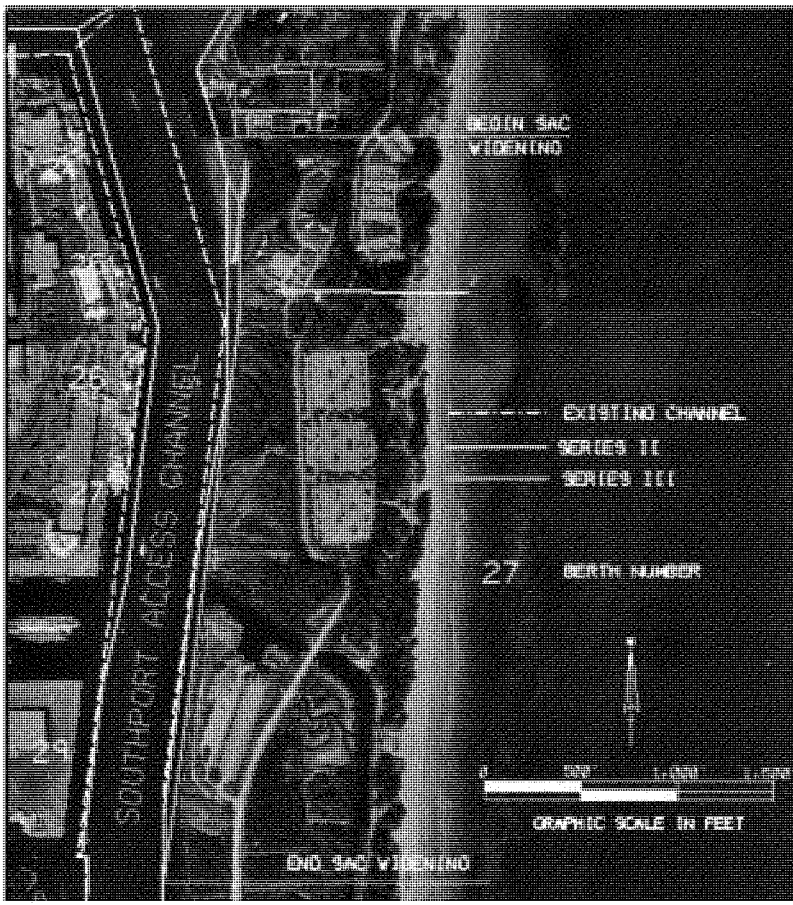


Figure 15. Modifications to Southport Access Channel for Series III Simulation

evaluate the difficult turning conditions at both locations. Winds were 15knots and originated from two directions, East and Northeast. Vessels at berth during transit are also specified.

Series III Pilot Evaluation Forms

Upon completion of each test run, pilot's were asked to fill out a pilot evaluation form. These forms, including questions and rating systems were identical to the evaluation forms used for the Series I Simulation (Table 2) with one exception. Under the topic of "Vessel Tracking" an forth question was added: "Maneuvering room at turning basin". The same rating scale was applied with "5" being given for an "extremely satisfactory" run and "1" being given for a run that was "not at all satisfactory". The remainder of the questions were unchanged.

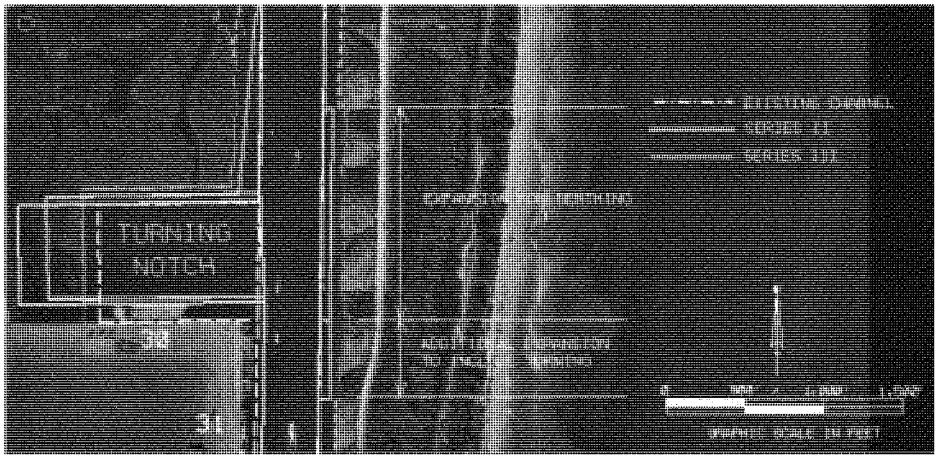


Figure 16. Modification of Turning Notch for Series III Simulation

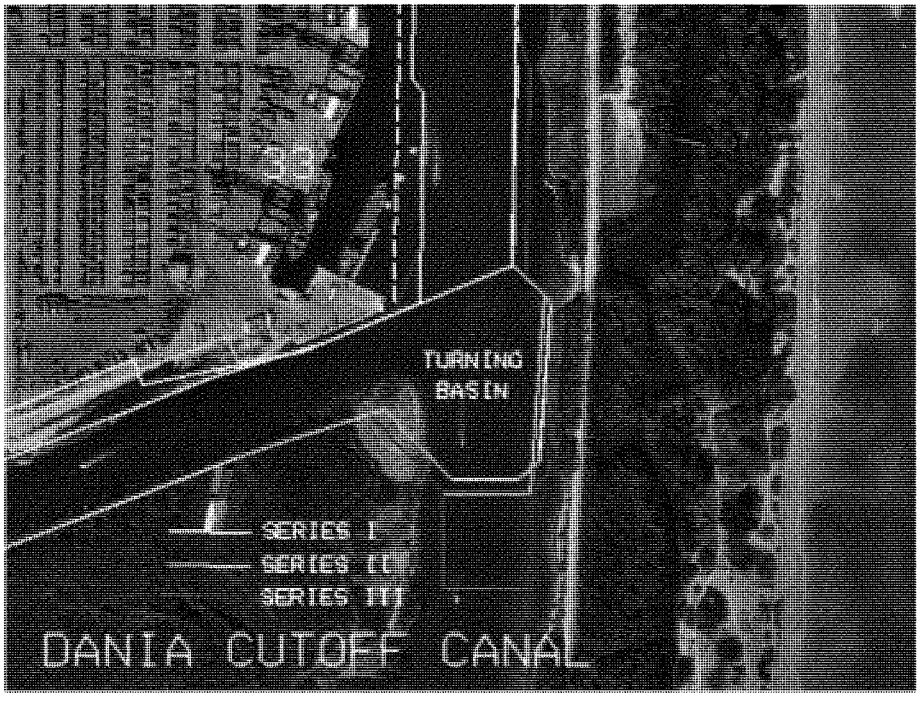


Figure 17. Modification of Dania Cutoff Canal for Series III Simulation

Table 4. Series III Testing Matrix

Run ID	Project Element(s)	Design Vessel	Direction	Bow/ Stern [1]	Tide	Wind	Vessels At Berth Berth	Vessel
E01	MTB, Widener, SAC (Series II layout)	Susan Maersk	Inbound		Flood	15knot - East	25,26,29	Cruise
E02	MTB, Widener, SAC (Series II layout)	Susan Maersk	Inbound		Ebb	15knot - East	25,26,29	Cruise
E03	MTB, Widener, SAC (Series II layout)	Susan Maersk	Outbound		Flood	15knot - East	25,26,29	Cruise
E04	MTB, Widener, SAC (Series II layout)	Susan Maersk	Outbound		Ebb	15knot - East	25,26,29	Cruise
E05	MTB, Widener, SAC (Series III layout)	Susan Maersk	Inbound		Flood	15knot - East	25,26,29	Cruise
E06	MTB, Widener, SAC (Series III layout)	Susan Maersk	Inbound		Ebb	15knot - East	25,26,29	Cruise
E07	MTB, Widener, SAC (Series III layout)	Susan Maersk	Outbound		Flood	15knot - East	25,26,29	Cruise
E08	MTB, Widener, SAC (Series III layout)	Susan Maersk	Outbound		Ebb	15knot - East	25,26,29	Cruise
E09	MTB, Widener, SAC (Series II layout)	Voyager	Inbound		Flood	15knot - East	25,26	Cruise
E10	MTB, Widener, SAC (Series II layout)	Voyager	Inbound		Ebb	15knot - East	25,26	Cruise
E11	MTB, Widener, SAC (Series II layout)	Voyager	Outbound		Flood	15knot - East	25,26	Cruise
E12	MTB, Widener, SAC (Series II layout)	Voyager	Outbound		Ebb	15knot - East	25,26	Cruise
E13	MTB, Widener, SAC (Series III layout)	Voyager	Inbound		Flood	15knot - East	25,26	Cruise
E14	MTB, Widener, SAC (Series III layout)	Voyager	Inbound		Ebb	15knot - East	25,26	Cruise
E15	MTB, Widener, SAC (Series III layout)	Voyager	Outbound		Flood	15knot - East	25,26	Cruise
E16	MTB, Widener, SAC (Series III layout)	Voyager	Outbound		Ebb	15knot - East	25,26	Cruise
E17	DCC – South Expansion Only	Bellatrix	Inbound	Bow	Flood	15knot - Northwest	33C	Ambassador
E18	DCC – South Expansion Only	Bellatrix	Inbound	Bow	Ebb	15knot - Northwest	33C	Ambassador
E19	DCC – South Expansion Only	Bellatrix	Inbound	Stern	Flood	15knot - Northwest	33C	Ambassador
E20	DCC – South Expansion Only	Bellatrix	Inbound	Stern	Ebb	15knot - Northwest	33C	Ambassador
E21	DCC – South Expansion Only	Bellatrix	Outbound	Bow	Flood	15knot - Northwest	33C	Ambassador
E22	DCC – South Expansion Only	Bellatrix	Outbound	Bow	Ebb	15knot - Northwest	33C	Ambassador
E23	DCC – South Expansion Only	Bellatrix	Outbound	Stern	Flood	15knot - Northwest	33C	Ambassador
E24	DCC – South Expansion Only	Bellatrix	Outbound	Stern	Ebb	15knot - Northwest	33C	Ambassador
E37	DCC – All Expansions	Bellatrix	Inbound	Bow	Flood	15knot - Northwest	33C	Ro/Ro
E38	DCC – All Expansions	Bellatrix	Inbound	Bow	Ebb	15knot - Northwest	33C	Ro/Ro
E39	DCC – All Expansions	Bellatrix	Inbound	Stern	Flood	15knot - Northwest	33C	Ro/Ro
E40	DCC – All Expansions	Bellatrix	Inbound	Stern	Ebb	15knot - Northwest	33C	Ro/Ro
E41	DCC – All Expansions	Bellatrix	Outbound	Bow	Flood	15knot - Northwest	33C	Ro/Ro
E42	DCC – All Expansions	Bellatrix	Outbound	Bow	Ebb	15knot - Northwest	33C	Ro/Ro
E43	DCC – All Expansions	Bellatrix	Outbound	Stern	Flood	15knot - Northwest	33C	Ro/Ro
E44	DCC – All Expansions	Bellatrix	Outbound	Stern	Ebb	15knot - Northwest	33C	Ro/Ro
E25	TN – All Expansions	SL Anchorage	Inbound	Bow	Flood	15knot - East	30, ro/ro	Susan Maersk, Ambassador
E26	TN – All Expansions	SL Anchorage	Inbound	Bow	Ebb	15knot - East	30, ro/ro	Susan Maersk, Ambassador
E27	TN – All Expansions	SL Anchorage	Outbound	Stern	Flood	15knot - East	30, ro/ro	Susan Maersk, Ambassador
E28	TN – All Expansions	SL Anchorage	Outbound	Stern	Ebb	15knot - East	30, ro/ro	Susan Maersk, Ambassador
E29	TN – All Expansions	Atlantic Class	Inbound	Bow	Flood	15knot - East	Ro/ro	Ambassador
E30	TN – All Expansions	Atlantic Class	Inbound	Bow	Ebb	15knot - East	Ro/ro	Ambassador
E31	TN – All Expansions	Atlantic Class	Outbound	Stern	Flood	15knot - East	Ro/ro	Ambassador
E32	TN – All Expansions	Atlantic Class	Outbound	Stern	Ebb	15knot - East	Ro/ro	Ambassador
E33	TN – All Expansions	Susan Maersk	Inbound	Bow	Flood	15knot - East	Ro/ro	Ambassador
E34	TN – All Expansions	Susan Maersk	Inbound	Bow	Ebb	15knot - East	Ro/ro	Ambassador
E35	TN – All Expansions	Susan Maersk	Outbound	Stern	Flood	15knot - East	Ro/ro	Ambassador
E36	TN – All Expansions	Susan Maersk	Outbound	Stern	Ebb	15knot - East	Ro/ro	Ambassador
E45	TN – No East Expansion	Jutlandia	Inbound	Bow	Flood	15knot - East	Ro/ro	Ambassador
E46	TN – No East Expansion	Jutlandia	Inbound	Bow	Ebb	15knot - East	Ro/ro	Ambassador
E47	TN – No East Expansion	Jutlandia	Outbound	Stern	Flood	15knot - East	Ro/ro	Ambassador
E48	TN – No East Expansion	Jutlandia	Outbound	Stern	Ebb	15knot - East	Ro/ro	Ambassador

[1] Orientation (bow or stern first) was left to pilot discretion except for DCC and TN simulation runs

Series III Results

Plots showing average Pilot evaluation ratings for each run completed during the Series III simulation are shown in Attachment III. Actual composite tracks plots and pilot questionnaires will remain at USACE SAJ as these original documents are considered to be proprietary information belonging to the Port Everglades Pilots Association.

Susan Maersk, Inbound (OEC to Berth 31-32)

Flood Tide

Inbound, flood tide Susan Maersk runs were conducted by four pilots. Two vessels crossed into the northern portion of Berth 24 during the turning maneuver in the MTB. The area is in deep water, however, and the pilots did not regard this to be a problem. Once they had completed the turn in the MTB and begin backing down the SAC, none of the vessels strayed from the channel. The pilots rated the modified SAC transit as significantly safer than the Series II configuration. Series II received an average pilot rating for Overall Safety of 1.7 while the Series III plan received a rating of 3.5. The higher numbers indicate increased safety. The pilots commented that the extra room to the east improved the maneuver significantly.

Ebb Tide

Inbound, ebb tide Susan Maersk runs were conducted by three pilots. Although none of the pilots strayed beyond the SAC channel limits, all of the vessels came very close to the western channel edge several times. It should be noted that one pilot stated that he did not know how much additional room was available in the widener, which affected his positioning going into the SAC. Although the pilots still noted a tightness to the knuckle area, comments were generally favorable about the added width. The average pilot rating for Overall Safety for this scenario is was 2.7 for both the Series II and Series III plans.

Susan Maersk, Outbound (Berth 31-32 to OEC)

Flood Tide

Outbound, flood tide Susan Maersk runs were conducted by four pilots. None of the pilots strayed beyond the channel limits of the SAC and gave generally favorable comments to the overall. In all cases the pilot noted the channel was tight, but also indicated sufficient room to complete the maneuver. The average pilot rating for Overall Safety increased from 2.8 for the Series II plan to 3.8 for the Series III plan.

Ebb Tide

Outbound, ebb tide Susan Maersk runs were conducted by four pilots. Two of the pilots left the channel south of the cruise ship docked at berth 29 while attempting to align with

the southern portion of the channel. Both pilots were able to recover and complete the remainder of the run without incident. Despite these minor incidents, the average pilot rating for Overall Safety increased from 2.8 for the Series II plan to 3.5 for the Series III plan.

Voyager, Inbound (OEC to Berth 29)

Flood Tide

Inbound, flood tide Voyager runs were conducted by three pilots. Two of the pilots swung too far west while making the turn in the MTB. This was partially due to lack of tug assist and experimentation with the thruster system. Once in the channel, all of the pilots were able to stay far enough to the east to avoid the cruise ships docked at berths 25 and 26. Comments reflected that the eastern expansion at the knuckle was required for safe completion of the maneuver. The average pilot rating for Overall Safety increased from 3.2 for the Series II plan to 3.8 for the Series III plan.

Ebb Tide

Inbound, ebb tide Voyager runs were made by three pilots. All of the runs were completed successfully, with the pilots being able to keep their vessels within all channel limits and away from the docked cruise ships. Comments were favorable and comments reflected the importance of the eastward expansion at the knuckle. The average pilot rating for Overall Safety increased from 3 for the Series II plan to 3.5 for the Series III plan.

Voyager, Outbound (Berth 29 to OEC)

Flood Tide

Outbound, flood tide Voyager runs were conducted by three pilots. Again, all of the runs were completed successfully with the pilots being able to maintain their positions within the channel limits and away from the cruise ship. Comments indicated that the maneuvers were "comfortable" with the additional width in the knuckle area. The average pilot rating for Overall Safety was 4 for both the Series II and Series III plans.

Ebb Tide

Outbound, ebb tide Voyager runs were conducted by three pilots. Although, the pilots commented that this was a somewhat difficult maneuver given the size of the vessel, all runs were completed successfully with the vessels remaining within the channel limits and away from the docked cruise ships. The average pilot rating for Overall Safety was 4 for both the Series II and Series III plans.

Susan Maersk, Inbound, Turning Bow First in the Turning Notch

Flood Tide

Inbound, Susan Maersk turning runs were conducted bow first under both flood tide conditions. Four pilots participated in this scenario. One pilot strayed 40ft out of the north channel limit during the turn. Two other vessels strayed less than 10ft out of the eastward expansion. All of the vessels required the additional widening to the north and east as well as the empty berth space at Berths 30 and 31. Pilots regarded this maneuver as having no room for error. In real-life it would be conducted only under ideal conditions. The average pilot rating for Overall Safety was 2.0 for this scenario.

Ebb Tide

Four pilots participated in the inbound, ebb tide cases. The ebb tide runs were conducted stern first. All of the pilots successfully completed the maneuver, again using all available space in the vicinity of the TN including berths 30 and 31. Comments reflected the difficulty of the maneuver and noted again that there was little to no margin of error. The average pilot rating for Overall Safety was 2.3 for this scenario.

Susan Maersk, Outbound, Turning Stern First in the Turning Notch

Flood Tide

Outbound, Susan Maersk turning runs were conducted bow first under flood tide conditions. For pilots participated in the scenario. All four runs were completed successfully, but were again considered to very difficult maneuvers. In each case, the pilot was able to penetrate further west into the TN and did not require the use of the additional widening to the east. The average pilot rating for Overall Safety was 2.5 for this scenario.

Ebb Tide

Four pilots participated in the outbound, ebb tide cases. During the ebb tide runs, one of the vessels left the northeast corner of the notch by approximately 10ft when swing the bow of the vessel in the SAC. Another vessel went to the channel's edge near the north end of the eastern expansion. All runs were completed successfully, but left no margin for error. The average pilot rating for Overall Safety was 3.5 for this scenario.

Atlantic Class, Inbound, Turning Bow First in the Turning Notch

Inbound, Atlantic Class turning runs were conducted bow first under both flood and ebb tide conditions. Four pilots participated in these runs. The Atlantic Class is a smaller vessel than the Susan Maersk and pilots had little difficulty in completing the maneuver successfully under either of the tide conditions. It should be noted that the Atlantic Class vessel did require the additional room offered by the eastern expansion in order to

complete the maneuver. The average pilot rating for the Overall Safety was 3.7 for flood tide runs and 4 for ebb tide runs.

Atlantic Class, Outbound, Turning Stern First in the Turning Notch

Outbound, Atlantic Class turning runs were conducted stern first under both flood and ebb tide conditions. Four pilots participated in these runs. Again, the Atlantic Class is a smaller vessel than the Susan Maersk and pilots had little difficulty in completing the maneuver. The average pilot rating for the Overall Safety was 3.7 for both flood tide runs and ebb tide runs.

SL Anchorage, Inbound, Turning Bow First in the Turning Notch

Inbound, SL Anchorage runs were made under both flood and ebb tide conditions. Four pilots participated in these exercises. It was left to the pilot to determine if the run would be made bow or stern first. All of the runs were completed successfully with little difficulty. During most runs, the eastern expansion was left unused, but vessels did stay very close to crossing into it. Comments were favorable and the average pilot rating for Overall Safety was 4 for the flood tide runs and 3.8 for ebb tide runs.

SL Anchorage, Outbound, Turning Stern First in the Turning Notch

Outbound, SL Anchorage runs were made under both flood and ebb tide conditions. Four pilots participated in these exercises. Again, it was left to the pilot to determine if the run would be made bow or stern first. All of the runs were completed successfully with little difficulty. Comments indicated that there was adequate room to maneuever. The average pilot rating for Overall Safety was 4 for both flood tide and ebb tide runs.

Jutlandia, Inbound, Turning Bow First in the Turning Notch

Inbound, Jutlandia runs were made under both flood and ebb tide conditions. Four pilots participated in these exercises. The Jutlandia was the smallest of the vessels to be turned in the TN. Once it became obvious that the east expansion would be unnecessary for this vessel, the expansion was removed. The northern expansions were left in place. Not surprisingly, all of the runs were completed successfully with little difficulty although the maneuver was tighter without the expansion. Comments were generally favorable and the average pilot rating for Overall Safety was 3 for both flood tide and ebb tide.

Jutlandia, Outbound, Turning Stern First in the Turning Notch

Outbound, Jutlandia runs were made under both flood and ebb tide conditions. Four pilots participated in these exercises. All of the runs were completed successfully with little difficulty with comments indicating a tight but doable maneuver. The average pilot rating for Overall Safety was 3.3 for the flood tide runs and 3.5 for the ebb tide runs.

Bellatrix, Inbound (Berth 31 to DCC Berth)

Flood Tide

Inbound, flood tide Bellatrix runs consisted of four bow first and four stern first scenarios. In addition, the same vessel orientations were run for two different design plans. The first plan involved adding only the southern expansion to the DCC turning basin. The second plan involved the complete expansion of the turning basin. It should be noted that a larger vessel was placed at Berth 33C during runs that included all of the proposed expansions.

All bow first runs with the south expansion were successful, although three of the pilots brought the stern of the vessel very close to the eastern edge across from Berth 33C as they made the turn into the DCC. Pilots noted that the vessel at Berth 33C was smaller than vessels that normally berth there and indicated that a larger vessel would significantly complicate the manuever. It should be noted that none of the pilots in these runs made use of the southern expansion. The average pilot rating for Overall Safety was 3.5 for this scenario.

During runs made with the full turning basin expansion, one pilot swung his stern into the eastward expansion, while the other three stayed very close to the eastern edge. All of the runs were completed successfully and received generally favorable comments. Pilots indicated that the expansion across from Berth 33C increases the safety of the manuever. The average pilot rating for Overall Safety was 3.7 for this scenario.

Bellatrix, stern first inbound runs under flood conditions were completed by four pilots. During runs made with the southern expansion alone, pilots were able to successfully able to bring the vessel to berth, but had to keep their vessels close to the corner of Berth 33C and the vessel docked there in order to keep the stern clear of the eastern channel limit. Pilots used the southern expansion to make the turn into the DCC and agreed that the additional space was necessary. However, pilots indicated they were uncomfortable with the proximity to the berthed vessel and felt the area around Berth 33C remained too tight. The average pilot rating for Overall Safety was 2 for this scenario.

During stern first runs made with the full turning basin expansion, pilots were able to stay within the channel limits by using the southern expansion and the extra room provided in the vicinity of Berth 33C. Comments indicated that all of the expansions used in this scenario were necessary to improve the safety of the manuever. The average pilot rating for Overall Safety was 3 for this scenario.

Ebb Tide

As with the flood tide runs, inbound ebb tide runs consisted of four bow first and four stern first scenarios for two different design plans. Again a larger vessel was placed at Berth 33C when the full expansion plan was evaluated.

During bow first, ebb tide runs made with the southern expansion, all of the runs were completed successfully. Although none of the pilots brought their vessels beyond the eastward channel limits across from Berth 33C, vessel remained close to it. Despite comments reflecting that the turning basin remained tight, the average pilot rating for Overall Safety was 4 for this scenario.

Bow first, ebb tide runs for the complete turning basin expansion were very similar to those with only the southern expansion. All of the runs were completed successfully. Although none of the pilots brought their vessels into the eastward expansion across from Berth 33C, one vessel did come close to the north-west edge of it. Comments were favorable about the additional space. The average pilot rating for Overall Safety was 3.3 for this scenario.

During stern first, ebb tide runs made with the southern expansion were all completed successfully. Pilots stayed within channel limits but tended to stray close to the corner of Berth 33C and the vessel docked there. Again it was noted that the vessel at Berth 33C was smaller than those normally at berth and that a larger vessel would impact the ability to complete the maneuver safely. The average pilot rating for Overall Safety was 3.5 for this scenario.

During stern first, ebb tide runs for the complete turning basin three pilots completed the maneuver successfully. The fourth pilot collided with the north side of the DCC just after turning in the basin. Pilot indicated that the error was a result of a communication problem. All of the runs made use of the additional room to the south, but none of the vessels made use of the eastern expansion. While the average pilot rating for Overall Safety was a relatively low 2.5, it should be noted that three of the pilots gave this scenario a 3 for safety while the remaining pilot rated it a 1, or "not safe at all". The pilot who rated the scenario lowest commented that the visibility in the simulator was not adequate.

Bellatrix, Outbound (DCC Berth to Berth 31)

Flood Tide

As with the inbound runs, outbound flood tide runs consisted of four bow first and four stern first scenarios for two different design plans. Again a larger vessel was placed at Berth 33C when the full expansion plan was evaluated.

During the bow first outbound runs for the southern expansion, pilots had to come close to the southern corner of Berth 33C in order to swing the stern of the vessel into the turning basin. While all runs were completed successfully, without use of the southern extension of the turning basin, the pilots commented that it required a great deal of power and assistance to keep the vessel from going aground on the east bank. The average pilot rating for Overall Safety was 3 for this scenario.

During the bow first outbound runs for the full turning basin expansion, pilots completed all of the runs successfully despite the larger vessel at Berth 33C. While none of the pilots brought their vessel into the east expansion across from the Berth, overall comments indicate that having the additional space provided increased confidence when bringing the bow into the flood current during the turn. The average pilot rating for Overall Safety was 3.5 for this scenario.

Bellatrix, stern first outbound runs using only the southern expansion were all completed successfully. It should be noted, however, that as the pilots emerged from the turning basin and began moving to the north, the flood current pressed the vessels to the west toward Berth 33C. Had the vessel at berth been larger, the runs may not have been as successful. The average pilot rating for Overall Safety was 3.3 for this scenario.

During the stern first outbound runs using the full expansion of the turning basin, one pilot was unable to back out of the DCC due to an inability to judge distances in the simulator. The run was unsucessful and resulted in an individual safety rating of 1. The remaining three runs were completed successfully although one pilot cut the southeast corner of the DCC while backing into the south expansion. The average pilot rating for Overall Safety was 3.0. However, pilots who completed the scenario gave it a safety rating of 4.

Ebb Tide

During the outbound, bow first runs using the southern expansion only, three of the runs were completed successfully. Of the three, two clipped the northwest corner of the turning basin and the third left the south channel limit just prior to entering the turning basin. The forth pilot left the channel to the east across from Berth 33C and caused the vessel to go aground. Pilot comments indicated that there was inadequate room in the basin for the run under ebb conditions and that if a longer vessel were at Berth 33C the maneuver would be unsafe. The average pilot rating for Overall Safety was 3.3 for this scenario.

During the bow first runs using the full turning basin expansion, pilots were able to keep their vessels within the channel limits despite the large vessel at Berth 33C. The ebb current forced the vessels to the east, requiring the additional space provided by the eastward expansion opposite the berth. Pilots commented that the added space was neccesary to complete the maneuver safely. The average pilot rating for Overall Safety was 3.3 for this scenario.

During the outbound, stern first runs using the southern expansion only, all of the pilots completed the maneuver successfully. None of the vessels left the channel limits, but vessels tended to press toward Berth 33C after completing the turn. Pilots indicated that the additional space to the south increased the safety of the maneuver and that additional room to the east would also be useful. The average pilot rating for Overall Safety was 4 for this scenario.

During the stern first runs using the complete turning basin expansion, two of the three participating pilots completed the scenario successfully. The third pilot was unable to turn his ship and went aground on the southeast corner of the turning area. Again the problem appeared to be a lack of visibility in the simulator. Of the two pilots who completed their runs, ratings were mixed. One pilot rated the run a 1 ("not at all safe") while the other rated it a 4. The average pilot rating for Overall Safety was 2.3 for this scenario.

Series III Conclusions and Recommendations

Maneuvering extremely large vessels such as the Susan Maersk and Voyager of the Seas past docked cruise ships and through the course changes necessitated by the knuckle is a difficult undertaking. The consequences of an incident involving a cruise ship (either at the dock or transiting the waterway) could be severe. The pilots have stated repeatedly that they fear not being able to bring ships to the new facilities unless the SAC is widened to the east across from the knuckle. Based on results from the final series of simulations it is recommended that the final configuration for the SAC as tested during the Series III simulations be adopted.

Turning the Susan Maersk or Voyager of the Seas in the turning notch is an extremely tight maneuver. Simulation results indicate that it can be done successfully if the final configuration, including the full eastern expansion is implemented. Pilots indicate that the conditions will have to be ideal for this maneuver to take place.

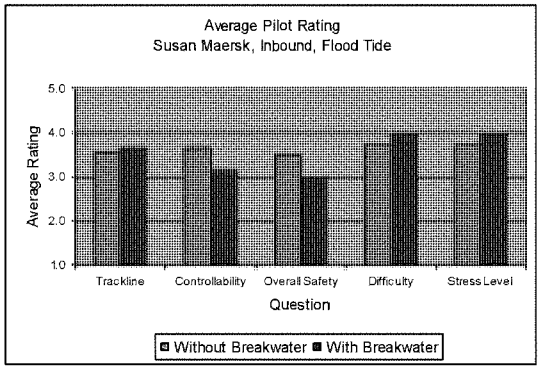
The eastern expansion across from the Turning Notch was also used by the Jutlandia, but was not required. Pilots indicated that they will turn panamax vessels on a regular basis if the expansion is constructed. They also indicated that they would turn panamax vessels without the expansion, but only under ideal circumstances. Smaller vessels, such as the SL Anchorage, will use the TN with our without the eastern expansion. Based on simulation results for the TN, it is recommended that the final configuration involving all north and expansions of the TN as tested during the Series III simulations be adopted.

In order to bring the Bellatrix into the DCC, modifications are required for the DCC turning basin. Pilots indicated that the both the eastward expansion north of the turning basin (across from Berth 33C), the eastward expansion within the turning basin, and the southern expansion of the turning basin are necessary for safe transit. Although not all vessels in the simulations used the expansion to the north, all agreed that it provided a margin of safety that increased their confidence in performing the maneuver. In addition, the eastern expansion to the north reduces bank effects making the maneuver easier. Pilots also indicated that the maneuver would not be possible during ebb tide if a larger vessel is docked at Berth 33C. Given the active nature of berth 33C and in light of simulation results and pilot's comments, it is recommended that the final configuration of the DCC including all eastern and southern expansions as tested during Series III simulations be adopted.

Attachment I

Average Pilot Evaluation Ratings

Series I Simulation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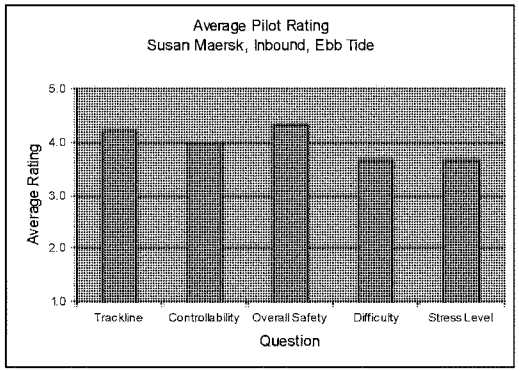
Without Breakwater
With Breakwater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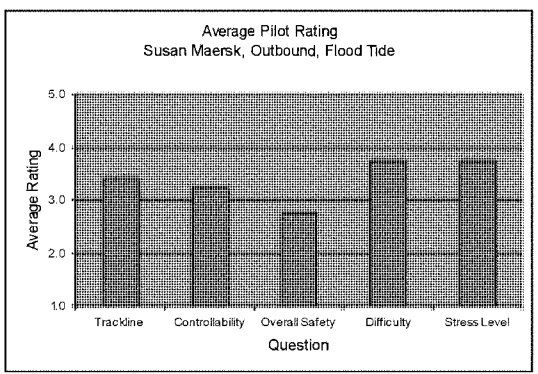
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Stress Level
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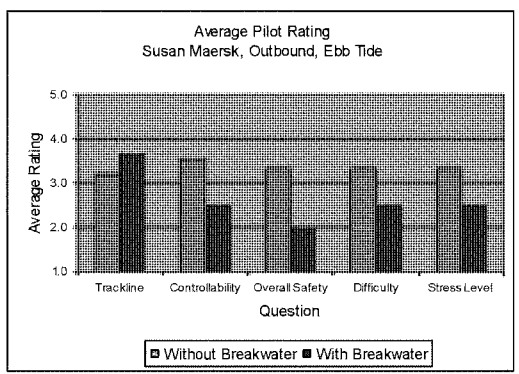
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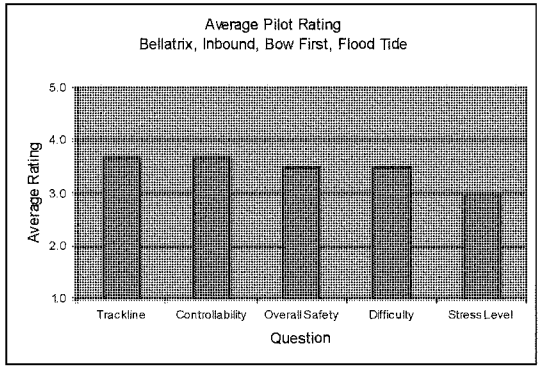
Difficulty
Stress Level
Question
Without Breakwater
With Breakwater

662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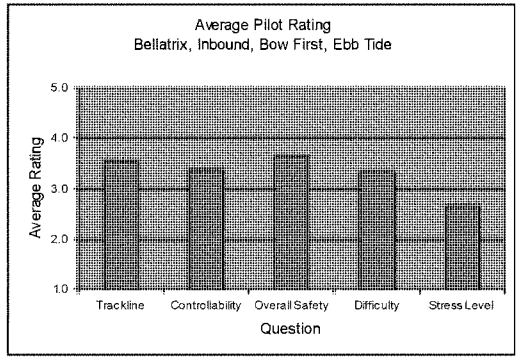
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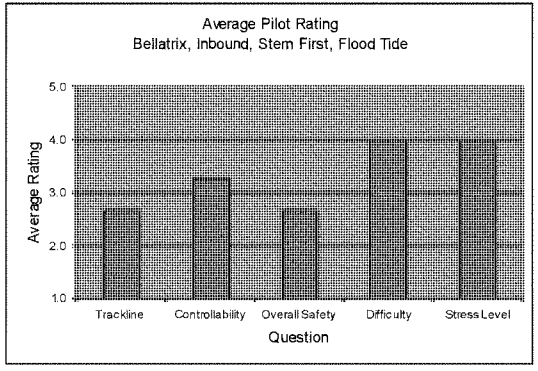
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Stress Level
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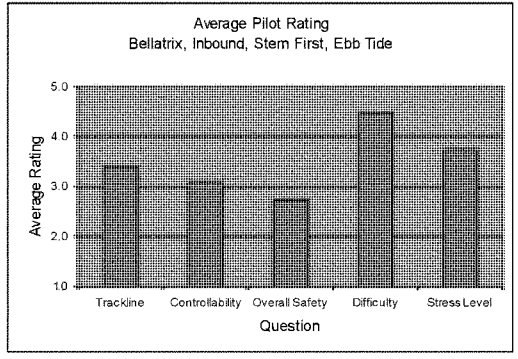
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Stress Level
Question

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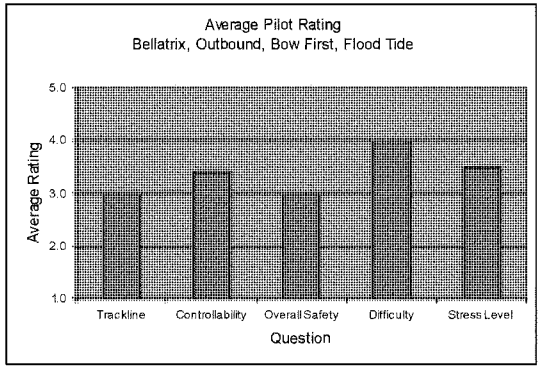
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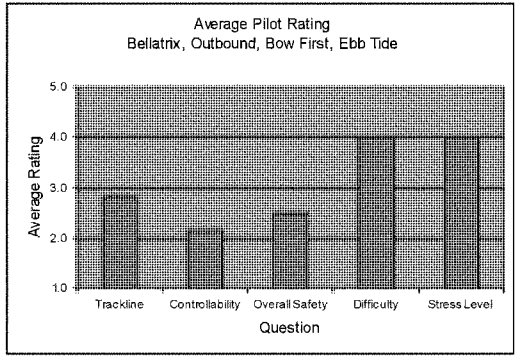
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Stress Level
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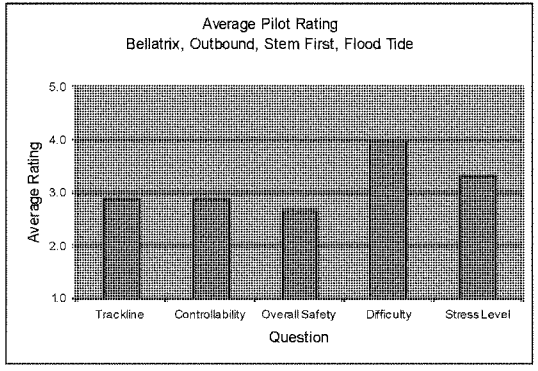
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Overall Safety
Difficulty
Stress Level
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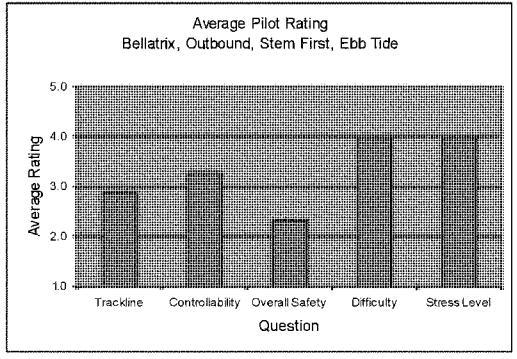
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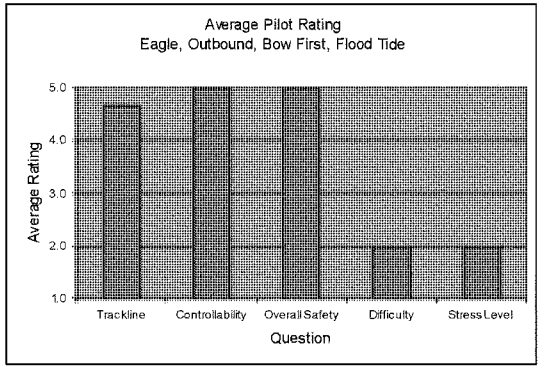
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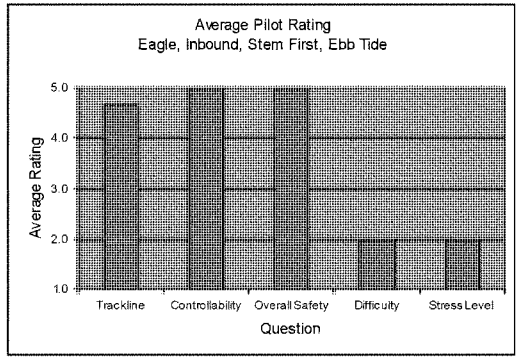
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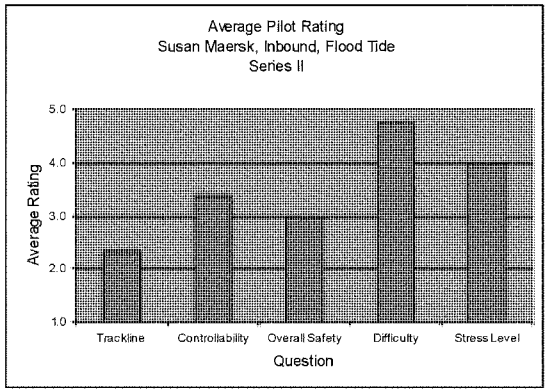
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question

Attachment II

Average Pilot Evaluation Ratings

Series II Simulation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Susan Maersk, Inbound, Flood Tide
Series II
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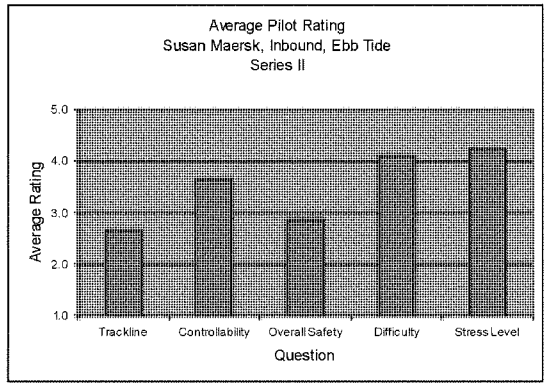
Controllability
Overall Safety
Difficulty
Stress Level
Question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Susan Maersk, Inbound, Ebb Tide
Series II
Average Rating
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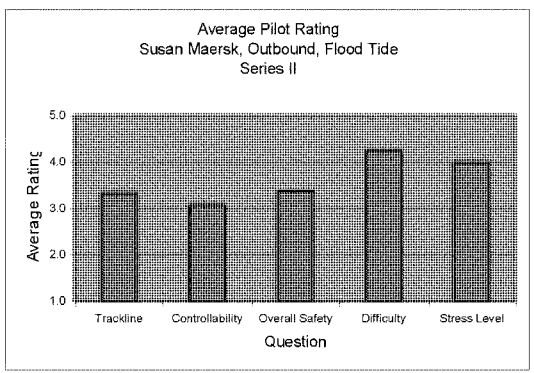
4.0
3.0
2.0
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Susan Maersk, Outbound, Flood Tide
Series II
Average Rating
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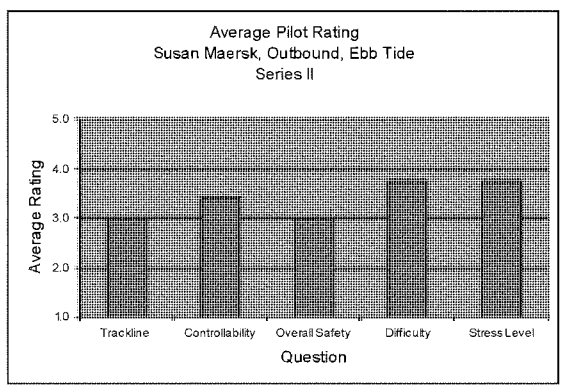
3.0
2.0
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Susan Maersk, Outbound, Ebb Tide
Series II
Average Rating
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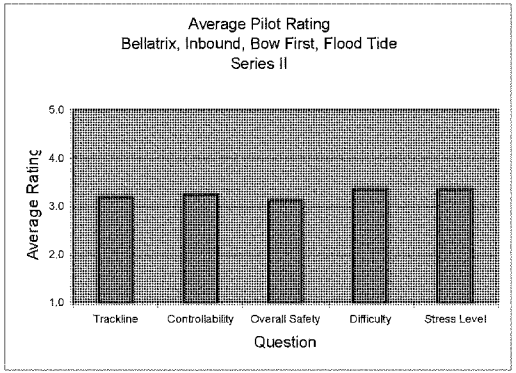
2.0
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Bellatrix, Inbound, Bow First, Flood Tide
Series II
Average Rating
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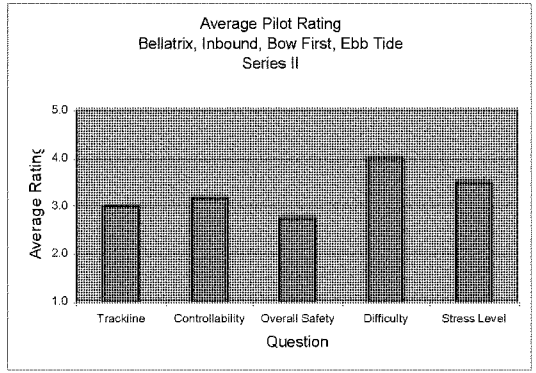
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Bellatrix, Inbound, Bow First, Ebb Tide
Series II
Average Rating
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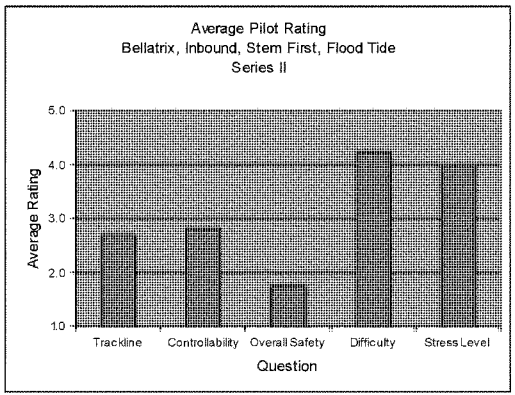
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Bellatrix, Inbound, Stem First, Flood Tide
Series II
Average Rating
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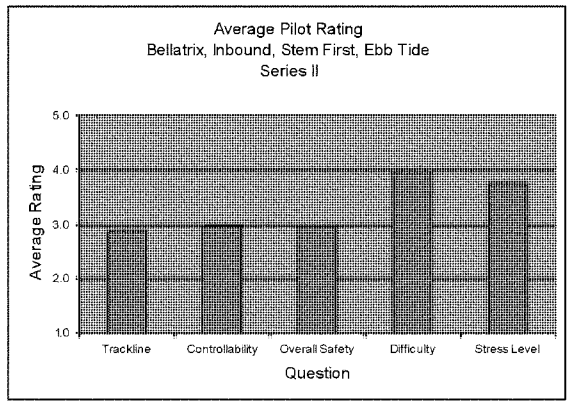
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Bellatrix, Inbound, Stem First, Ebb Tide
Series II
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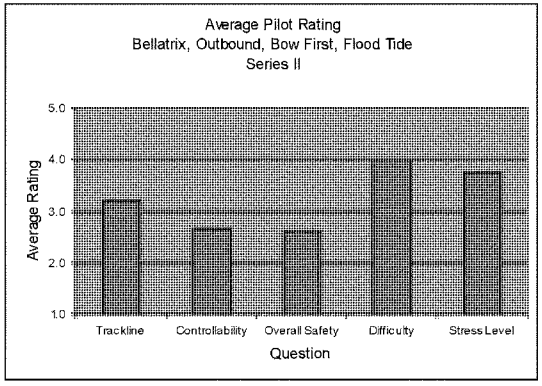
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Bellatrix, Outbound, Bow First, Flood Tide
Series II
Average Rating
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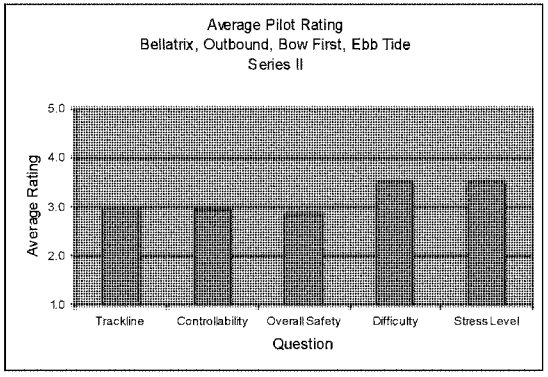
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Bellatrix, Outbound, Bow First, Ebb Tide
Series II
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Trackline
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Difficulty
Stress Level
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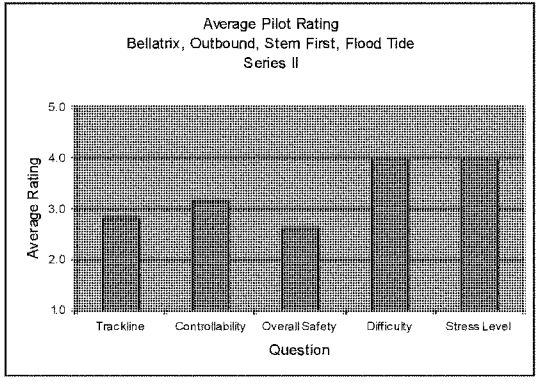
Average Pilot Rating
Bellatrix, Outbound, Stem First, Flood Tide
Series II
Average Rating
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Trackline
Controllability
Overall Safety
Difficulty
Stress Level
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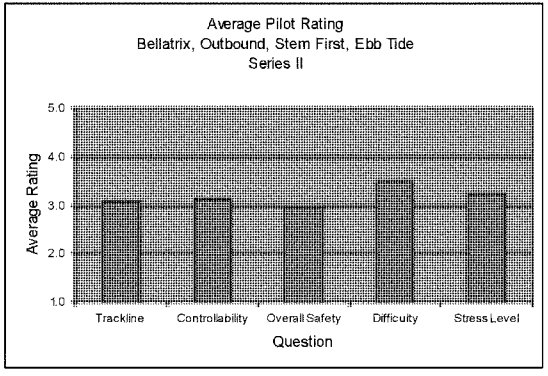
Average Pilot Rating
Bellatrix, Outbound, Stem First, Ebb Tide
Series II
Average Rating
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Trackline
Controllability
Overall Safety
Difficulty
Stress Level
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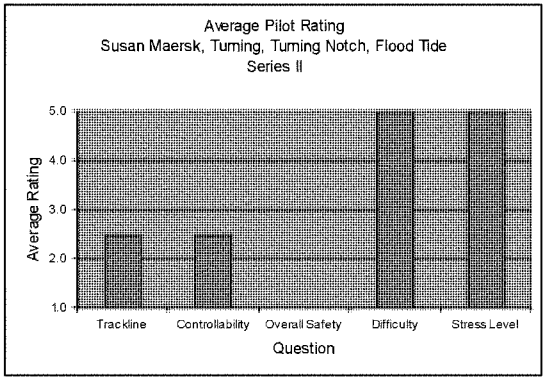
Average Pilot Rating
Susan Maersk, Turning, Turning Notch, Flood Tide
Series II
Average Rating
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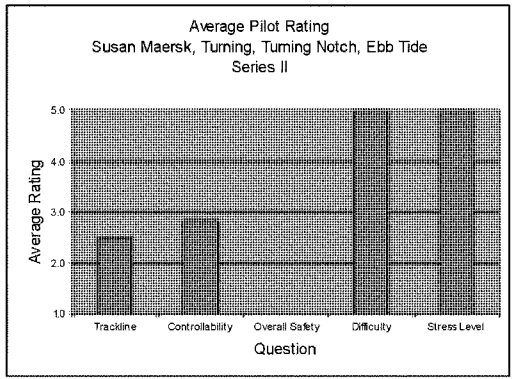
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Susan Maersk, Turning, Turning Notch, Ebb Tide
Series II
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Trackline
Controllability
Overall Safety
Difficulty
Stress Level
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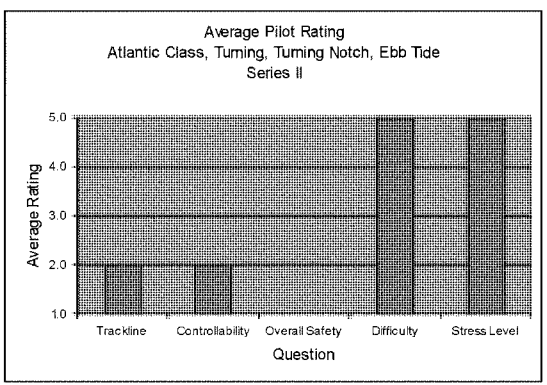
Average Pilot Rating
Atlantic Class, Turning, Turning Notch, Ebb Tide
Series II
Average Rating
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4.0
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2.0
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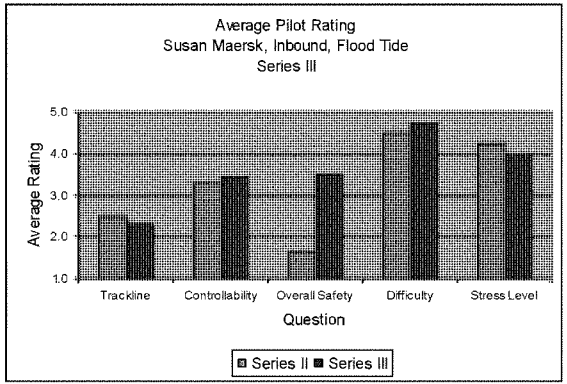
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question

670

Attachment III

Average Pilot Evaluation Ratings

Series III Simulation


Average Pilot Rating
Susan Maersk, Inbound, Flood Tide
Series III
Average Rating
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3.0
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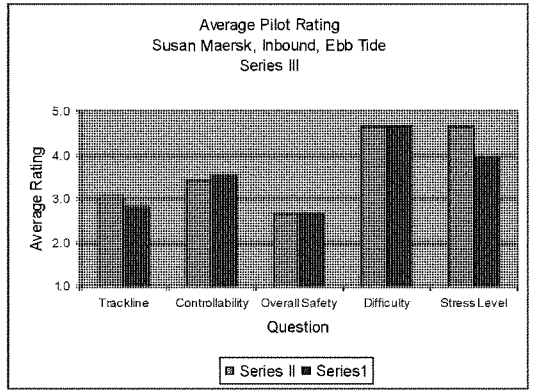
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III


Average Pilot Rating
Susan Maersk, Inbound, Ebb Tide
Series III
Average Rating
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3.0
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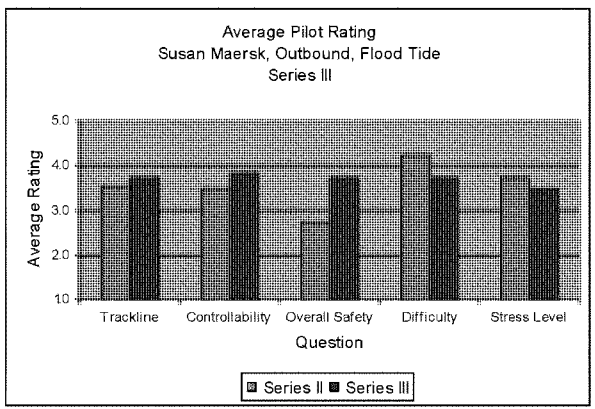
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series1


Average Pilot Rating
Susan Maersk, Outbound, Flood Tide
Series III
Average Rating
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3.0
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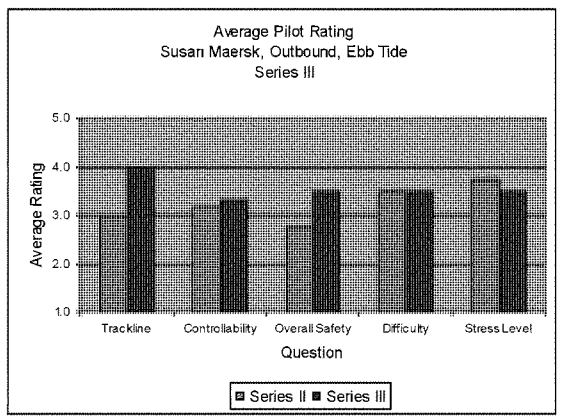
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III


Average Pilot Rating
Susan Maersk, Outbound, Ebb Tide
Series III
Average Rating
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Trackline
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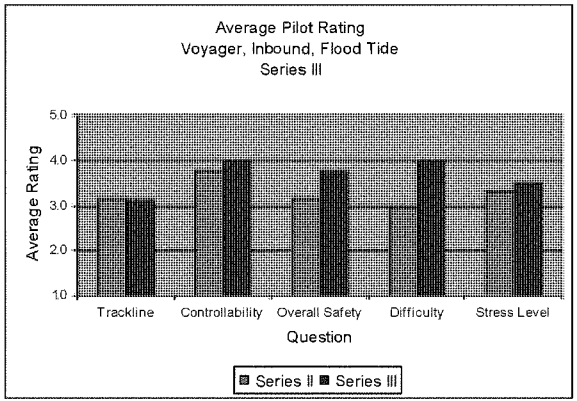
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III

672


Average Pilot Rating
Voyager, Inbound, Flood Tide
Series III
Average Rating
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3.0
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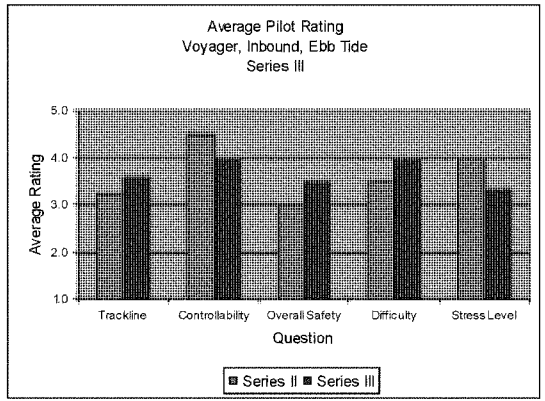
1.0
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III


Average Pilot Rating
Voyager, Inbound, Ebb Tide
Series III
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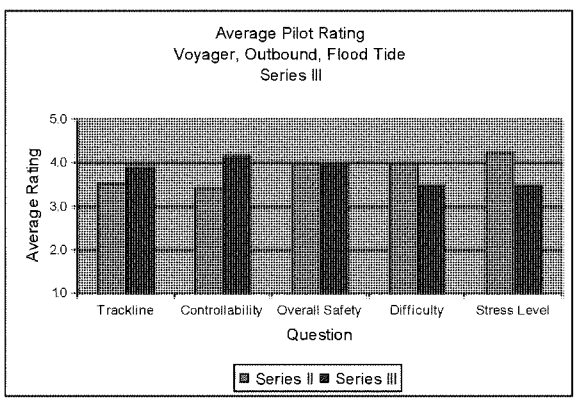
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III


Average Pilot Rating
Voyager, Outbound, Flood Tide
Series III
Average Rating
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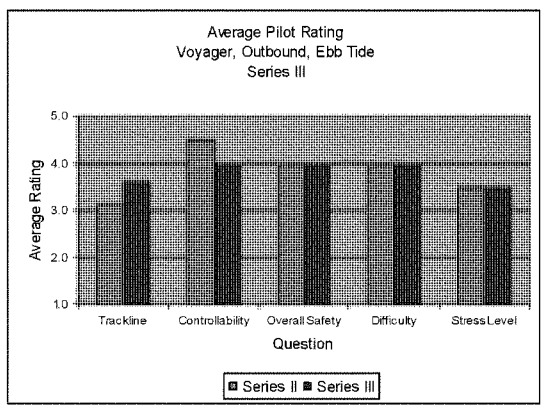
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III


Average Pilot Rating
Voyager, Outbound, Ebb Tide
Series III
Average Rating
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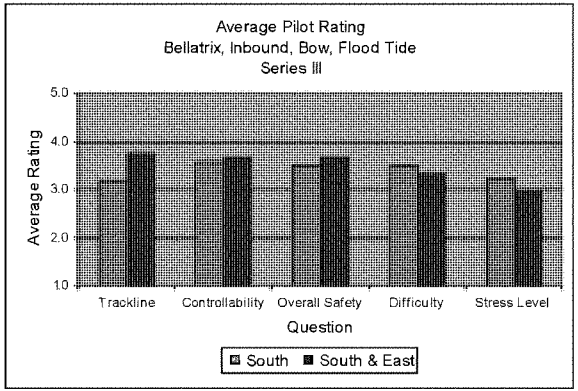
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
Series II
Series III


Average Pilot Rating
Bellatrix, Inbound, Bow, Flood Tide
Series III
Average Rating
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3.0
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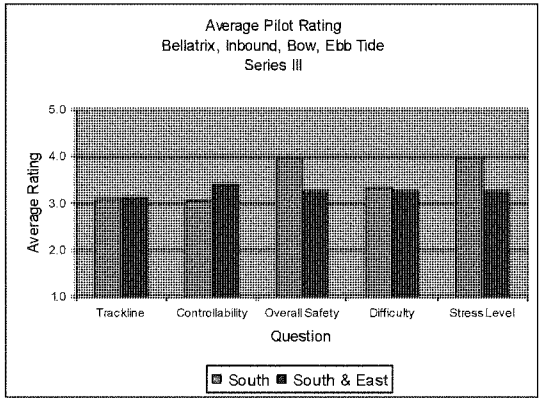
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
South
South & East


Average Pilot Rating
Bellatrix, Inbound, Bow, Ebb Tide
Series III
Average Rating
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Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
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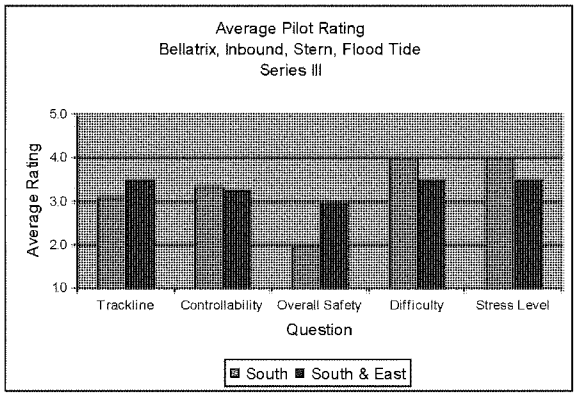
South & East


Average Pilot Rating
Bellatrix, Inbound, Stern, Flood Tide
Series III
Average Rating
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3.0
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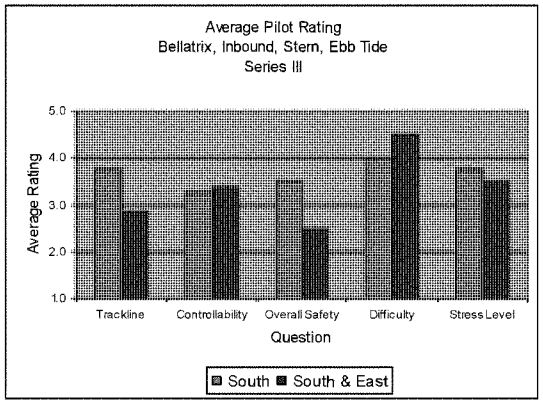
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
South
South & East


Average Pilot Rating
Bellatrix, Inbound, Stern, Ebb Tide
Series III
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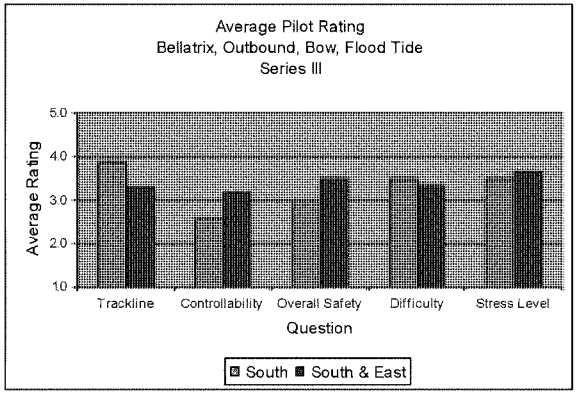
Controllability
Overall Safety
Difficulty
Stress Level
Question
South
South & East

674


Average Pilot Rating
Bellatrix, Outbound, Bow, Flood Tide
Series III
Average Rating
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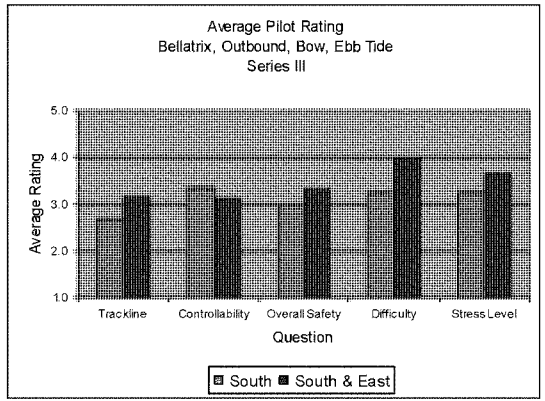
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
South
South & East


Average Pilot Rating
Bellatrix, Outbound, Bow, Ebb Tide
Series III
Average Rating
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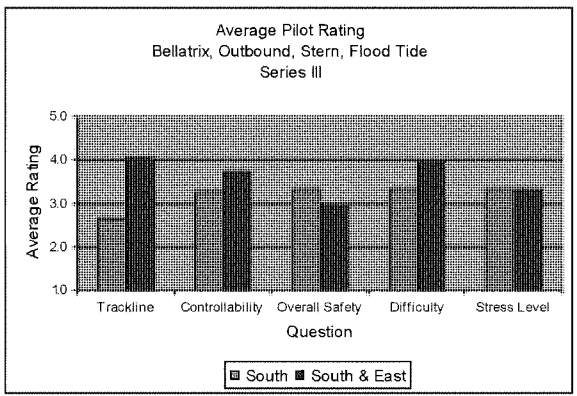
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question
South
South & East


Average Pilot Rating
Bellatrix, Outbound, Stern, Flood Tide
Series III
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Trackline
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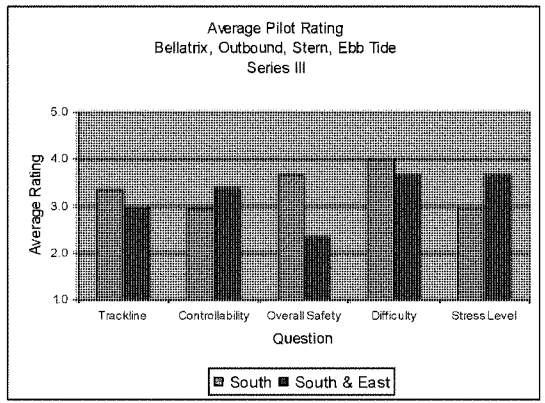
Overall Safety
Difficulty
Stress Level
Question
South
South & East


Average Pilot Rating
Bellatrix, Outbound, Stern, Ebb Tide
Series III
Average Rating
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Overall Safety
Difficulty
Stress Level
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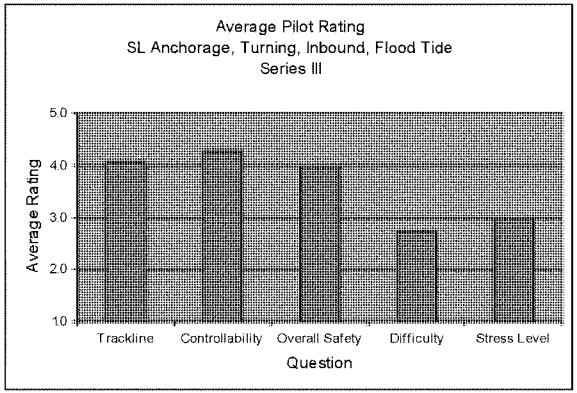
South
South & East

675


Average Pilot Rating
SL Anchorage, Turning, Inbound, Flood Tide
Series III
Average Rating
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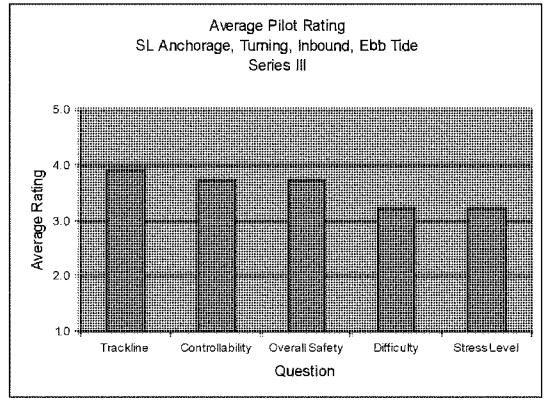
Trackline
Controllability
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
SL Anchorage, Turning, Inbound, Ebb Tide
Series III
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Trackline
Controllability
Overall Safety
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Stress Level
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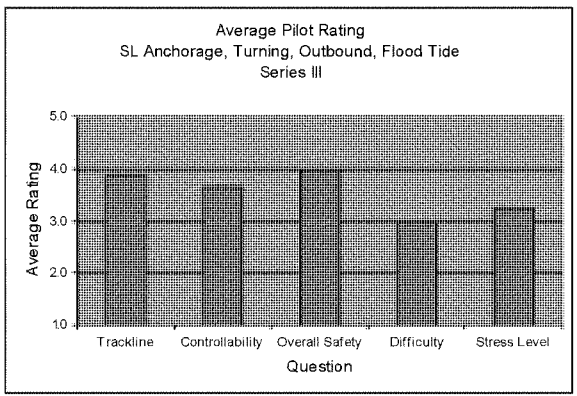
Average Pilot Rating
SL Anchorage, Turning, Outbound, Flood Tide
Series III
Average Rating
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Trackline
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Overall Safety
Difficulty
Stress Level
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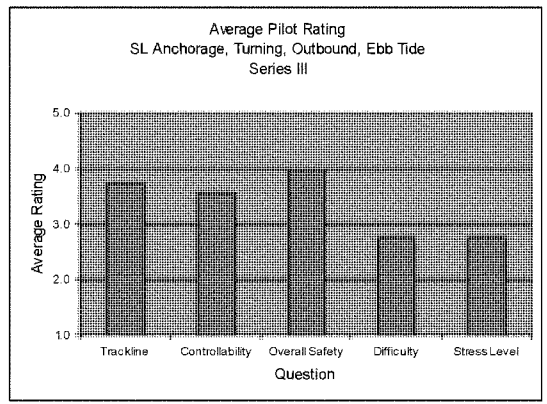
Average Pilot Rating
SL Anchorage, Turning, Outbound, Ebb Tide
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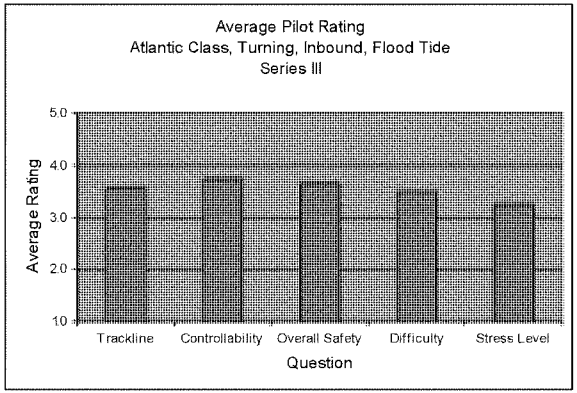
Controllability
Overall Safety
Difficulty
Stress Level
Question

676


Average Pilot Rating
Atlantic Class, Turning, Inbound, Flood Tide
Series III
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Trackline
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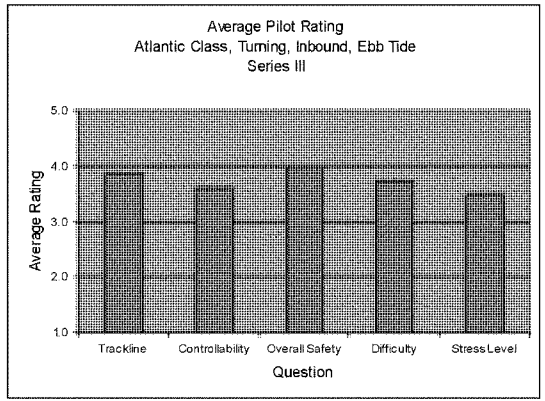
Overall Safety
Difficulty
Stress Level
Question


Average Pilot Rating
Atlantic Class, Turning, Inbound, Ebb Tide
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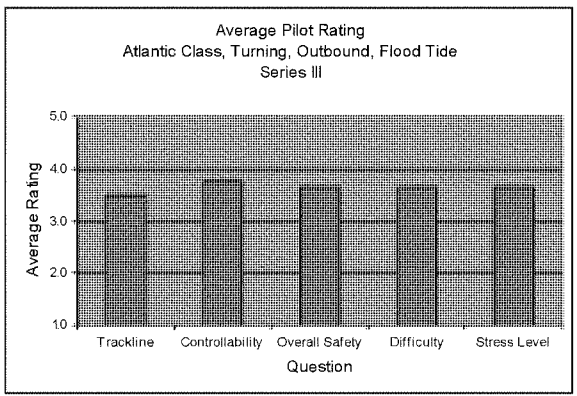
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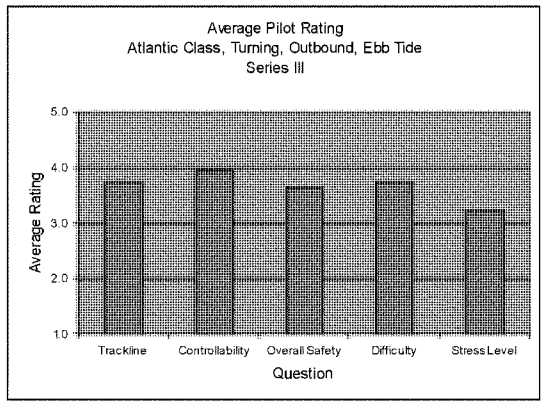
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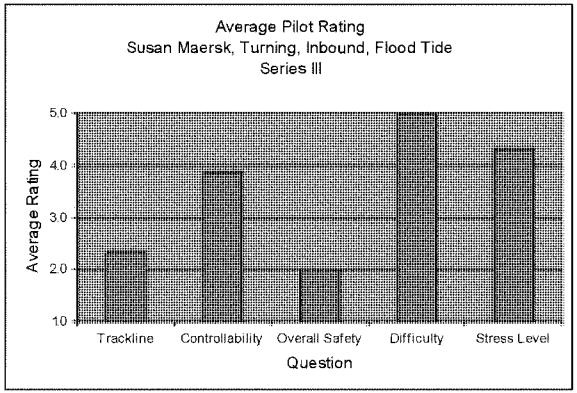
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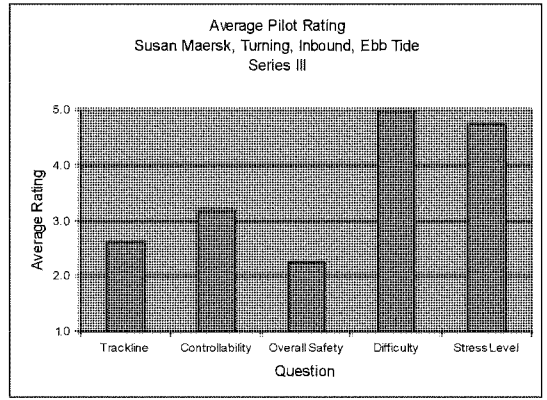
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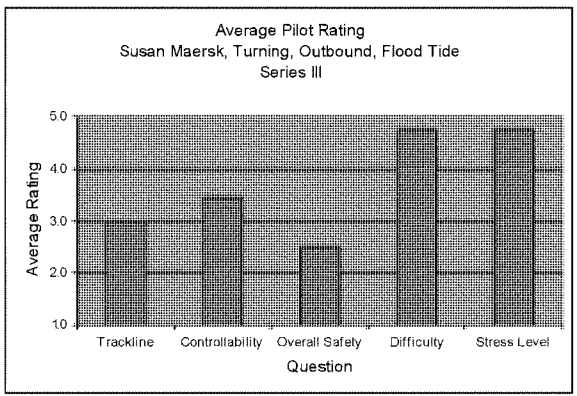
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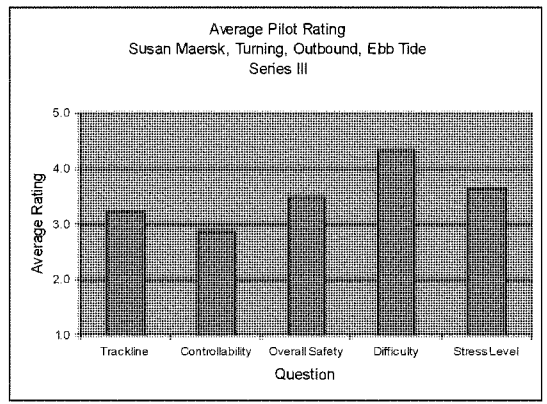
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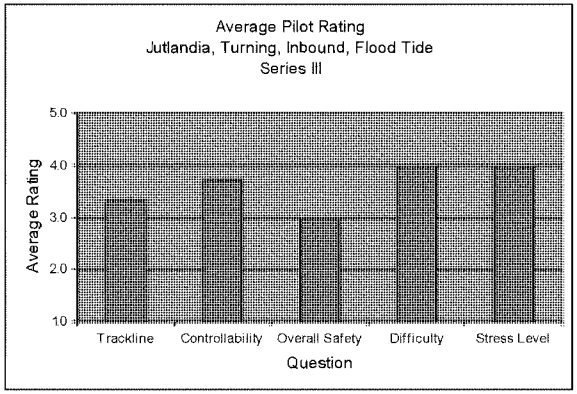
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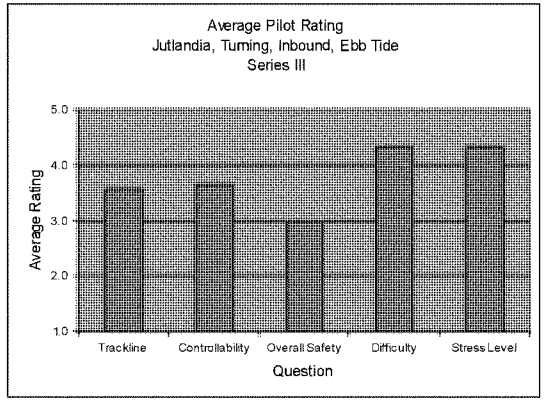
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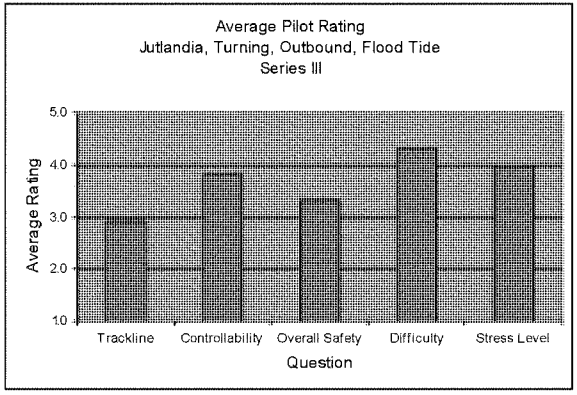
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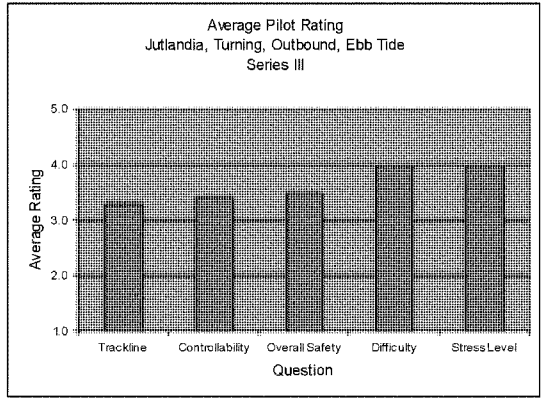
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PORT EVERGLADES HARBOR, FLORIDA

SUB-APPENDIX B

WAVE RESPONSE MODELING OF THE U.S. COAST GUARD STATION, PORT EVERLGADES, FORT LAUDERDALE, FLORIDA

Wave Response Modeling of the U.S. Coast Guard Station, Port Everglades, Fort Lauderdale, Florida

EN-WC
USACE Jacksonville District

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Attachment A: Facility & Infrastructure Requirements for Station Fort Lauderdale Multi-Mission Facility
Attachment B: Maximum Wave Amplification for Relocated Basin Alternatives: Alternatives B through G

Background

The U.S. Army Corps of Engineer's (USACE) Port Everglades feasibility study currently being prepared by the Jacksonville District office proposes widening the Southport Access Channel (SAC) in the area of the port referred to as "the knuckle" (berths 24 through 27). The U.S. Coast Guard (USCG) station at Fort Lauderdale is located across from berth 24 on the eastern side of the SAC (Figure 1). If approved, the expansion of the knuckle area will broaden the existing SAC channel such that the limits of the channel fall within the area currently occupied by Fort Lauderdale's U.S. Coast Guard (USCG) boat basin (Figure 2). While portions of the present USCG facility will remain unaffected, accommodation of the expanded SAC will require modification of the outer breakwater, boat basin, and some adjacent infrastructure.

Purpose

The purpose of this study is to determine to what extent the present USCG facility at Fort Lauderdale will need to be modified in order to maintain current levels of operation. The existing basin layout, including the positioning of the outer breakwater, was established to protect the interior of the USCG boat basin from ship wake and wind waves generated outside of the boat basin. In order to maintain the USCG basin at its present position, with an adequate level of protection for USCG vessels, a series of alternative harbor configurations were developed and the wave response of each was analyzed using the numerical harbor response model CGWAVE (Coastal Gravity WAVE). This report provides of summary of the methodology of the wave response analysis and presents model results for evaluation.

Wave Response Modeling

CGWAVE Model

CGWAVE is a finite element model for the calculation of wave response in harbors of arbitrary size, shape, and depth (Demirbilek and Panchang, 1998). CGWAVE includes both wave diffraction and refraction and is a standard tool for numerical harbor response studies.

The CGWAVE model covers in detail a domain that includes all harbor features. This domain is bounded by a 180-deg semicircle in the water region seaward of the harbor (boat basin) entrance. The area outside of the semicircle is treated as a semi-infinite region which extends seaward to infinity. This region is assumed to have a constant water depth and no bottom friction. For the present application the following assumptions were also made:

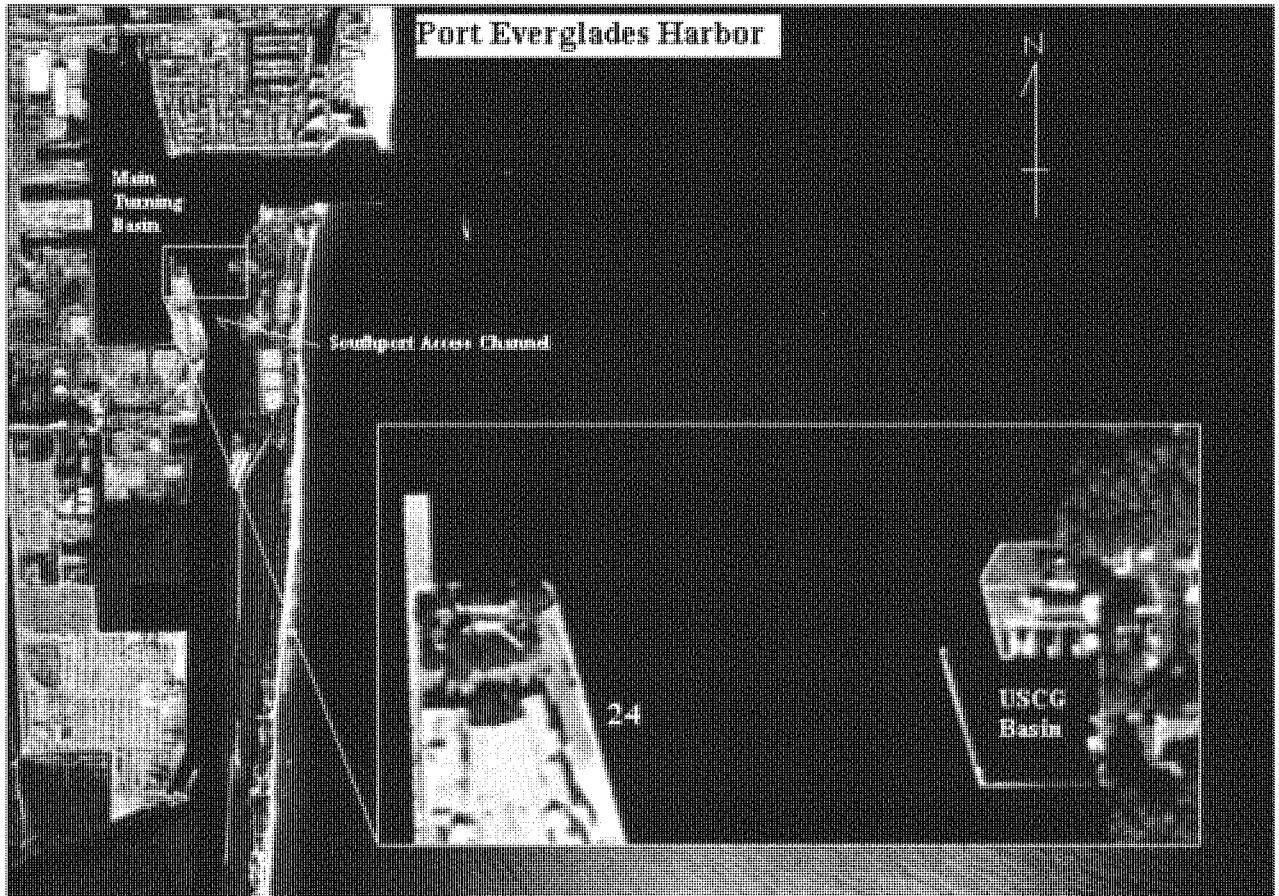

Figure 1. Location of U.S. Coast Guard Station at Fort Lauderdale

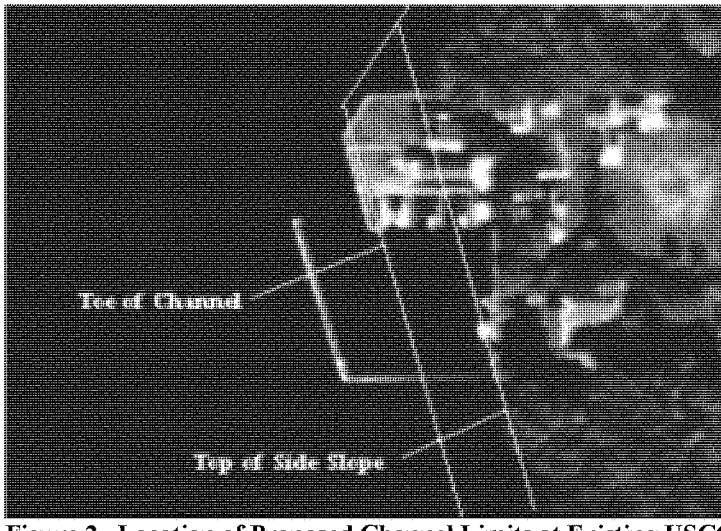

Figure 2. Location of Proposed Channel Limits at Existing USCG Station

a) No wave transmission or overtopping of structures.
b) No optimization of structure crest elevations.
c) No wave-current interactions.
d) No wave-bottom interactions.
e) No wave breaking effects.
f) No nonlinear effects.

Despite limitations imposed by the above assumptions, the CGWAVE tests can be expected to give a reasonable evaluation of the relative differences in protection between the existing and proposed harbor configurations.

Model Input

CGWAVE is run on a conventional finite element grid that is developed and solved over the harbor domain. In addition to the finite element grid, CGWAVE requires the specification of a number of parameters. Parameters include wave period, wave direction, wave height, and reflection coefficients specified for all solid boundaries within the model domain. Reflection coefficients are set according to boundary type (coastal or structural), but can differ depending on structure characteristics. For example, a permeable rubble mound breakwater will exhibit lower wave reflection than an impermeable breakwater. A compilation of accepted ranges of values for common structures is shown in Table 1.

Table 1. Reflection Coefficients by Structure Type

Structure Type	Description	Reflection Coefficient
Vertical Wall	Crown above water	0.7 – 1.0
	Submerged crown	0.5 – 0.7
	Crown above water, thick rubble toe protection	0.4 – 0.6
	Vertical energy dissipater	0.3 – 0.8
Smooth Impermeable Slope	Crown above water, 1:1.5 to 1:2.5 slope	0.5 – 0.9
	Submerged crown, 1:1.5 slope	0.3 – 0.5
Rough Slope	Rubble, 1:1.5 to 1:3 slope	0.3 – 0.6
	Rubble, less than 1:3 slope	0.1 – 0.3
	Energy dissipating concrete blocks	0.3 – 0.5
Rough, Permeable Breakwater	Rubble, 1:1.5 slope	0.2 – 0.6
	Rubble, 1:2.5 slope	0.1 – 0.5
	Dolos, 1:1.5 to 1:3 slope	0.1 – 0.4
Natural Beach		0.05 – 0.2

Since no wave measurements are available within the SAC, a range of incident wave conditions (wave height, wave period, and wave direction) were evaluated.

Due to the nature of the study, specific wave height and occurrence parameters were not necessary. As the objective was to assess the relative difference in harbor wave response between the existing and proposed harbor configurations, rather than to estimate specific wave conditions within the harbor, quantification of the local wave climate was not essential and an input wave height of 1ft was used. CGWAVE is used in a linear mode, therefore the results for each incident wave period and direction can be taken as representative for any non-breaking wave height.

The USCG boat basin is located within the relatively sheltered environment of Port Everglades Harbor. Therefore, wave periods were limited to short waves likely to be produced by passing vessels (2 and 4 seconds), wind waves developed over the fetch of the Main Turning Basin (MTB) and SAC (6 and 8 seconds), and two cases representative of storm conditions (10 and 15 seconds). Wave periods greater than 15 seconds are extremely unlikely within Port Everglades and were not considered.

Given the location of the harbor and the established routes of vessels transiting through Port Everglades' MTB and SAC, it was determined that the incident waves could approach from a wide range of directions, depending upon the orientation of the boat basin entrance channel. The complete range of incident wave directions (covering all the existing and proposed entrance channel orientations), is illustrated in Figure 3. Wave directions were evaluated in 15° increments.

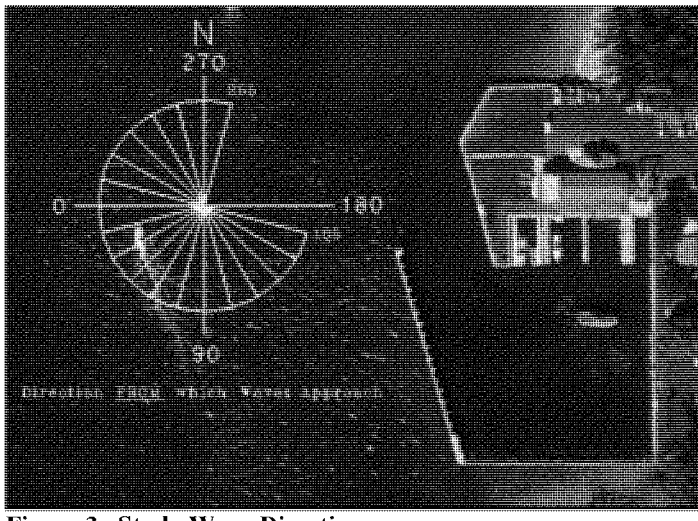

Figure 3. Study Wave Directions

Model Output

CGWAVE's principal output consists of an amplification factor (i.e. the ratio of the computed wave height to the incident input wave height) and phase at each node of the input finite element grid. Amplification factors are easily interpreted (i.e. if it is assumed that a 3ft wave is incident to the harbor entrance, an amplification factor of 0.1 at a given location will result in a wave height of 0.3ft at that location). Phases are more complex, but provide a useful means in long wave studies of interpreting harbor oscillation patterns. This study is a short wave application (incident waves have periods of less than 30 seconds), therefore phases are not considered.

CGWAVE Model Runs (Existing Layout vs Preliminary Alternative Layouts)

Existing USCG Layout

The existing USCG basin is equipped with 3 pile-supported piers, 2 aluminum floating docks, and a travel lift slip bordered by a permeable interior wall. Pile supported piers are essentially invisible to the CGWAVE model and are therefore removed as solid boundaries. The remaining piers and permeable interior wall were retained and are evident along the northern boundary of the finite element grid representing the existing harbor configuration (Figure 4). The finite element grid for the existing boat basin was generated using the USACE flow-model grid generator FASTTABS/SMS (Brigham Young, 1997). Model boundaries were defined by the existing basin dimensions and bathymetry was based on an evaluation of existing survey data and a proposed operating depth of 11ft.

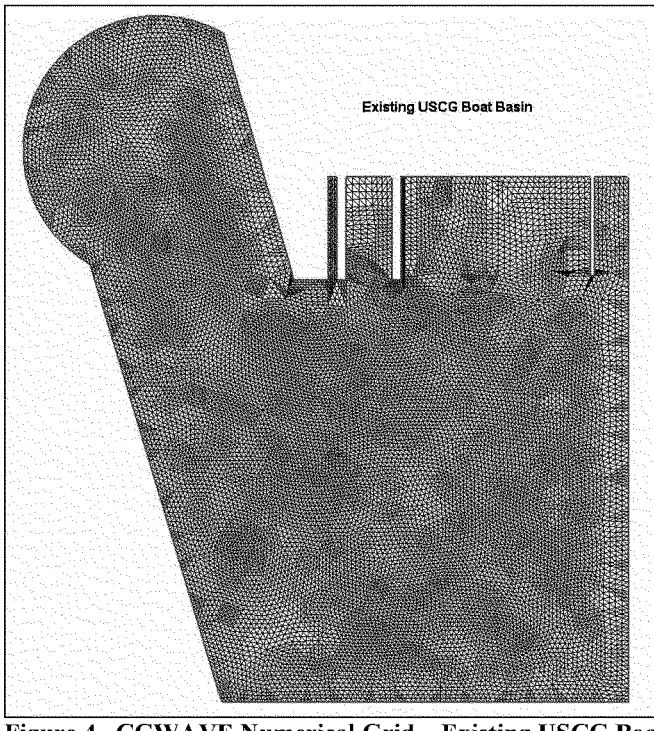

Figure 4. CGWAVE Numerical Grid – Existing USCG Boat Basin

Reflection coefficients for solid boundaries were based on visual inspection of the existing basin and the accepted ranges (based on structure type) provided previously in Table 1. The basin configuration was divided into zones based on structure type with a representative reflection coefficient assigned to each. For the existing layout, there were five structure types, standard vertical concrete bulkheads (Figure 5), wave damping bulkheads (Figures 6 and 7), rubble wave absorbers (Figure 8), floating aluminum docks, and, a permeable interior wall. Structural types and their corresponding reflection coefficients are summarized in Table 2. Reflection coefficients assigned to the existing harbor configuration are shown in Figure 9.

Table 2. Reflection Coefficients for Given Structural Zones

Structure Type	Reflection Coefficient
Standard Bulkhead	1.0
Wave Damping Bulkhead	0.8
Rubble Wave Absorber	0.5
Floating Aluminum Pier	0.2
Permeable Interior Wall	0.2

Figure 5. Example of Standard Vertical Concrete Bulkhead at USCG Fort Lauderdale

Figure 6. Example of Wave Damping Bulkhead at USCG Fort Lauderdale (East Bulkhead)

Figure 7. Example of Wave Damping Bulkhead at USCG Fort Lauderdale (Entrance Channel Bulkhead)

Figure 8. Example of Rubble Wave Absorber at USCG Fort Lauderdale (South Bulkhead)

While CGWAVE provides amplification information at every grid element, in order to closely evaluate areas where Coast Guard vessels are most affected by wave conditions, 11 output locations (OLs) were selected. A single OL is comprised of a small cluster of grid elements over which the CGWAVE response is averaged. The eleven output locations were placed in berthing areas along the harbor's boundaries. OLs 1-6 are located along the northern bulkhead berths and OLs 7-11 are located along the eastern berthing areas (Figure 10).

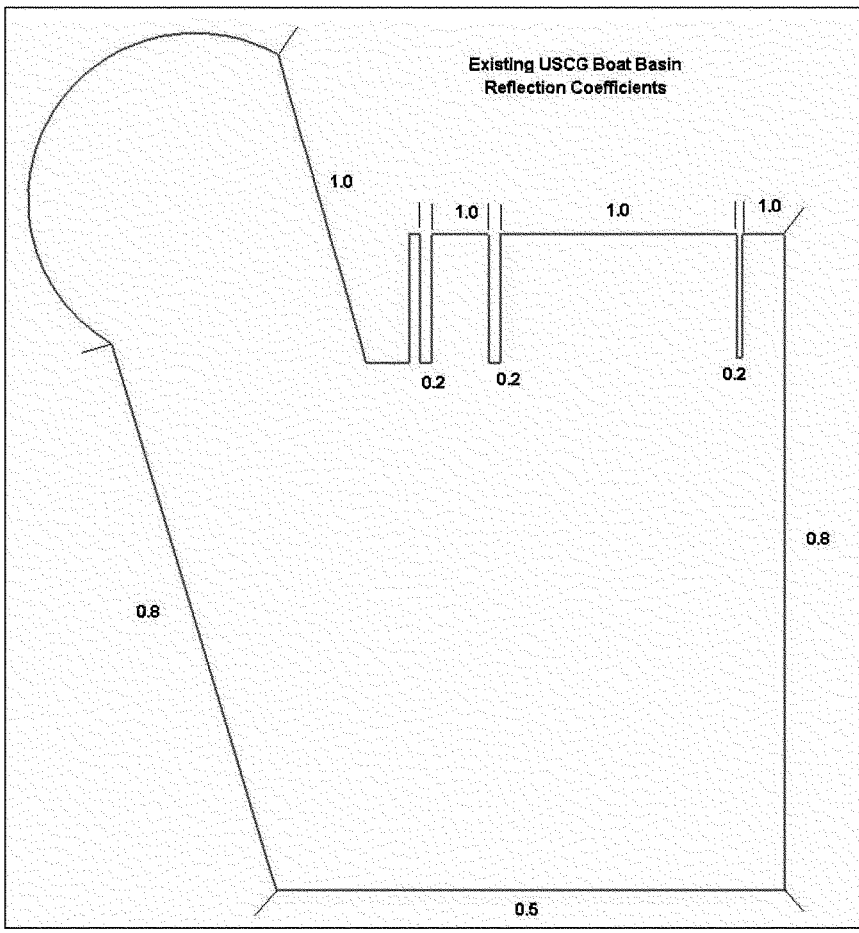

Figure 9. Reflection Coefficients Representing Existing Boundary Conditions

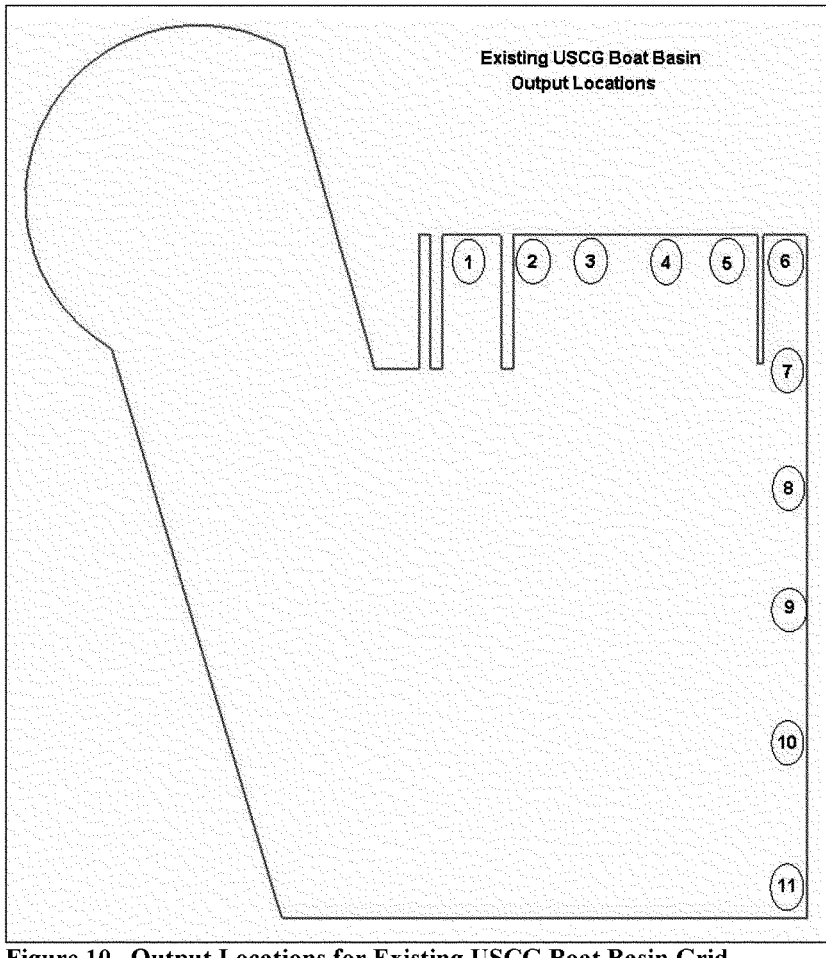

Figure 10. Output Locations for Existing USCG Boat Basin Grid

Initial Relocation Plans

Initially, a series of eight alternative plans were developed and analyzed using the CGWAVE model (Figure 11). Each alternative plan was designed to keep the existing boat basin intact, with the exception of the outer entrance channel and breakwater. Finite element grids for each alternative were generated using the USACE flow-model grid generator FASTTABS/SMS. Model boundaries were defined by existing and proposed basin dimensions. Bathymetry was based on an evaluation of existing survey data and a proposed operating depth of 11ft.

Each of the eleven output locations previously defined (OLs 1-6 located along the northern bulkhead and OLs 7-11 located along the eastern berthing areas) was repeated in each of the alternative basin configurations, allowing for a one-to-one comparison of conditions between existing and alternative plans. Additionally, reflection coefficients between the existing and alternative basin configurations were the same.

The CGWAVE numerical model was run for the existing plan and alternative plans Alt 1 through Alt 8. The incident wave height for each model run was 1ft, while incident wind directions varied based on the orientation of the basin entrance. Eleven input wind directions were evaluated for each alternative plan. Two wave periods, 2 seconds and 4 seconds, were specified for the initial runs. These are considered to be representative of a majority of incident waves and provide a sound basis for initial evaluation of relative changes in basin amplification.

Results(Existing vs Initial Plans)

Maximum amplification factors, regardless of incident wave direction, were determined for each basin configuration for each wave period. The percent increase/decrease of amplification at each basin (relative to the existing basin) is provided in Tables 3 and 4.

As shown in Tables 3 and 4, alternatives Alt 1 through Alt 7, show marked increases in the amplification of wave energy within the USCG boat basin, particularly in the northwest and northeast regions. Maximum increases for these alternatives exceed 200% and reach a maximum (Alt 6) of 486%. Such increases are not acceptable in meeting the goal of maintaining the existing level of protection to USCG vessels. Therefore, alternatives Alt 1 through Alt 7 were discarded from further consideration.

Both Tables 3 and 4 indicate that Alt 8 does not show significant increases in wave amplification. This alternative has only a 2% increase at OL 11 (southeast corner) for a 4-second wave and displays reductions in amplification at all other berthing locations for both 2- and 4-second waves. However, while numerical results show an adequate level of protection from incident waves, consultation with USCG personnel indicated that the overall basin configuration would create undue navigational hazards to larger USCG vessels. The configuration of the basin entrance would also unacceptably increase response times for smaller USCG vessels during emergency operations. Alternative 8 was therefore also eliminated from further consideration.

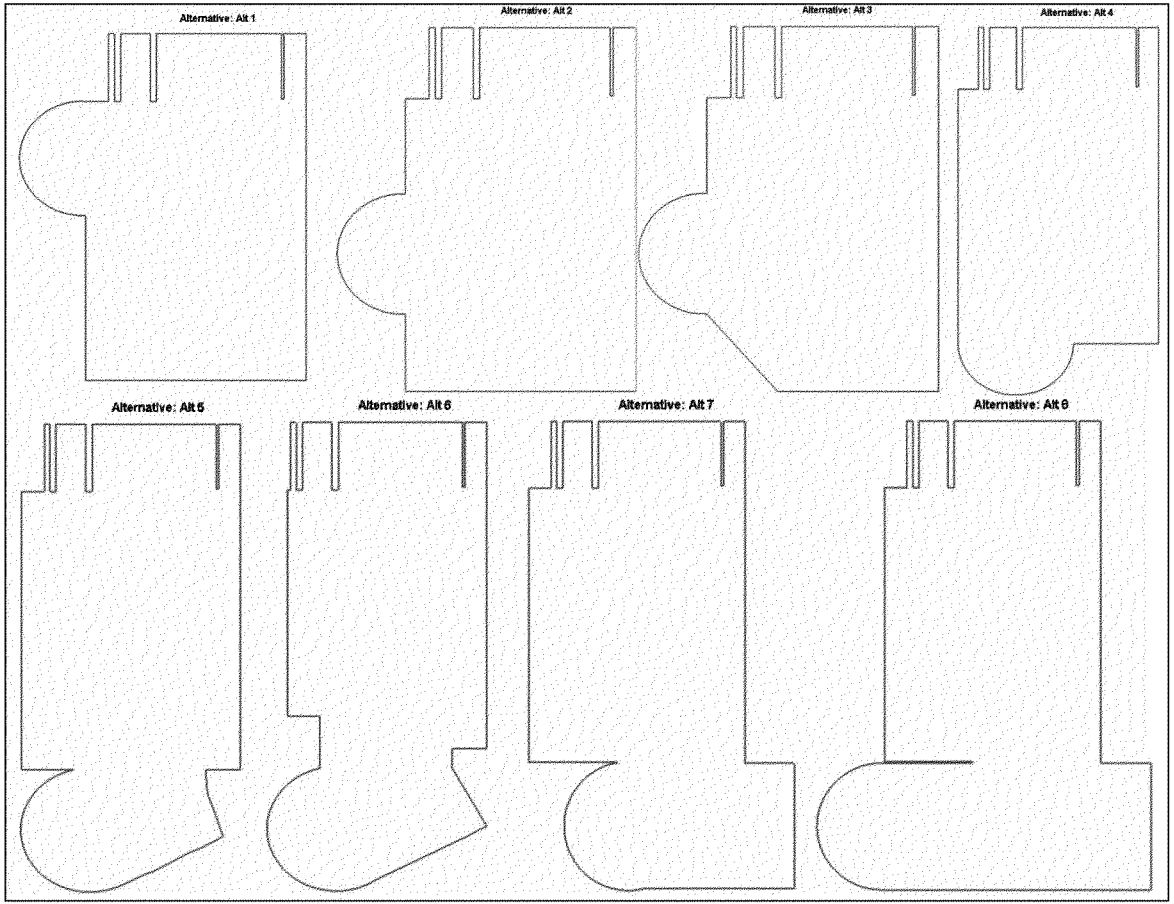

Figure 11. Alternate USCG Plans: Alt 1 through Alt 8

Table 3. Percent Increase/Decrease of Amplification (2-Second Wave Period)

Percent Increase/Decrease of Amplification Relative to Existing Boat Basin (2sec Wave)								
OL	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
1	54	37	31	438	134	-3	-17	-74
2	227	184	48	119	51	151	-5	-43
3	120	82	8	73	-26	98	37	-66
4	149	107	109	88	27	48	24	-44
5	192	290	153	233	75	486	67	-12
6	290	473	165	215	248	324	208	-2
7	284	311	236	155	245	275	129	-14
8	77	31	41	9	-12	-16	-23	-72
9	155	120	102	29	3	68	24	-52
10	151	189	121	45	20	83	71	-10
11	65	26	15	-28	-15	10	16	-6

Table 4. Percent Increase/Decrease of Amplification (4-Second Wave Period)

Percent Increase/Decrease of Amplification Relative to Existing Boat Basin (4sec Wave)								
OL	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8
1	269	177	75	554	182	73	4	-67
2	147	109	5	189	95	292	41	-18
3	22	18	13	54	-33	19	-40	-48
4	106	113	60	163	21	24	2	-57
5	117	202	108	115	-22	37	19	-51
6	256	180	88	218	52	172	24	-72
7	39	13	51	157	97	113	21	-70
8	93	139	97	127	26	153	5	-43
9	78	29	-14	-18	-38	12	-50	-82
10	19	43	63	6	-14	8	-9	-23
11	99	124	31	-37	-44	18	29	2

Modified USCG Design Plans

After the elimination of the original eight design plans, USACE and USCG personnel coordinated to develop a second set of plans that would better accommodate vessel maneuverability and operational functions. The resulting alternatives were denoted USCG Designs 1, 2, and 3 and can be seen graphically in Figure 12.

The CGWAVE numerical model was run for the three USCG Design configurations for 2- and 4-second wave periods using variable boundary reflection coefficients to minimize reflections.

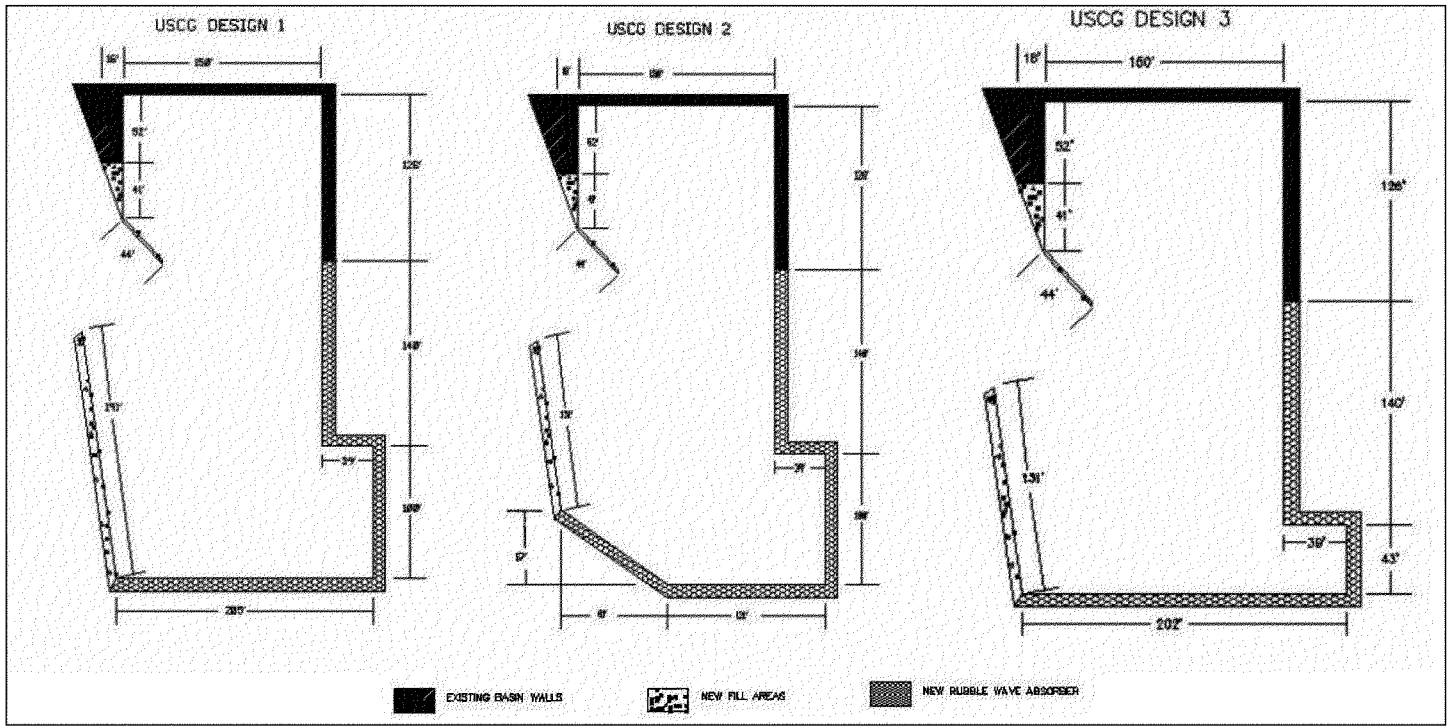

Figure 12. USCG Boat Basin Alternatives: Design 1, Design 2, and Design 3

Results(Existing vs Modified Plans)

While initial model runs showed promising amplification results, further refinement of the SAC (based on ship simulation results) resulted in additional changes to channel dimensions that directly conflicted with the outer breakwater of Designs 1 – 3. Removal of the breakwater would result in unacceptably high wave conditions within the basin. Therefore, Designs 1 – 3 were removed from further consideration.

CGWAVE Model Runs (Existing Layout vs Final Layout)

Final Relocated USCG Basin Layout

The final relocated USCG layout addressed in this report was developed in coordination with USCG personnel. Previous coordinated efforts to develop alternative basin layouts were unsuccessful due to either unacceptable wave amplification detected by CGWAVE or operational constraints that would interfere with the function of the station. In August of 2009, as part of the coordination effort, the USCG Civil Engineering Unit Miami provided a facility and infrastructure requirements report for Station Fort Lauderdale (Attachment A). Included in this report was a proposed relocated basin layout, made possible by removal of restrictions on relocating specific structures, that would meet operation requirements of the facility. Figure 13 shows a slightly modified version of this layout, with the entire basin footprint shifted approximately 80ft to the west in order to minimize property impacts. Based upon this modified layout, a numerical grid and corresponding set of CGWAVE model runs were developed.

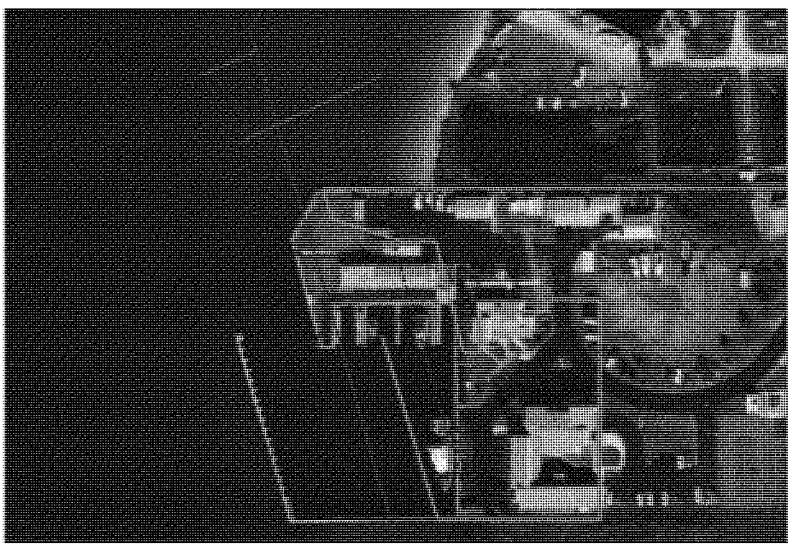

Figure 13. Proposed Relocated USCG Boat Basin

The relocated boat basin has approximately the same shape and dimensions as the existing boat basin. The primary difference between the two layouts is their location within the boundary of the USCG property. The relocated basin is approximately 170ft east of the existing basin, allowing for the expansion of the SAC. Due to the similar layout and dimensions, 11 OLs were specified (Figure 14). Each OL corresponds to a similarly placed OL in the existing basin layout. This allows for a one-to-one comparison of conditions between existing and relocated design.

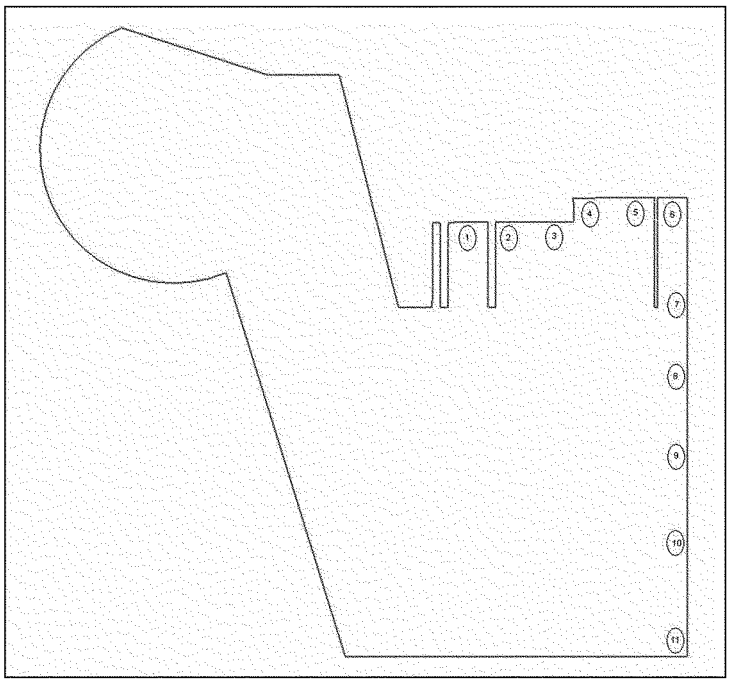

Figure 14. Output Locations for Relocated USCG Boat Basin Grid

Specification of reflection coefficients within the relocated basin were initially based on those of the existing basin (Figure 15). Because the type and location of docks can influence the amplification characteristics of the basin, docks identical to the existing docks were placed in similar locations within the relocated basin and assigned the same reflection coefficients. The basin boundaries, including wave damping bulkheads and rubble wave absorbers, remained unchanged.

Input wave conditions for the relocated basin were identical in amplitude (1ft) and period as those evaluated for the existing basin layout. Due to a slightly more western facing entrance, however, the range of wave directions differed. Table 5 provides the input wave period and directions associated with CGWAVE runs of the relocated basin layout (compared to those of the existing basin runs).

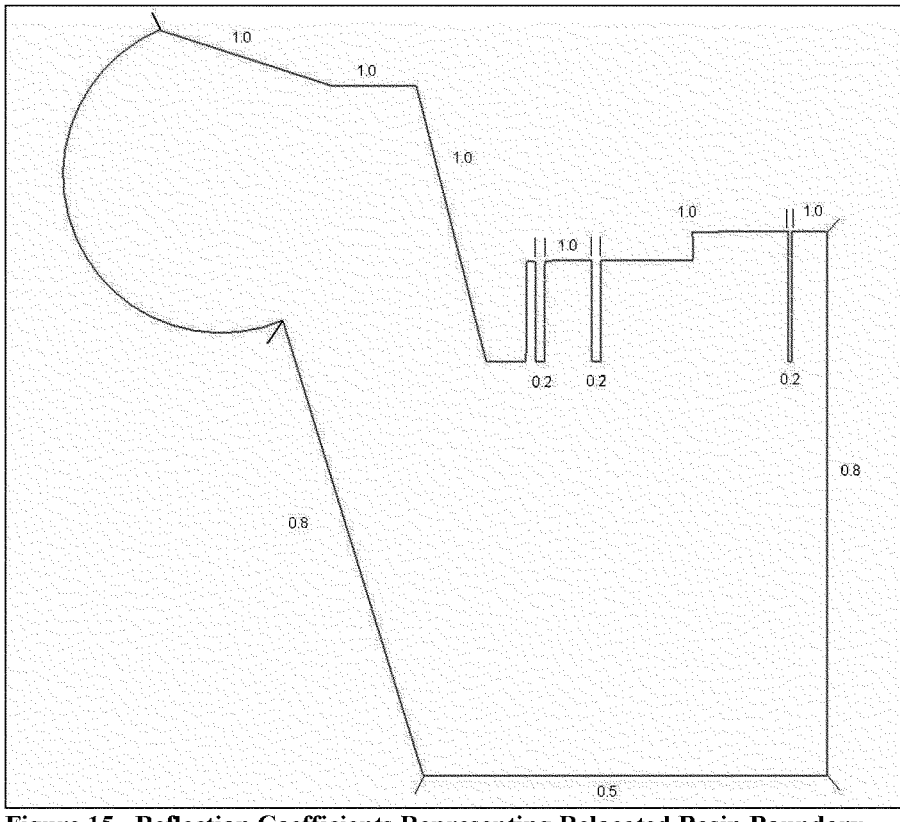

Figure 15. Reflection Coefficients Representing Relocated Basin Boundary Conditions

Table 5. CGWAVE Input Conditions – Relocated Basin

Wave Period (Sec)	Wave Direction (Deg-from)	
	Existing Basin	Relocated Basin
2	255	300
4	270	315
6	285	330
8	300	345
10	315	0
15	330	15
	345	30
	0	45
	15	60
	30	75
	45	90
	255	105

Results (Existing vs Relocated)

Maximum amplification factors, regardless of incident wave direction, were determined for both basin configurations. Maximum amplification factors for each basin layout (at each OL) are shown in Figures 16-21 for each wave period. The percent increase/decrease of amplification, indicating the increase or decrease in wave height (wave energy) at each OL relative to the existing basin, is provided in Figure 22.

Figure 22 indicates that at each OL, at least one wave condition (wave period) induces an increase in wave height (increase in wave amplification factor). The percent increase ranges from 4% at OL 9 (eastern dock) to 135% at OL 2 (northern dock). Given the magnitudes of the larger percent increases and the fact that all areas of interest show some degree of increased wave energy, it is apparent that the present relocation plan does not provide the same degree of protection to moored vessels as the existing layout.

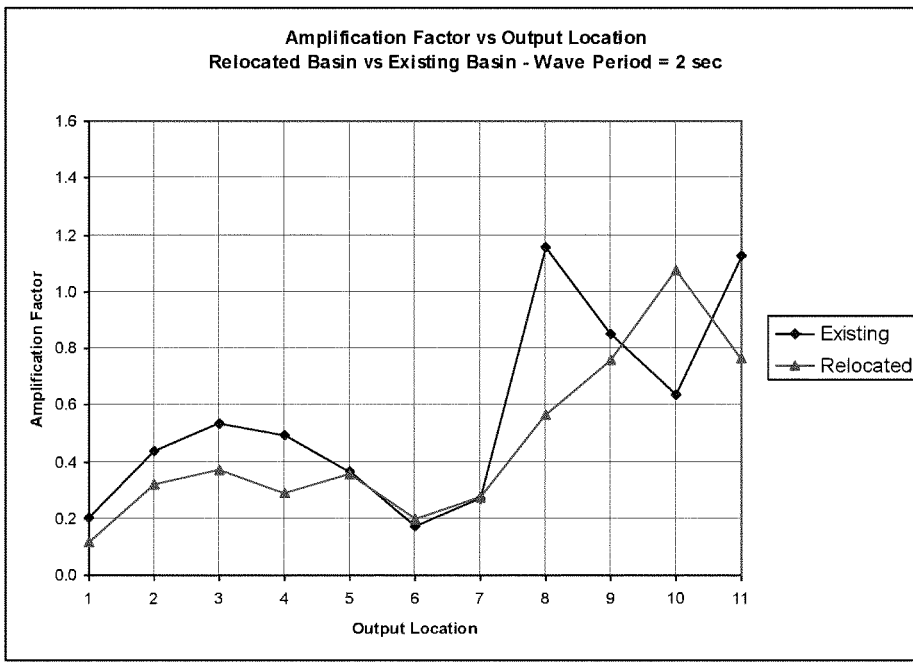

Figure 16. Maximum Amplification Factor – Relocated vs Existing (Period = 2sec)

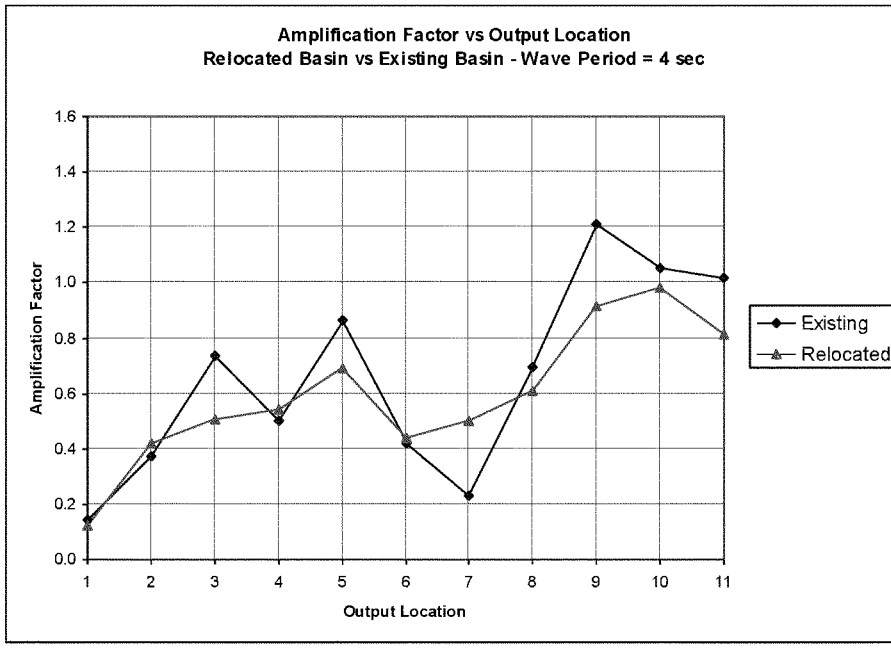

Figure 17. Maximum Amplification Factor – Relocated vs Existing (Period = 4sec)

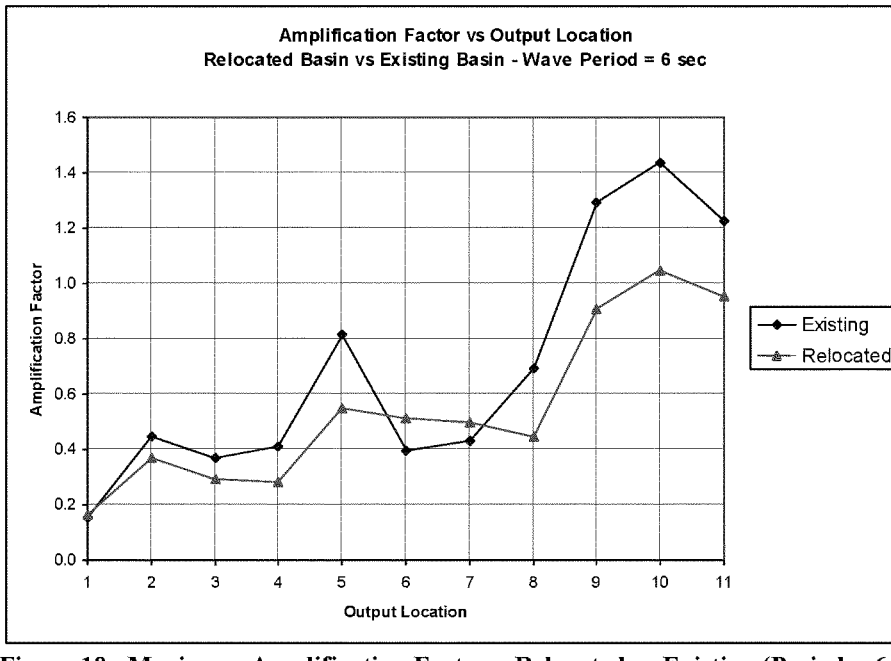

Figure 18. Maximum Amplification Factor – Relocated vs Existing (Period = 6sec)

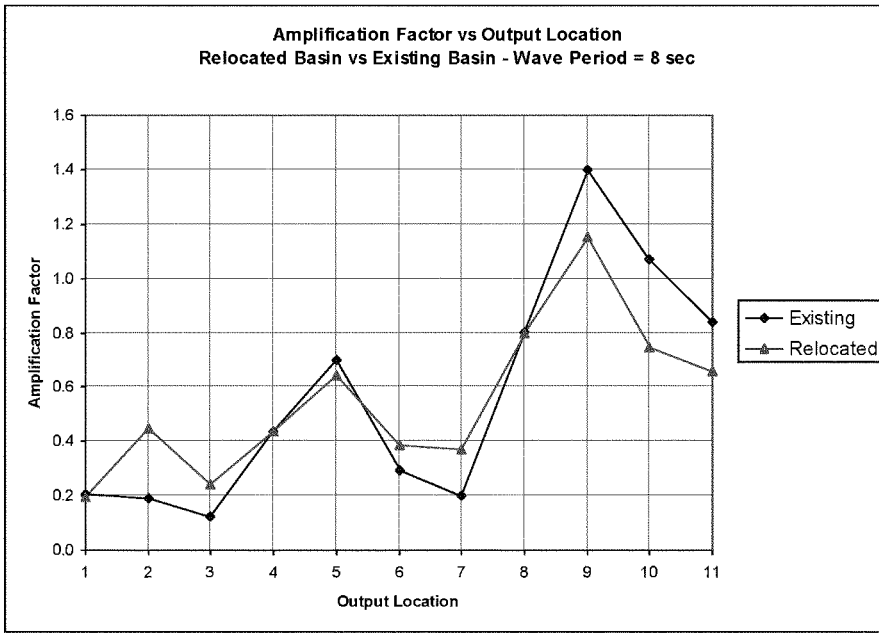

Figure 19. Maximum Amplification Factor – Relocated vs Existing (Period = 8sec)

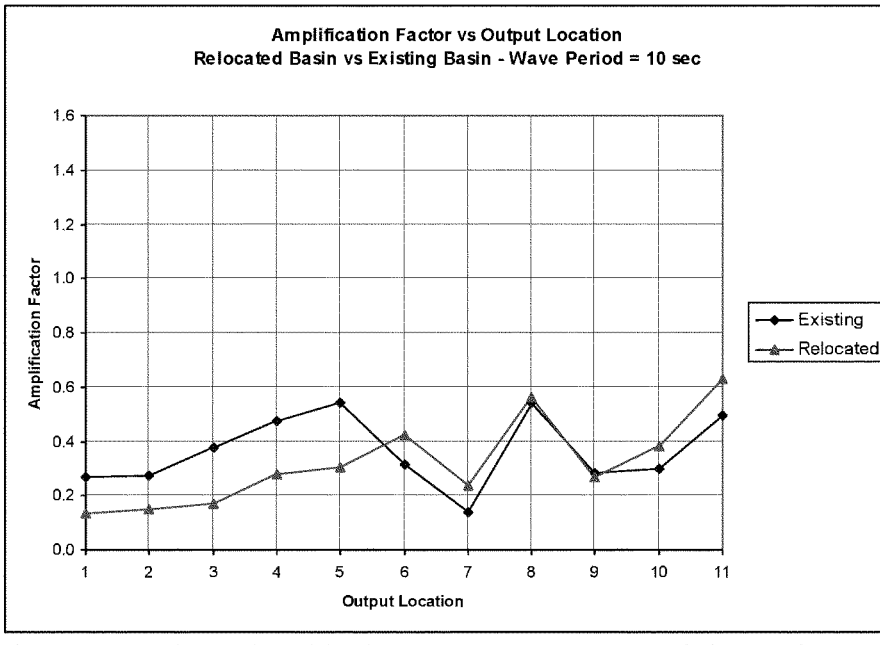

Figure 20. Maximum Amplification Factor – Relocated vs Existing (Period = 10sec)

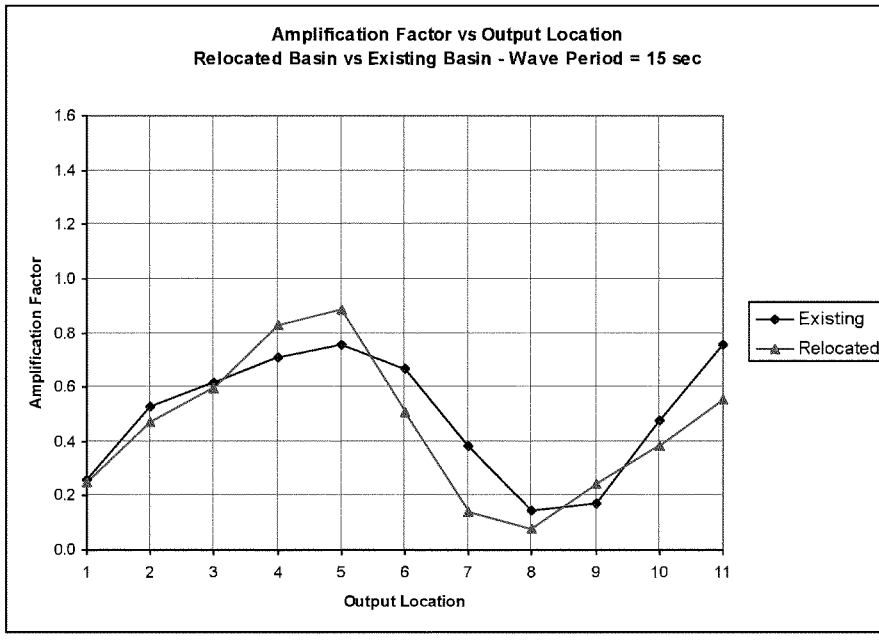

Figure 21. Maximum Amplification Factor – Relocated vs Existing (Period = 15sec)

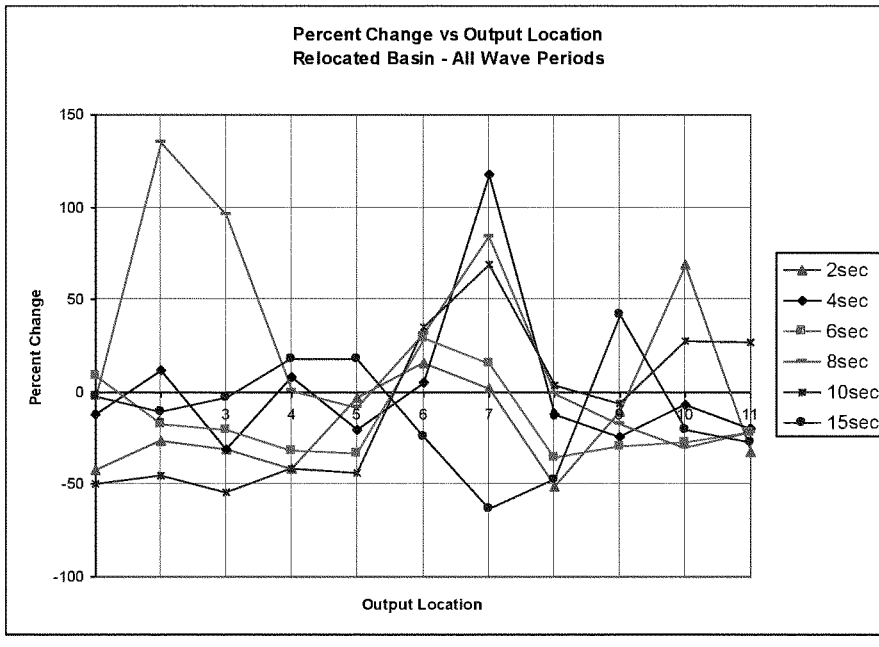

Figure 22. Percent Change in Amplification Factor – Relocated (All Wave Periods)

Relocated Basin Optimization

Optimization Alternatives

The results of the preliminary comparison between the existing basin layout and the relocated basin layout show that the new basin layout does not provide the same level of protection against incident wave energy. Because the physical layout of the proposed basin is the most suitable to date for operations, it is preferable to optimize the wave response by modifying bulkhead types rather than reconfiguring basin dimensions. The bulkheads selected for optimization were the three segments nearest the opening of the basin entrance channel (Figure 23). Modification involved altering the original bulkhead type from a standard vertical bulkhead to either a wave damping bulkhead, or rubble wave absorber. Table 6 provides 8 alternative bulkhead configurations (including the original relocation design) with corresponding reflection coefficients. Other than the three bulkhead portions indicated, all reflection coefficients remained the same.

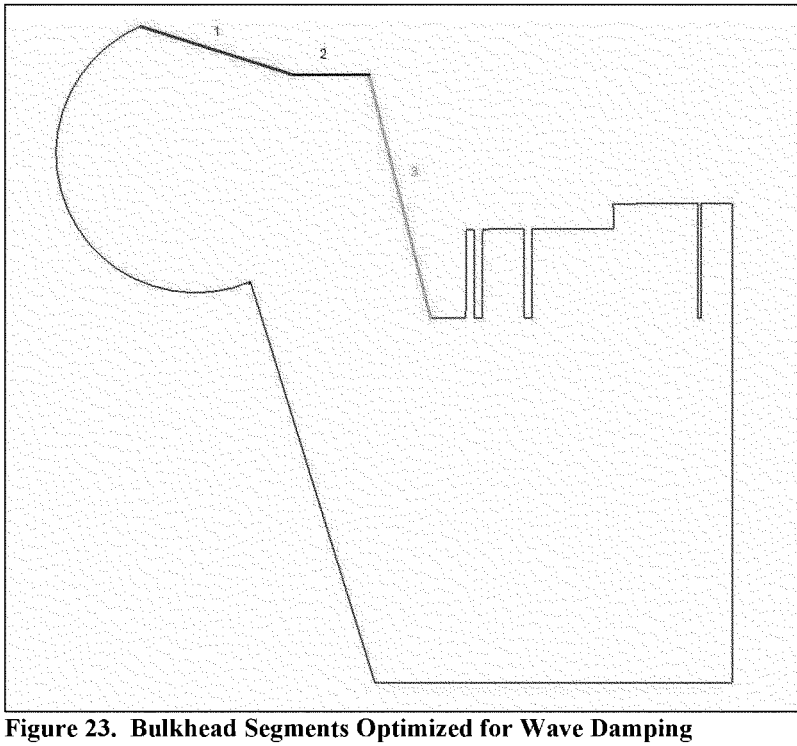

Figure 23. Bulkhead Segments Optimized for Wave Damping

Table 6. Entrance Channel Bulkhead Type (Reflection Coefficient) by Alternative

Alternative Configuration	Bulkhead Type (Reflection Coefficient) by Bulkhead Segment		
	1	2	3
A (Original "Relocated")	Standard (1.0)	Standard (1.0)	Standard (1.0)
B	Wave Damping (0.8)	Standard (1.0)	Standard (1.0)
C	Rubble (0.5)	Standard (1.0)	Standard (1.0)
D	Wave Damping (0.8)	Wave Damping (0.8)	Wave Damping (0.8)
E	Rubble (0.5)	Wave Damping (0.8)	Wave Damping (0.8)
F	Rubble (0.5)	Rubble (0.5)	Wave Damping (0.8)
G	Rubble (0.5)	Rubble (0.5)	Rubble (0.5)

Optimization Results

Maximum amplification factors, regardless of incident wave direction, were determined for all basin configurations for each wave period. Maximum amplification factors for the six additional configurations (B – G) can be found in Attachment B. The percent increase/decrease of amplification at each OL for each alternative plan (relative to the existing basin) is provided in Figures 24 to 29.

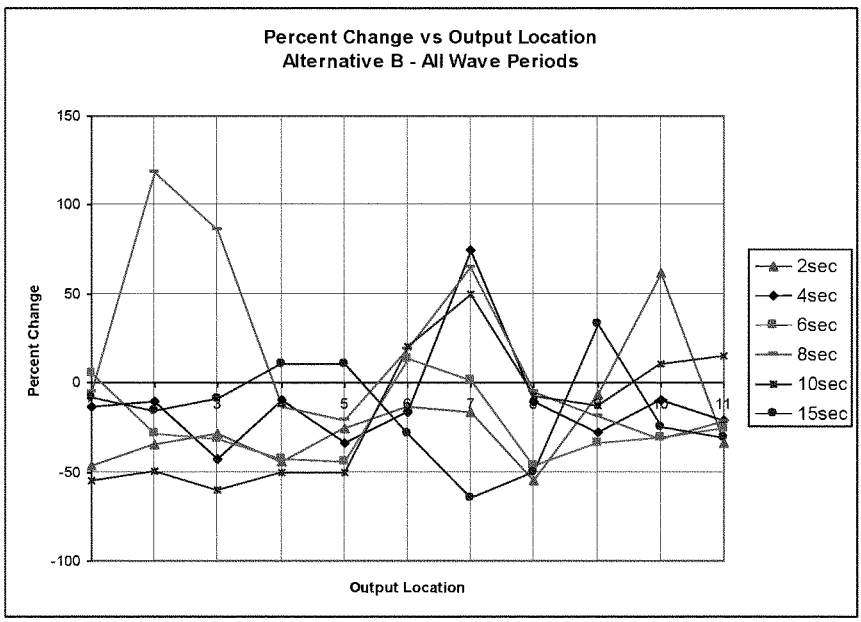

Figure 24. Percent Change in Amplification Factor – Alt. B (All Wave Periods)

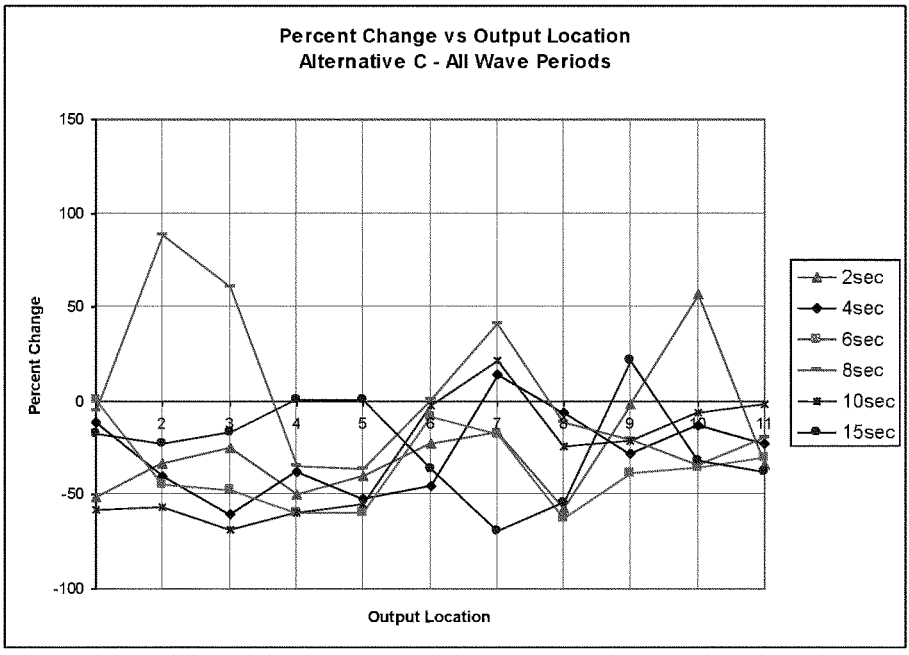

Figure 25. Percent Change in Amplification Factor – Alt. C (All Wave Periods)

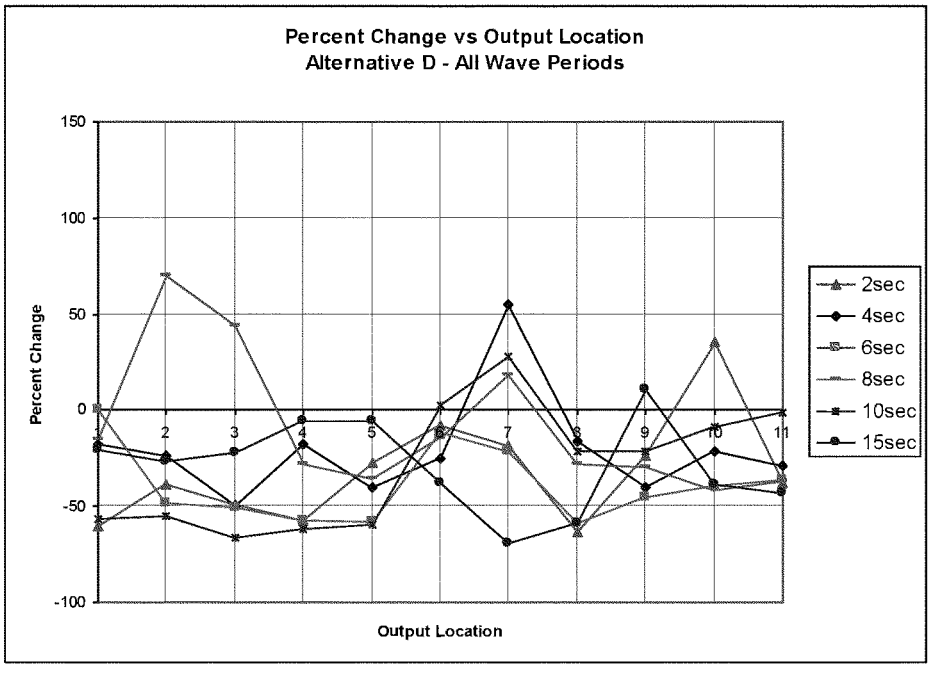

Figure 26. Percent Change in Amplification Factor – Alt. D (All Wave Periods)

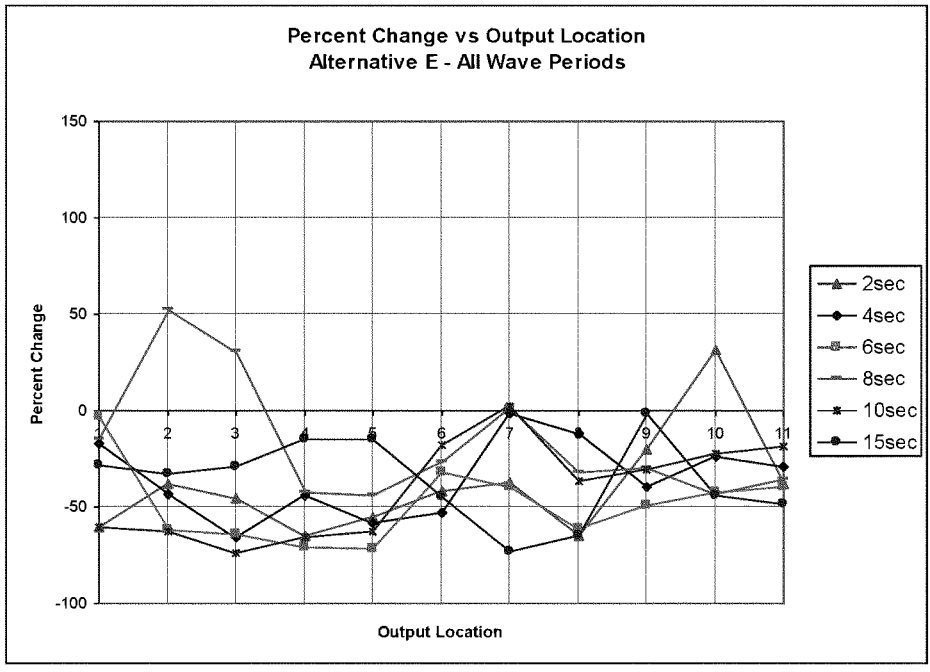

Figure 27. Percent Change in Amplification Factor – Alt. E (All Wave Periods)

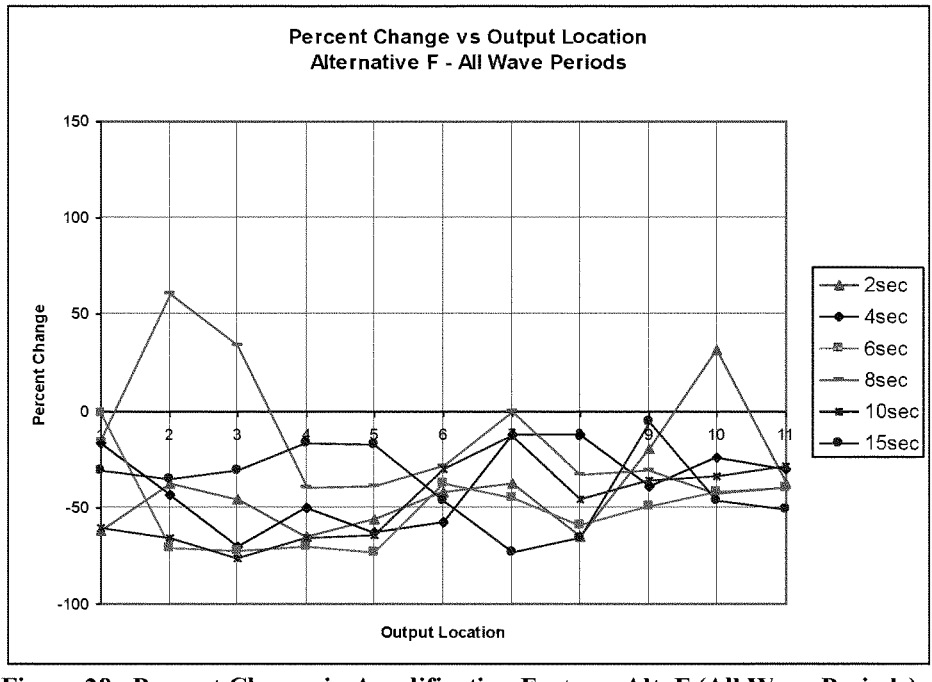

Figure 28. Percent Change in Amplification Factor – Alt. F (All Wave Periods)

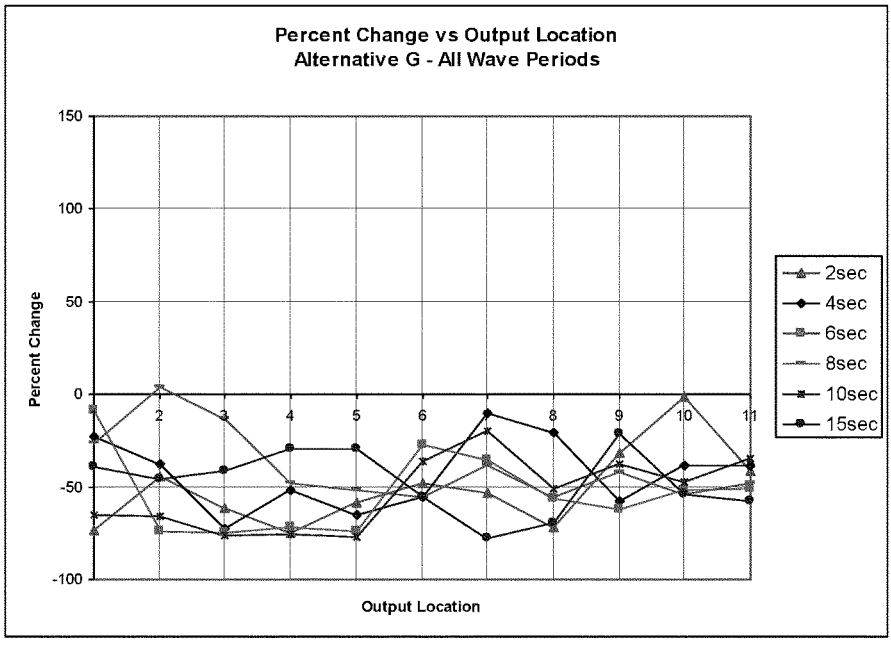

Figure 29. Percent Change in Amplification Factor – Alt. G (All Wave Periods)

Results provided in Figures 24 through 29 show instances of both significantly increased wave amplification and significantly decreased wave amplification. Alternatives with standard vertical concrete bulkheads in the vicinity of the entrance channel (B and C) have the largest increases in wave amplification over the existing basin. Percent changes range from -5% to 118% (B) and -6% to 88% (C). Replacing standard bulkheads with wave damping bulkheads (D, E, and F) reduces the magnitude, but does not eliminate increases of wave amplification. Percent changes in amplification for these alternatives range from -16% to 70% (D), -18% to 52% (E), and -29% to 61% (F).

Replacing all three standard bulkheads with riprap proved to be the most effective way to virtually eliminate increases in wave amplification in the mooring areas of the relocated plan. Alternative G produces percent changes ranging from -35% to 4%. Of the 11 OLs, all but OL 2 experience a reduction in wave amplification, which reduces predicted wave heights (wave energy) in a majority of the mooring locations. OL 2 does experience an increase in wave amplification. However the increase is small (4%) and occurs for only a single case (8 second wave period). The remaining wave periods resulted in decreases in wave amplification at OL 2 ranging from -38% to -74%. Based on an examination of all cases, it was determined that the minor increase in wave amplification was not significant enough to pose a danger to USCG vessels or negatively impact operations.

Conclusions

Figure 29 indicates that the relocated USCG boat basin (as presented in Figure 13), with bulkheads constructed according to reflection coefficients optimized in Alternative G, provides a level of wave protection that is, in most cases, greater than that of the existing basin. A 4% increase for a single wave condition was shown, but is not considered to be detrimental to station vessels or operations. Based on these results and pending verification that the layout of the basin and orientation of the entrance channel continue to meet USCG operational requirements, the Alternative G relocated basin design will be adopted as the draft USCG boat basin design for inclusion in the draft Port Everglades Harbor Feasibility Report.

It should be noted that although this report provides a draft USCG basin relocation plan, it does not draw conclusions other than to indicate that the draft plan meets safety and operational requirements in regard to the local wave climate. USCG personnel have the final authority on the design and construction of USCG facilities and may chose to conduct further evaluations or make further modifications as necessary to meet USCG goals. This report provides both a viable alternative appropriate for the feasibility phase of the Port Everglades Harbor Study and a set of data that can be used in conjunction with first hand knowledge of operational and safety requirements, local wind and current climates, and existing navigational conditions to determine a final design plan for relocation of the USCG facility at Fort Lauderdale.

References

Demirbilek, Z. and Panchang, V. (1998). CGWAVE: A Coastal Surface Water Wave Model of the Mild Slope Equation, *Technical Report CHL-98-26*, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Ms.

Brigham Young University Engineering Computer Graphics Laboratory (1997), "Surface-Water Modeling System Reference Manual," Brigham Young University, Provo, UT.

Attachment A

Facility & Infrastructure Requirements for

Station Fort Lauderdale Multi-Mission Facility

Fort Lauderdale, Florida

FACILITY & INFRASTRUCTURE REQUIREMENTS FOR

STATION FORT LAUDERDALE MULTI MISSION FACILITY

FORT LAUDERDALE, FLORIDA

U.S. Coast Guard
Civil Engineering Unit Miami

15608 S.W. 117th Avenue
Miami, FL 33177

August 2009

EXECUTIVE SUMMARY

The purpose of this document is to identify the current Coast Guard Station Ft Lauderdale facility requirements, and to provide the necessary background information should it become necessary to relocate or rebuild the Station as a result of the Southport access channel widening project.

In 1997 when the Port Everglades Harbor Feasibility Study was initiated, it was identified that widening of the "knuckle" (Southport access channel) is necessary for port expansion. The proposed Southport access channel impacts the USCG boat basin's exterior breakwater and requires the property to setback approximately 300 feet parallel to the channel. The original plan proposed by the Army Corps of Engineers (ACOE) was to cut a new basin into the Station property and rebuild the structures previously in the footprint of the new basin. However, this plan did not provide mitigation for the property loss and greatly reduced the Station's spatial functionality, operational readiness, and capacity for surge, expansion, recreation, and community outreach, and is therefore considered nonviable to the Coast Guard.

The ACOE has requested a cost estimate for the anticipated construction at Station Ft Lauderdale associated with this project. However, since the proposed plan was determined nonviable, the Coast Guard has identified and presented additional options in order to capture a more realistic summary of the implications and costs associated with necessary mitigation strategies. This document describes the shortfalls of the proposed plan, recommends potentially acceptable alternatives, and provides an estimated cost of constructing new facilities.

The most viable alternative is to rebuild a new, single, multi-mission facility east of the current basin, demolish all existing buildings, and rebuild a new basin that will maintain the same proportion and dimensions of the current basin. This new building is envisioned to meet the requirements of the Station, Aids to Navigation Team (ANT), and USCGC GANNET. This will minimize the amount of property lost for the construction of the basin and ensure that the Coast Guard missions are not adversely affected. The new facility should be constructed to support Station Ft Lauderdale's operational mission and personnel allocation at the time of construction, which is subject to minor changes between now and then.

The new facility should be designed to withstand a Category III hurricane, as per the load requirements of ASCE 7-05 for gravity loads, flood, wave action and wind. The lowest finished floor elevation should be 1 foot above the 100 year flood plain.

The optimal facility is approximately 34,000 Gross Square Feet at a cost of $19 million, based on historical cost of construction of similar facilities. *Note: The costs represented in this document are only those associated with the building and associated site work but do not include the costs of the new basin, waterfront, or new land acquisition, remediation, and/or preparation.*

LIST OF ACRONYMS AND GLOSSARY

AC	Acre
ANT	Aids to Navigation Team
AOR	Area of Responsibility
AtoN	Aids to Navigation
BFR	Basic Facility Requirement
CG	Coast Guard
CGC	Coast Guard Cutter
CATEX	Categorical Exclusion (NEPA)
COMDTINST	Commandant Instruction
GSF	Gross Square Feet
NSEU	Nova South Eastern University
NSF	Net Square Feet
NEPA	National Environmental Policy Act
NM	Nautical Mile
OIC	Officer in Charge
PAL	Personnel Allocation List
SFCAM	Shore Facilities Capital Asset Management
SF	Square feet/ Square Foot
UFC	Unified Facilities Criteria
US ACOE	United States Army Corp of Engineers
USCG	United States Coast Guard
USCGC	United States Coast Guard Cutter

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Appendix B - STATION FT LAUDERDALE, ANT FT LAUDERDALE AND COAST GUARD CUTTER GANNET BASIC FACILITY REQUIREMENTS

Appendix C - EXISTING & RECOMMENDED SITE LAYOUT

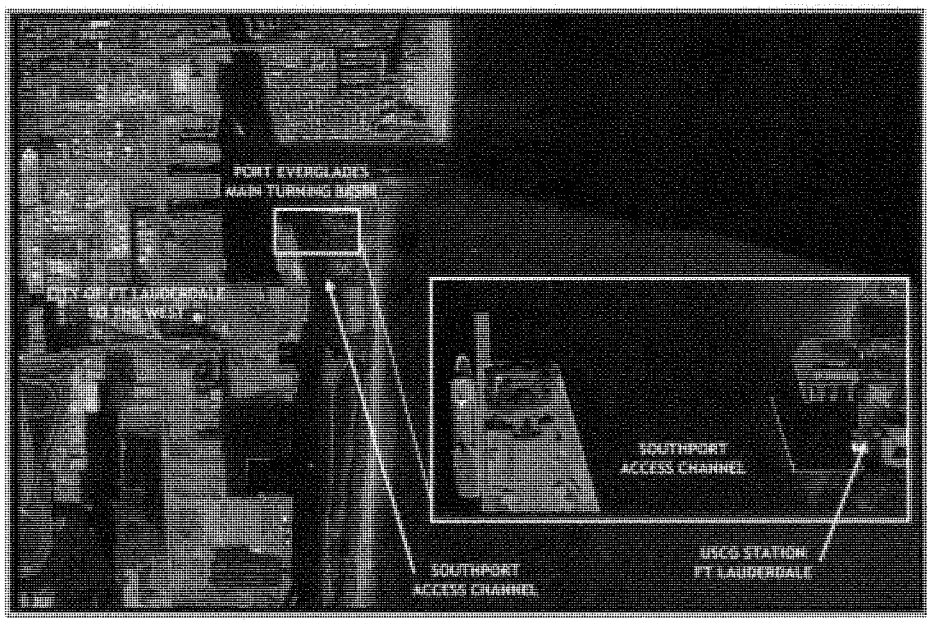
Appendix D - COST ESTIMATE

1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to present alternatives that will accommodate the proposed port expansion and associated widening of the Southport access channel, while maintaining at a minimum, the present level of protection afforded to USCG vessels within the boat basin, and the level of operations and readiness required at the Station's current site.

Exhibit 1.1. Vicinity Map



1.2 Methodology

This document includes recommendations, alternative analysis, preliminary cost estimates, supporting photos and other graphical documentation. The alternatives were developed using COMDTINST M11012.9, Shore Facility Standards Manual (SFSM) outlined requirements, GIS mapping, and on-site interviews with Station personnel. This report ensures a right-sized facility that meets the minimum operational requirements and potential future growth.

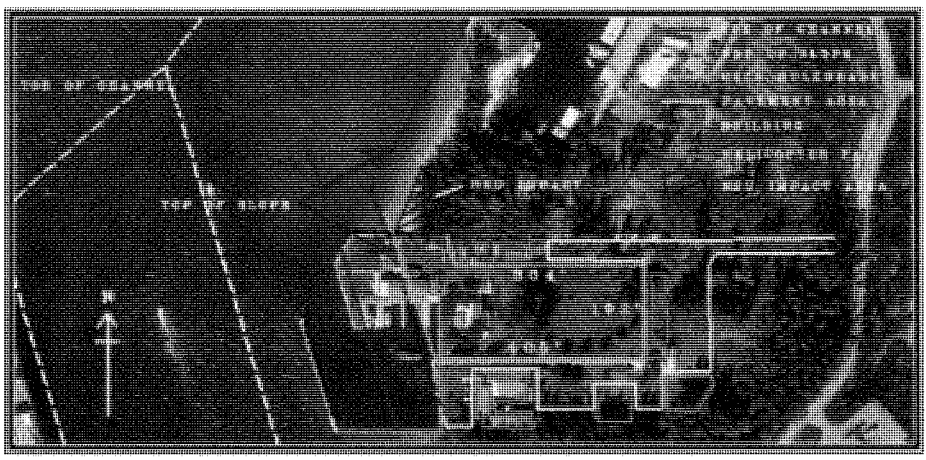
2.0 PROBLEM STATEMENT

2.1 Problem Description

In 1997, the Port Everglades Harbor Feasibility Study was initiated. In 2002, initial ship simulations indicated widening of the "knuckle" (Southport access channel) was necessary for the port expansion, and impacted the USCG boat basin's exterior breakwater. Also, wave response modeling of the USCG boat basin layouts with relocated exterior breakwater/ channel entrance locations were developed. In 2003, additional ship simulation indicated further widening of the "knuckle" was necessary, proposing relocation of the USCG boat basin to the east of its current location.

However, the proposed site plan resulting from this additional widening requirement was determined nonviable by the Coast Guard due to the amount of real estate lost and the functional inefficiency of the site layout.

Exhibit 1.2. Latest US ACOE Proposed Relocated USCG Station Ft Lauderdale Design



2.2 Problem Definition

The proposed design supplied by the US ACOE (Exhibit 1.2), incorporated relocating the boat basin to the east of its current location. This layout demolishes the two maintenance buildings and one administrative building to open space for the new basin but avoids moving the two-story multi-purpose building. This results in the multi-purpose building being separated from the new maintenance and support buildings by the new basin. The current property area is approximately 7.8 AC including the boat basin. Approximately 1.8 AC will be deducted from the available property after the channel widening is accomplished, leaving the total size of the property to be 6 AC including the boat basin. The proposed layout is unacceptable for Coast Guard mission accomplishment and operational requirements due to the following reasons:

- Locating the basin in the center of the property, leaves two narrow strips of land to access the facilities on the south and north side of the property. This jeopardizes the ability to maneuver equipment, boat trailers and personnel in such narrow areas.
- With the two narrow areas of land located on the south and north of the property, there is very limited available land for future growth.
- Unlike the existing basing, which is 262' wide, the proposed basin regardless of being 0.76 AC larger presents greater challenges for the Station's operational requirements. The proposed basin is only 192' wide, making maneuvering large Coast Guard vessels more difficult, and possibly restricting the size of vessels that could be moored at the station.
- The proposed basin is only approximately 20' north of the multipurpose building, greatly impacting access to the main entrance. The majority of traffic would need to enter through the back of the facility where all the services are located.
- Typically, when multi-function stations are designed, only two sides of the basin are used for facilities. By using the three sides of the basin, access from the administrative and maintenance buildings will be very limited and unpractical. This can jeopardize response time and the unit effectiveness.
- The proposed layout provides insufficient parking area for all of the Station's personnel and equipment. The proposed parking area, at a minimum, shall be equal to the existing area.
- The total acreage of the property will be reduced by 24%, greatly affecting the already limited available developable land and green areas.
- The proposed plan greatly reduces the Station's capacity for surge, expansion, recreation, and community outreach.

The Coast Guard's operational capabilities cannot be sacrificed in order to make the project more feasible.

2.3 Mission Functions of Benefiting Units

Multi-mission Station Ft Lauderdale is located in a 7.8 AC site on John U. Lloyd state park, Dania, Fl. Normal Area of Responsibility (AOR) covers over 950 square miles from Boca Raton to Bakers Haulover and 30 Nautical Miles (NM) offshore. The mission of Coast Guard Station Ft Lauderdale is to operate boats safely and effectively in support of all Coast Guard missions. It defines those missions as Search and Rescue (SAR), Enforcement of Laws and Treaties (ELT), Recreational Boating Safety (RBS), Marine Safety and Security (MSS), Defense Operations (DO), Short Range Aids to Navigation (SRA), Ports and Waterways Safety, Marine Environmental Protection (MEP), Marine Protected Species, and Natural Disaster and Civil Preparedness. The Station mission plays a crucial role, due to its location and high traffic of commercial, pleasure and cargo vessels in the area.

Station Ft Lauderdale is a Coast Guard shore facility with an OPFAC, command cadre, permanently assigned duty standers, unit boat allowance, and equipment, which reports to Sector Miami and/or District 7 Commander. The station also has a weapons allowance, designations for allowable covered moorings, and associated waterfront and shore-side facilities. To accommodate the allowances, the Station will require facilities in the following

space codes: 100 Operations and Training, 200 Maintenance and Production, 400 Warehouse, 600 Administrative, 700 Housing and Community, and 800 Utilities and Ground Improvements.

The total active duty compliment ashore at Station Ft Lauderdale is 83 personnel (60 Station Ft Lauderdale, 9 ANT Ft Lauderdale and 14 from the CGC GANNET). Station and ANT Ft Lauderdale staffing is presented in the following tables, and also documented in Appendix A.

Table 2.1. Station Ft Lauderdale Personnel Allowance List

CG STATION FT LAUDERDALE (000011) PERSONNEL ALLOWANCE LIST			
	Current Allowance	Position	Rank
Officer	1	STATION CO	LT
Officer	1	STATION XO	LTJG
Enlisted	1	OPS	BMC
Enlisted	3	TACTICAL & PURSUIT COXSWAIN	BM1
Enlisted	9	TACTICAL & PURSUIT COXSWAIN	BM2
Enlisted	10	COXSWAIN/TACTICAL & PURSUIT BCM	BM3
Enlisted	4	BCM	SN
Enlisted	6	BCM	SA
Enlisted	1	WEAPONS PETTY OFFICER & SAI	GM1
Enlisted	1	EPO/ENG	MKC
Enlisted	1	ENG/TACTICAL & PURSUIT BCM	MK1
Enlisted	6	ENG/TACTICAL & PURSUIT BCM	MK2
Enlisted	5	ENG/TACTICAL & PURSUIT BCM	MK3
Enlisted	1	HOUSING/MAINTENANCE	DC2
Enlisted	1	ENG/TACTICAL & PURSUIT BCM	EM1
Enlisted	2	BCM	FA
Enlisted	3	BCM	FN
Enlisted	1	SUPPORT PETTY OFFICER	SK2
Enlisted	1	FOOD SERVICES OFFICER	FS1
Enlisted	2	GALLEY WATCH STANDER	FS2
TOTAL	60		

Source: Coast Guard Central

Table 2.2. ANT Ft Lauderdale Personnel Allowance List

CG ANT FT LAUDERDALE (000266) PERSONNEL ALLOWANCE LIST			
	Current Allowance	Position	Rank
Enlisted	1	OIC/ATON COXSWAIN	BMC
Enlisted	1	XPO/ATON COXSWAIN	BM1
Enlisted	1	ATON COXSWAIN	BM2
Enlisted	1	COXSWAIN/ATON BCM	BM3
Enlisted	1	EPO/ENG	MK1
Enlisted	2	ENG/ATON BCM	MK3
Enlisted	2	ATON BCM	FN
TOTAL	9		

Source: Coast Guard Central

Table 2.3. CGC GANNET Personnel Allowance List

CGC GANNET (WBP-87334) (006267) PERSONNEL ALLOWANCE LIST			
	Current Allowance	Position	Rank
Enlisted	1	OIC	BMCM
Enlisted	1	XPO	BMC
Enlisted	1	DUTY	BM1
Enlisted	3	DUTY	BM2
Enlisted	3	DUTY	FN,SN,SA
Enlisted	1	ENGINEER PETTY OFFICER	MKC
Enlisted	1	ENGINEER DUTY	MK2
Enlisted	1	STRIKER TRAINING BILLET	FNMK
Enlisted	2	DUTY	FN, FS2
TOTAL	14		

The total active ashore equipment at Station Ft Lauderdale is 10 vessels (7 Station Ft Lauderdale, 2 ANT Ft Lauderdale and 1 from the CGC GANNET). Station and ANT Ft Lauderdale and CGC GANNET equipment lists are presented in the following tables.

Table 2.4.Station Ft Lauderdale Equipment Assignment List

CG STA FT LAUDERDALE (000011) EQUIPMENT ASSIGNMENT LIST		
Resource	Class	Unit
Boat	RBS (25515)	CG STA FT LAUDERDALE
Boat	RBS (25611)	CG STA FT LAUDERDALE
Boat	RBS (25775)	CG STA FT LAUDERDALE
Boat	(33125)	CG STA FT LAUDERDALE
Boat	(33135)	CG STA FT LAUDERDALE
Boat	UTB (41341)*	CG STA FT LAUDERDALE
Boat	UTB (41424)*	CG STA FT LAUDERDALE
TOTAL	7	

* The UTBs may be replaced by 45' RB-M's, which will bring larger utility and covered moorings requirements

Table 2.5.ANT Ft Lauderdale Equipment Assignment List

CG ANT FT LAUDERDALE (000266)) EQUIPMENT ASSIGNMENT LIST		
Resource	Class	Unit
Boat	(231218)	CG ANT FT LAUDERDALE
Boat	TANB (26157)	CG ANT FT LAUDERDALE
TOTAL	2	

Table 2.6.CGC Gannet Equipment Assignment List

CGC GANNET (WBP-87334) (006267) EQUIPMENT ASSIGNMENT LIST		
Resource	Class	Unit
Boat	CBM (171190)	CGC GANNET (WBP 87334)
TOTAL	1	

This section summarizes the facility space requirements that were calculated using Commandant Instruction (COMDTINST) M11012.9 Shore Facilities Standards Manual (SFSM). Appendix C provides the detailed space requirements for Station Ft Lauderdale, FL with the current PAL. The total net area required for a new Station facility equals 26,821 Net Square Feet (NSF), which translates to a total gross area requirement of 33,794 gross square feet (GSF). We will assume an area of 34,000 GSF for planning purposes. More specific functional areas and their respective net space requirements are as follows:

Table 2.7.SpaceCategory Area Breakdown

SPACE CATEGORY AREA BREAKDOWN	
• SPACE	AREA (SF)
• PERSONNEL SUPPORT	850
• OPERATIONS AND TRAINING	3,735
• MAINTENANCE AND PRODUCTION	5,615
• ADMINISTRATIVE	7,181
• HOUSING AND COMMUNITY	8,095
• FACILITY SUPPORT	1,345
• **TOTAL NET AREA (NSF)**	**26,821 NSF**
• ADJUSTMENT FACTORS	6,973
• **TOTAL (GSF)**	**33,794 GSF**
• **ASSUME**	**34,000 GSF**

For Detail Space Breakdown see Appendix B

2.4 Planning Factors and Assumptions

1. If real estate is reduced due to the widening of the channel, an equal amount of property needs to be acquired adjacent to the current property line to compensate for the area lost and the several new facilities spread around the site.
2. A single multi-function, multi-story facility may be built to incorporate all of the station, ANT, and cutter functions in a smaller footprint, in order to compensate for the real property lost.
3. During construction, the station operations should not be negatively affected. The project needs to incorporate consideration for temporary facilities, project sequencing and pier space to ensure no disruption of operational capabilities.
4. Right-sized facilities shall be provided, incorporating requirements from COMDTINST M11012.9 Shore Facilities Standards Manual (SFSM). Appendix C.
5. The new basin will expand to the east of the property maintaining the same size and proportion of the existing basin in order to maximize use of the current available real estate.
6. Any new construction will be designed to withstand a Category III hurricane, as per the load requirements of ASCE 7-05 for gravity loads, flood, wave action and wind. Specific design parameters shall be based on the location of the building with respect to the coastline, type of terrain, building category occupancy and importance factor. These requirements are included in chapters 1 through 6 of ASCE 7-05.
7. The majority of the building is to be of reinforced concrete construction.

3.0 ALTERNATIVE DEVELOPMENT

3.1 Status Quo

The Station is currently slightly undersized due to its mission expansion since it was originally established; the unit has a projected usable life of at least another 15 years before the Coast Guard will be forced to replace or repair the facilities. The Station continues to be very effective in the accomplishment of its mission, however, the expansion project has the potential to jeopardize this level of effectiveness.

3.2 Non Viable Alternative

Army Corps of Engineers' proposal, as presented, has been identified as a nonviable alternative for numerous reasons. See section 2.2 for the specific discussion.

3.3 Viable Alternatives

There are three different alternatives that have been identified by the Coast Guard as more feasible than the current proposal. These alternatives will allow execution of the channel widening project with minimal operational impact to the Station mission:

Alternative 1:

Development of the current recommended layout by the ACOE. The only way this option can become feasible is by acquiring more land either south or north of the current property in order to minimize or eliminate the issues described in section 2.2 of this document.

Advantages:

- Lower construction and infrastructure cost since existing facilities will be re-used, minimizing the amount of new construction.

Disadvantages:

- Adjacent land will need to be acquired, which will likely require significant environmental remediation.
- This option may require temporary relocation of the Station while construction is being executed.

Alternative 2:

Construction of the Station at an alternate waterfront site within a two mile radius of the current Station's location. The selected property features, at a minimum, must be equivalent to the current property owned by the Coast Guard and have the same area of developable land.

Advantages:

- The Station Mission will suffer no impacts, since it will continue to operate from its current location while construction is being done in the alternate site, and once construction is finished the Station will permanently move to the new location.

Disadvantages:

- Waterfront land will need to be acquired, which is currently believed to be scarce.
- Site will most likely require full development and new construction, greatly exceeding the other two options cost.
- This alternative will require a relocation cost.

Alternative 3:

Construction of a single multi-function, multi-story Station building and supporting infrastructure at current location. Site planning will need to account for the ANT's buoy yard, as well as other equipment currently stored on site to ensure the impacts of the loss of land is mitigated.

Advantages:

- No additional land will be required. A smaller footprint for a single facility allows for more efficient use of the available real estate, eliminating the need of more land to compensate for the footprint of several buildings spread around the site.
- The Station mission impact will be minimized; it will be easier to phase the project and ensure operations can continue while construction of the new facility is executed.
- Although the initial construction cost will be higher than Alternative 1, it will be more economical than trying to acquire new land.

Disadvantages:

- Initial construction cost higher than Alternative 1.
- Will likely require some temporary boat mooring and crew berthing arrangements.

3.4 Preferred Alternative

The preferred alternative is Alternative 3, to rebuild Station Ft Lauderdale as a single, multi-function, multi-story facility, capable of withstanding a Category III hurricane. The facility at a minimum will be designed to meet the following parameters:

1. The new multi-mission building will be a three-story, approximately 34,000 GSF facility accommodating the Station, ANT, and USCGC GANNET needs. The first deck will be maintenance & shops; the second deck will be administrative, operations, and training; and the third deck will be housing and personnel support spaces. It will include all associated site work, utilities, roadways and parking areas in accordance with Coast Guard guidelines, standards and requirements.
2. The old maintenance, administrative and housing buildings will be demolished to open space for the new basin. Construction must be executed in a manner that will allow construction of the multi-mission facility on site while the old facilities continue to be used.

Appendix A
STATION FT LAUDERDALE, ANT FT LAUDERDALE AND COAST GUARD CUTTER GANNET PAL

Position Details						
Position information for: CG STA FORT LAUDERDALE (000011) (PAL)						
	Unit Type	Position	Rank	Number	BCN	Source
Officer	Boat Stations	XO	LTJG	00033892	0795491	MIL
Officer	Boat Stations	CO	LT	00035662	0702361	MIL
Enlisted	Boat Stations	OPS	BMC	00035396	0785703	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM1	00072799	P072799	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM1	00072799	P072799	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00069994	P069994	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00028853	0844003	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00037388	0718773	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00033769	0718663	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM1	00033768	0718653	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00033767	0718643	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00068712	P068712	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00035686	0718693	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00033766	0718633	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00033766	0718633	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00033763	0718593	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00035686	0718693	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00033765	0718623	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00033787	0718983	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00033764	0718613	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00035688	0718783	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00035685	0718603	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00072802	P072802	MIL
Enlisted	Boat Stations	BCM	SN	00033776	0718803	MIL
Enlisted	Boat Stations	BCM	SN	00033777	0718823	MIL
Enlisted	Boat Stations	BCM	SN	00033778	0718833	MIL
Enlisted	Boat Stations	BCM	SA	00035692	0718973	MIL
Enlisted	Boat Stations	BCM	SA	00035687	0718723	MIL
Enlisted	Boat Stations	BCM	SA	00033773	0718733	MIL
Enlisted	Boat Stations	BCM	SA	00033771	0718703	MIL
Enlisted	Boat Stations	BCM	SN	00033781	0718883	MIL
Enlisted	Boat Stations	WEAPONS PETTY OFFICER & SAI	GM1	00091561		MIL
Enlisted	Boat Stations	EPO/ENG	MKC	00035691	0718933	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK2	00035690	0718903	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK1	00033784	0718923	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK2	00022661	0113543	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK2	00035689	0718813	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK2	00033782	0718893	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK2	00072798	P072798	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK3	00033762	0718583	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK3	00033779	0718843	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK3	00022972	0721323	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK3	00022973	0721343	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK3	00033780	0718863	MIL

Enlisted	Boat Stations	HOUSING/MAINTENANCE	DC2	00033783	0718913	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	EM1	00033785	0718953	MIL
Enlisted	Boat Stations	BCM	FA	00033786	0718963	MIL
Enlisted	Boat Stations	BCM	FN	00000420	0717573	MIL
Enlisted	Boat Stations	BCM	FN	00000421	0717593	MIL
Enlisted	Boat Stations	BCM	FN	00000420	0717573	MIL
Enlisted	Boat Stations	BCM	FA	00000438	0718123	MIL
Enlisted	Boat Stations	ENG/TACTICAL & PURSUIT BCM	MK2	00022993	0721833	MIL
Enlisted	Boat Stations	SUPPORT PETTY OFFICER	SK2	00033788	0719003	MIL
Enlisted	Boat Stations	BCM	SA	00000439	0718133	MIL
Enlisted	Boat Stations	FOOD SERVICES OFFICER	FS1	00033790	0719033	MIL
Enlisted	Boat Stations	GALLEY WATCH STANDER	FS2	00035693	0719023	MIL
Enlisted	Boat Stations	GALLEY WATCH STANDER	FS2	00033789	0719013	MIL
Enlisted	Boat Stations	BCM	SA	00033772	0718713	MIL
Enlisted	Boat Stations	COXSWAIN/TACTICAL&PURSUIT BCM	BM3	00035684	0718573	MIL
Enlisted	Boat Stations	TACTICAL & PURSUIT COXSWAIN	BM2	00037387	0718743	MIL

TOTAL OFFICERS	2
TOTAL ENLISTED	58
TOTAL ACTIVE PAL	60

Position Details						
Position information for: CG STA FORT LAUDERDALE (000011) (RPAL)						
	Unit Type	Position	Rank	Number	BCN	Source
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BMCS	00051188	B009781	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BMC	00051549	B009807	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM1	00051608	B009809	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM1	00051199	B009808	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM1	00069805	P069805	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM3	00051189	B009782	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM2	00051200	B009810	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM2	00051201	B009811	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM2	00069806	P069806	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM2	00048934	B009604	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM2	00051187	B009780	RSV
Enlisted	Boat Stations	CONTINGENCY COXSWAIN	BM3	00051708	B009779	RSV
Enlisted	Boat Stations	CONTINGENCY BCM	SN	00051709	B009783	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK1	00051465	B013847	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK1	00051190	B009784	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK2	00051192	B009786	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK3	00051768	B009791	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK1	00069807	P069807	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK3	00051194	B009788	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK2	00051191	B009785	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK2	00069808	P069808	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK3	00051195	B009789	RSV
Enlisted	Boat Stations	CONTINGENCY BCM	FN	00051710	B009794	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK3	00051768	B009791	RSV
Enlisted	Boat Stations	CONTINGENCY ENG	MK3	00051757	B009790	RSV
Enlisted	Boat Stations	GALLEY WATCH STANDER	FS2	00051186	B009762	RSV
TOTAL RESERVE PAL		26				

Position Details

Position information for: CG ANT FORT LAUDERDALE (000266) (PAL)

	Unit Type	Position	Rank	Number	BCN	Source
Enlisted	AtoN	OIC/ATON COXSWAIN	BMC	00038182	0726753	MIL
Enlisted	AtoN	XPO/ATON COXSWAIN	BM1	00039652	0786803	MIL
Enlisted	AtoN	ATON COXSWAIN	BM2	00040078	0726743	MIL
Enlisted	AtoN	COXSWAIN/ATON BCM	BM3	00041545	0726763	MIL
Enlisted	AtoN	EPO/ENG	MK1	00038183	0726803	MIL
Enlisted	AtoN	ENG/ATON BCM	MK3	00039651	0786793	MIL
Enlisted	AtoN	ENG/ATON BCM	MK3	00040079	0726783	MIL
Enlisted	AtoN	ATON BCM	FN	00038184	0726813	MIL
Enlisted	AtoN	ATON BCM	FN	00038184	0726813	MIL
ALL ACTIVE PAL		9				

Position Details

PAL Information for: CGC GANNET (WPB-87334) (006267)

	Unit Type	Position	Rank	Number	BCN	Source
Enlisted	Patrol Boats	OFFICER IN CHARGE	BMCM	00000381	0704813	MIL
Enlisted	Patrol Boats	EXECUTIVE PETTY OFFICER	BM1	00000382	0704823	MIL
Enlisted	Patrol Boats	EXECUTIVE PETTY OFFICER	BM1	00000382	0704823	MIL
Enlisted	Patrol Boats	DUTY	BM2	00000383	0704833	MIL
Enlisted	Patrol Boats	DUTY	BM2	00000383	0704833	MIL
Enlisted	Patrol Boats	DUTY	BM2	00000383	0704833	MIL
Enlisted	Patrol Boats	DUTY	FN	00002472	0704893	MIL
Enlisted	Patrol Boats	DUTY	SN	00002470	0704843	MIL
Enlisted	Patrol Boats	DUTY	SA	00000384	0704853	MIL
Enlisted	Patrol Boats	ENGINEER PETTY OFFICER	MKC	00000385	0704863	MIL
Enlisted	Patrol Boats	DUTY	MK2	00002471	0704873	MIL
Enlisted	Patrol Boats	STRIKER TRAINING BILLET	FNMK	00000386	0704883	MIL
Enlisted	Patrol Boats	DUTY	FN	00002472	0704893	MIL
Enlisted	Patrol Boats	DUTY	FS2	00000387	0704903	MIL
TOTAL ACTIVE PAL			14			

Appendix B
STATION FT LAUDERDALE, ANT FT LAUDERDALE AND COAST GUARD CUTTER GANNET BASIC FACILITY REQUIREMENTS

SUMMARY
BASIC FACILITY REQUIREMENTS FOR STATION FT LAUDERDALE, ANT FT LAUDERDALE AND CGC GANNET

Space Name	Space Code SFSM-1	Personnel/ Equipment Allot	Qty	Space Allocations CMDT	TOTAL
PERSONNEL SUPPORT					
Lobby	900.002	150	3	450	
Elevator Lobby	900.005	50	3	150	
Shop Lunch Room	900.053	250	1	250	
			Personnel Support PNA		850
PARTIAL NET AREA CALCULATIONS					
Operations & Training PNA					3,735
Station				3,735	
Maintenance & Prod. PNA					5,615
Station				2,710	
ANT				2,190	
CGC GANNET				715	
Administrative PNA					7,181
Station				5,475	
ANT				1,456	
CGC GANNET				250	
Housing and Community					8,095
Station				8,095	
			Partial Net Area		24,626
FACILITY SUPPORT					
Mechanical Equipment	800.006	285	3	855	
Electrical Equipment	800.012	10	3	30	
Telecomm Equipment	800.040	15	3	45	
Telephone Equipment	800.044	15	3	45	
Emergency Generator	800.020	270	1	270	
General Building Storage	800.400	100	1	100	
			Total Facilities Support		1,345
GROSS AREA CALCULATION					
Partial Net Area				24,626	
Facilities Support				1,345	
			Total Net Area (TNA)		26,821
ADJUSTMENT FACTORS					6,973
Net/ Gross		0.25	TNA	5,364	
Thicker Exterior Walls		0.02	TNA	536	
Vertical Circulation (.04/ flr)		800	min.	1,073	
			Gross Floor Area		33,794
			SAY		34,000

BASIC FACILITY REQUIREMENT (BFR)

ASSET CLASS: STATION FORT LAUDERDALE

TOTAL NET AREA REQUIREMENT (SQFT)	20,015

Functional Statement:

l To accommodate the allowances, Stations will require facilities in the following space codes: 100 Operations and Training, 200 Maintenance and Production, 400 Warehouse, 600 Administrative, 700 Housing and Community, and 800 Utilities and Ground Improvements.

Space Codes:

l **100- Operations and Training.** Stations are assigned one or more standard boats; sizes are typically a 47' Motor Life Boat (MLB), 41' Utility Boat (UTB), a Response Boat Medium (RB-M), and Response Boat Small (RB-S). Actual Station requirements are determined from each Individual Station's boat allowance. Stations may also have legacy non-standard boats such as skiffs for extreme shallow water missions. A Station requires a secure communications/operations room to maintain command and control, provide SAR communications, and maintain contact with its boats underway (radio guard) and Command. Station personnel carry weapons for patrols and boardings which must be stored in a secure area. Wet rooms are required to provide a dedicated drying area for Station SAR and boarding gear. Station Operations are described in U.S. Coast Guard Boat Operations and Training (Boat) Manual, Volume 1 COMDTINST M16114.32 (series). A critical part to station operations are the associated training requirements which are described in U.S. Coast Guard Boat Operations and Training (Boat) Manual, Volume II COMDTINST M16114.33 (series).

l **200- Maintenance and Production.** The Stations are responsible for accomplishment of all organizational level maintenance (inspecting, servicing, lubricating, and adjusting) on all installed equipment. Shop facilities are required to perform the maintenance and repair of the assigned boats and will typically include a boatswain shop, a machine and engine shop for engine repairs and maintenance, and an associated flammable storage.

l **400- Warehouse.** Storage facilities are required to store spare parts and tools for maintenance and repair of boats.

l **600- Administrative.** Administrative facilities are required for the CO / Officer-in-Charge, the Executive Petty Officer, and the Engineering Petty Officer. Other Station personnel will require periodic shared access to a workstation at a ratio of 1 per 7 personnel.

l **700- Housing and Community.** Station operations are 24/7, requiring duty standers. Ready crew berthing must be provided for these duty standers in close proximity to meet BO readiness. Associated laundry, linen and storage areas are also required. In some locations, depending upon other living arrangements, stations will require a small UPH for its unaccompanied members, but this is a site-specific decision and is addressed in the Coast Guard Housing Manual COMDTINST M11101.13 (series). Stations will also require a physical fitness area if not collocated with a physical fitness center.

l **800- Utilities and Ground Improvements.** A Station's boats require shore ties and other utility connections as outlined in the Operational Logistics Support Plan (OLSP) for the various boats. Additionally, the grounds of the Station are typically maintained by unit personnel.

Space Code	Space Name	Maximum Allowance	Unit of Measure	Notes See Below)	Required	Total
FACILITY REQUIREMENTS						
100	**OPERATIONS AND TRAINING**					
140.016	Weapons Storage	80	NSF		1	80
140.023	Communications/Operations Room	300	NSF		1	300
140.401	Maintenance Equipment Storage	200	NSF		1	200
140.142	Wet Rooms (Unit PAL of 11 or more)	300	NSF		1	300
140.904	Male and Female Locker area	300	NSF		1	300
140.905	Male and Female toilets	200	NSF		1	200
140.906	Laundry Area	120	NSF		1	120
140.144	Wet Rooms					
140.910	Male and Female Locker area	15	NSF	1,2	15	225
140.912	Male and Female toilets/showers	350	NSF		1	350
	Drying Area	40	NSF	3	1	40
140.913	Laundry Area	120	NSF		1	120
171.001	Training Space			4		
171.003	12 or less	300	NSF			
171.004	13 to 24	600	NSF			
171.005	25 to 36	900	NSF			0
	above 36	25	NSF	5	60	1,500
	TOTAL OPERATIONS AND TRAINING					3,735

Notes

1 Locker space is sized for duty crew, not entire PAL and is based on 15 NSF per double locker. Double lockers are for those members who do not otherwise have assigned locker space for their duty gear (pilots, MSO inspectors, boat crews, etc). Provides a 3' wide double locker, 2 feet deep, with 2.5 feet of space to edge of a bench for seating that is 1 foot wide. This is for storage of equipment, but not a drying area.

2 The space allocated should be 120% of the duty crew PAL, with a 90% male, 30% female ratio. Local justification is required to alter this ratio. No more than 120% of the duty crew PAL should be counted towards this requirement.

3 This is a dedicated ventilated area with a drain.

4 Training facilities should be provided only if the unit is isolated, otherwise training facilities will be shared with other units. Training facilities can also function as an all-hands facility but should not be sized specifically to accomplish this function. The 300-900 SF training requirement can be met through the use of a conference room, or other available spaces. It should be sized based on type of training conducted, rather than the total PAL.

5 Provided for each additional student.

200	MAINTENANCE AND PRODUCTION					
	Covered Mooring	Individual	sized individually	6	2	
213.002	Boatswain Shop					
213.003	Workstation	150	NSF		2	300
213.401	Parts/Tool Storage	300	NSF		1	300
213.011	Machine and Engine Shop					
213.010	Work Bay (for up to 21 ft. boats)	600	NSF	7		0
213.011	Work Bay (for up to 41 ft. boats)	1350	NSF	7	1	1,350*
213.012	Outboard Engine Test	200	NSF	8	1	200
213.406	Flammable Storage	40	NSF		1	40
	Industrial Laundry	120	NSF	9	1	120
	Shop Lunch Area	15	NSF	10		0
	TOTAL MAINTENANCE AND PRODUCTION				2	2,310

Notes	
6	Covered mooring facilities provided per COMDTNOTE 11010 on an individual basis.
7	Up to 21 or 41 ft. boats, where severe weather conditions require indoor maintenance and ability exists to move equipment. *Will increase when Station shifts to 45' boats.
8	Provide (2) 100 NSF test areas.
9	Industrial Laundry space includes 2 washers and 2 dryers. This space is for shop laundry and is separate from domestic laundry.
10	Size per person. Minimum size 250 NSF, this includes a seating area (150 NSF) and a kitchenette (100 NSF). To be provided for shop personnel only.

400	WAREHOUSE					
140.404	Small Boat Storage	400	NSF	11	1	400
	TOTAL WAREHOUSE					400

Notes	
11	Space justified based on severe weather conditions. Required to store spare parts and tools for maintenance and repair of boats.

600	ADMINISTRATIVE					
	PRIVATE OFFICE SPACE					
	Command Cadre					
	Officer-In-Charge	150	NSF		1	150
	Executive Petty Officer	150	NSF		1	150
	OPEN OFFICE SPACE					
	Supervisory O-1 and O-2	80	NSF	12		
	Supervisory E-6 through E-8	80	NSF	12,13	9	720
	Non-Supervisory O-1 through O-4	60	NSF			
	Non-Supervisory E-7 through E-9	60	NSF			0
	Title 10 Reservist	60	NSF	14		
	E-1 through E-6	48	NSF		48	2,304
	Hoteling Cubicles	48	NSF	15	4	192
	Workstation Circulation @ 25% of Open Office Space			16		804

	SHARED USE OFFICE SPACE					
610.100	*File Areas*					
610.103	Lateral file cabinet/bookcase (ea.)	8	NSF		1	8
610.111	Conference/Training Space (if Station small)	150	NSF	17,18		
610.111	Conference/Training Space (if Station large)	300	NSF	17,18	1	300
	Resource/Technical Library Room	See Note	LF	19		
610.120	Coffee Mess (ea.)	60	NSF	20	2	120
610.130	Administrative Storage	65	NSF	21	1	65
610.150	Office Equipment Space	150	NSF	22	1	150
	Mail Distribution Area	40	NSF	23	1	40
	Locker (ea.)	8	NSF	24	59	472
	TOTAL ADMINISTRATIVE					5,475

Notes	
**	Administrative facilities shall not exceed 230 gross square feet per person (based on GSA standards). To calculate the SF per person, total the sum of all office space and divide by the number of billets authorized on the PAL for office space.
**	Reservists - Include space for Reservists listed as billets on the RPAL. One space should be provided per every 7 reservists (7 reservists = 1 FTE).
12	Supervisory means that the position has signature authority on a performance evaluation, either military or civilian.
13	Also includes Supervisory WG/WL/WS equivalent if applicable.
14	Title 10 Reservists - Calculate open office space based on the average annual total Title 10 hours over the past 3 years and divide by 2,080. Round up to the nearest full FTE. Individual justification is required for this space.
15	Office carrels are recommended for those spending less than 25% of total time in the office at a rate of 1:7 personnel assigned.
16	A circulation factor of 25% should be added to the sum of the Open Office Space spaces and is to be used in addition to the Net to Gross Multiplier. The circulation factor provides interior circulation between workstations in an open office plan.
17	Conference room size is based on the number of typical users and function, not on the PAL. Allocate 150 NSF for 1 - 7 persons and 300 NSF for 8 - 15 persons. Conference rooms may need to be located adjacent to each other to benefit from configurable partitions.
18	Conference rooms and mess deck should be collocated to allow for use as all hands training space.
19	Provides space for technical manuals, reference materials. This space is to be accommodated within the conference room requirement. The space is calculated by linear footage of bookcases. 100% retention on site is not required.
20	Coffee mess includes refrigerator, coffee maker, microwave, and sink. Provide at a rate of 1 per 35 people. Provide one per floor if Unit is located on multiple floors. This space is not provided if the unit is located on a single floor and a non-established mess is already provided.
21	Includes general office supplies (e.g. paper, files, pens, staples, etc.). Provide one per Unit, or Department/Division if Unit is not collocated. Provide one per floor if Unit is located on multiple floors.
22	To include fax, printer, copier, scanner. Additional equipment requires individual justification. Provide one per Unit, or Department/Division if Unit is not collocated. Provide one per floor if Unit is located on multiple floors.
23	Provide only one per Unit, even if the Unit resides on multiple floors.
24	Provides a private locker (full height - 1' wide, 1.5' deep, 2.5' area in front to access) for all military personnel, civilians, and contractors.

700	HOUSING AND COMMUNITY					
	READY CREW BERTHING			25		
721.014	Officer-of-the-Day night room	240	NSF		1	240
721.014	Enlisted Watch stander E-1 thru E-9	240	NSF	26	16+	3,840
721.014	Enlisted Watchstander Male/Female Sep	150	NSF			
721.972	Domestic Laundry Room	80	NSF	27	1	80
721.470	Linen Storage	50	NSF		1	50
	TV Room / Recreation Room (Station Small)	150	NSF			0
	TV Room / Recreation Room (Station Large)	300	NSF		1	300
	Physical Fitness Area	8	NSF	28	70	560
	ESTABLISHED MESS (Food Service Specialist (FS) Personnel Assigned			31		
722.150	Dinning for 41-80 people MESS DECK	540	NSF		1	540
722.935	Foyer	80	NSF		1	80
722.936	Public Toilets	180	NSF		1	180
722-153	GALLEY		NSF	31		
722.154	Can Wash	30	NSF		1	30
722.155	Dish Washing	175	NSF		1	175
722.433	Dry Storage	95	NSF		1	95
722.157	Inventory Work Station	75	NSF		1	75
722.832	Janitor's Closet	30	NSF		1	30
722.158	Pot Washing	90	NSF		1	90
722.159	Preparation/cooking/Baking	345	NSF		1	345
722.160	Receiving /Issue	135	NSF		1	135
722.161	Refrigerator/Freezer	345	NSF		1	345
722.169	Serving Area	810	NSF		1	810
722.937	Staff Toliets/Lookers	95	NSF		1	95
	SENTRY BOOTH		NSF			
730.252	Guard Booth	50	NSF	32		0
	TOTAL HOUSING AND COMMUNITY					8,095

Notes

25	This is for ready crew berthing only. UPH for permanent party is a based upon site specific condition. The maximum is two watch standers per room. A head is included in the 240 NSF.
26	Single module - 150 NSF minimum, 240 NSF preferred.
27	Provides one washer and one dryer for every 15 persons.
28	Minimum size 200, maximum size 1,200. Provide only if there is no fitness center located on site.
29	This space utilized by watch standers only for food preparation. It will be provided even if the Unit is collocated with a galley. This space includes a kitchenette, pantry and mess deck.
30	Equipment should include refrigerator, stove, microwave, and sink.
31	An Established Mess will be provided if the Unit is not collocated with an ISC or district that provides a galley. Requirements for this space can be found in the 700 series Space Allocation List.
32	Provide only if not collocated at a site that provides security.

SITE REQUIREMENTS						
100	OPERATIONS AND TRAINING					
	BOAT SUPPORT			33		
	47' MLB					
	Depth Requirement (minimum (preferred))	5 (7)	Feet			
	Mooring Length (alongside a single pier)	58	Feet			
	Mooring Length (finger pier on one side)	53	Feet			
	Mooring Length (finger piers on both sides)	40	Feet			
	Mooring Height (Mast Lowered)	18	Feet			
	Mooring Height (Mast Raised)	28.33	Feet			
	Mooring Width (nominal wind or currents)	24	Feet			
	Mooring Width (no wind or currents)	21	Feet			
	Trailer	N/A	N/A			
	RB-M					
	Depth Requirement (minimum (preferred))	4.5 (6)	Feet			
	Mooring Length (alongside a single pier)	55	Feet			
	Mooring Length (finger pier on one side)	50	Feet			
	Mooring Length (finger piers on both sides)	37	Feet			
	Mooring Height (Mast Lowered)	13.2	Feet			
	Mooring Height (Mast Raised)	26.7	Feet			
	Mooring Width (nominal wind or currents)	24	Feet			
	Mooring Width (no wind or currents)	21	Feet			
	Trailer	N/A	N/A			
	41' UTB				2	
	Depth Requirement (minimum (preferred))	4.5 (6)	Feet			
	Mooring Length (alongside a single pier)	52	Feet			
	Mooring Length (finger pier on one side)	47	Feet			
	Mooring Length (finger piers on both sides)	34	Feet			
	Mooring Height (Mast Lowered)	13.2	Feet			
	Mooring Height (Mast Raised)	26.7	Feet			
	Mooring Width (nominal wind or currents)	24	Feet			
	Mooring Width (no wind or currents)	21	Feet			
	Trailer	N/A	N/A			
	RB-S				3	
	Depth Requirement	3.25	Feet			
	Mooring Length	36	Feet			
	Mooring Height	15	Feet			
	Mooring Width	12	Feet			
	Trailer	TBD	Feet			
	33' Utility Boat Light (UTL)				2	
	Depth Requirement	2.5	Feet			
	Mooring Length	43	Feet			
	Mooring Width	15	Feet			
	Trailer	TBD	Feet			
	TOTAL OPERATIONS AND TRAINING					
Notes						
33	Standards provided for standard boats only. Non-standard boat support requirements are subject to CCB approval.					

800	UTILITIES AND GROUND IMPROVEMENTS					
	Boat Ramp					
	47' MLB					
	Sewage	N/A	N/A	34		
	Fuel					
	Connection	1	Schedule 40 Pipe	35		
	Grey Water	N/A	N/A			
	Bilge Water	N/A	N/A			
	Connection					
	Electrical					
	VAC	120	VAC			
	Amps	100	AMPS			
	Water		Gallons	36		
	45' RB-M					
	Fuel					
	Connection	1	TBD			
	Electrical					
	VAC	120	VAC			
	Amp	100	AMPS			
	Water	5	Gallons	36		
	41' UTB				2	
	Fuel					
	Connection	1	TBD	37		
	Electrical					
	VAC	120	VAC			
	Amps	100	AMPS			
	Water	20	Gallons	36		
	25' RB-S				3	
	Fuel					
	Connection	1	TBD			
	Electrical					
	VAC	120	VAC			
	Amp	100	AMPS			
	Potable Water		Gallons	36		
	PARKING					
	GOVs	See note		38	**3**	
	Personnel Parking	See note		39	56	
	TOTAL UTILITIES AND GROUND IMPROVEMENTS					

Notes	
34	Manually emptied.
35	2" connection, capacity 412 gallons
36	Potable water is stored aboard the vessel in containers, a supply line is not necessary at mooring.
37	capacity 486.8 gallons
38	Size parking spaces per assigned vehicles.
39	Parking to be provided for 70% of assigned personnel. This a generalized criterion, and local site conditions (e.g. availability of mass transit), along with implemented strategies to reduce parking demand, should determine the final ratio. The turning radius needs to accommodate the largest vehicle and trailer accessing that area.
**	Consult the associated Process Guide for guidance on restroom and facility support space determination.

BASIC FACILITY REQUIRMENT (BFR)

ASSET CLASS: AIDS TO NAVIGATION TEAM (ANT) FORT LAUDERDALE

TOTAL NET AREA REQUIREMENT	3,646

Functional Statement:

The mission of a Coast Guard ANT is to provide maintenance of all assigned aids to navigation, including buoys, lighthouses, lighthouse structures, and daybeacons. ANT is also responsible for positioning and repositioning buoys that shift. The Coast Guard also uses cutters to place, position, and maintain aids to navigation. Each Inland (65' and 100'), Coastal (175'), or Seagoing (225') buoy tender is a separate OPFAC that has its own requirements.

l An ANT is a Coast Guard shore unit with an OPFAC, command cadre, unit boat allowance, and equipment, which reports to a Sector. An ANT also has associated waterfront and shore-side facilities.

l To accommodate the allowances, ANTs will require facilities in the following space codes: 100 Operations and Training, 200 Maintenance and Production, 400 Warehouse, 600 Administrative, 700 Housing and Community, and 800 Utilities and Ground Improvements.

Space Codes:

l **100- Operations and Training.** ANT boats can include Trailerable Aids to Navigation Boat (TANB) varying from 17' to 23', 49' BUSL, 55' ATON, and 64' ANB. Actual ANT requirements are determined from each Individual ANT's boat allowance.

l **200- Maintenance and Production.** ANTs are responsible for accomplishment of all organizational level maintenance (inspecting, servicing, lubricating, and adjusting) on all installed equipment. Shop facilities are required to perform the maintenance and repair of the assigned boats and will typically include a boatswain shop, a machine and engine shop for engine repairs and maintenance, and an associated flammable storage. In addition to maintaining the equipment the ANT uses to access aids, it repairs and maintains aids in shop spaces.

l **400- Warehouse.** Storage facilities are required to store spare parts and tools for maintenance and repair of boats and ATON. Outdoor storage is also required for buoys, sinkers, and chains. Indoor storage is required for dayboards and lanterns.

l **600- Administrative.** Administrative facilities are required for the Officer-in-Charge, Executive Petty Officer, and Engineering Petty Officer. Other ANT personnel will require periodic shared access to a workstation at a ratio of 1 per 7 personnel.

l **700- Housing and Community.** In some remote locations, the CG may elect to have duty watchstanders. If so, watchstanders will require watchstander berthing and a small mess deck for food preparation. Fitness facilities may also be required in those cases.

l **800- Utilities and Ground Improvements.** ANT's boats require shore ties and other utility connections as outlined in the Operational Logistics Support Plan (OLSP) for the various boats. Parking is required for GOV vehicles and boat trailers (for trailerable boats). These spaces are not included in this SAL as they are not considered typical.

Space Code	Space Name	Maximum Allowance	Unit of Measure	Notes (See Below)	Required	Total
FACILITY REQUIREMENTS						
200	**MAINTENANCE AND PRODUCTION**					
	AIDS TO NAVIGATION TEAM SHOP					
218.011	Shop (Size Per 2 Team Members)	100	NSF	1	2	200
218.411	ANT Shop Storage (Size Per 2 Team Members)	100	NSF	1	2	200
218.012	Small Boat Bay (Size Per TANB)	400	NSF	2	1	400
218.412	Battery Charging/Storage	40	NSF		1	40
218.413	Flammable Storage	150	NSF	3	1	150
	DAYBOARD PRODUCTION SHOP					
218.041	Shop	400	NSF		1	400
218.440	Storage	150	NSF		1	150
	ELECTRICAL (EM) SHOP					
218.051	Shop (size per required workstation)	150	NSF		1	150
218.450	Storage (size per workstation)	100	NSF		1	100
	ELECTRONICS (ET) SHOP					
218.061	Shop (size per required workstation or mock-up)	100	NSF		0	0
218.460	Storage (size per workstation)	100	NSF		0	0
	TOTAL MAINTENANCE AND PRODUCTION					1,790

Notes

1. If separate ET and/or EM shops required, do not count EM/ET(s) toward team members. Separate EM/ET shops are required if both EM and ET billets are assigned.
2. Space must be justified based on severe weather conditions that hamper operations.
3. Not required if collocated with a Sector or ISC.
4. Spaces not required if collocated with depot level boat maintenance facility.
5. Spaces are in addition to the Carpentry Shop.
6. If collocated with a depot level boat maintenance facility, add 1/2 of this NSF to the boat maintenance shop space at the depot facility.
7. Space includes 2 welding stations sized at 165 sf each.
8. Industrial Laundry space includes 2 washers and 2 dryers. This space is for shop laundry and is separate from domestic laundry.

400	**WAREHOUSE**					
	Tractor/Forklift Storage					
218.403	Storage (for buoys up to 2744 mm x 10,668 mm (9' x 35'))	400	NSF		1	400
218.404	Storage (for river buoys only)	200	NSF			0
	TOTAL WAREHOUSE					400

Notes

600	ADMINISTRATIVE					
	PRIVATE OFFICE SPACE					
	Command Cadre					
	Officer-In-Charge	150	NSF		1	150
	Executive Petty Officer	150	NSF		1	150
	Engineering Petty Office	150	NSF		1	150
	OPEN OFFICE SPACE					
	Supervisory E-6 through E-8	80	NSF	9	0	0
	Non-Supervisory E-7 through E-9	60	NSF		0	0
	Title 10 Reservist	60	NSF	10	0	0
	E-1 through E-6	48	NSF		6	288
	Hoteling Cubicles	48	NSF	11	0	0
	Workstation Circulation @ 25% of Open Office Space			12		185
	SHARED USE OFFICE SPACE					
610.100	*File Areas*					
610.103	Lateral file cabinet/bookcase (ea.)	8	NSF	13	4	32
610.111	Conference/Training Space	150	NSF	14	1	150
610.120	Coffee Mess (ea.)	60	NSF	15	1	60
610.130	Administrative Storage (ea.)	65	NSF	16	1	65
610.150	Office Equipment Space	150	NSF	17	1	150
	Mail Distribution Area	40	NSF	18	1	40
	Locker (ea.)	4	NSF	19	9	36
	Shop Lunch Area	15	NSF	20		
	TOTAL ADMINISTRATIVE					1,456

Notes

9	Supervisory means that the position has signature authority on a performance evaluation, either military or civilian, and not assigned a private office.
10	Title 10 Reservists - Calculate open office space based on the average annual total Title 10 hours over the past 3 years and divide by 2,080. Round up to the nearest full FTE. Individual justification is required for this space.
11	Office carrels are recommended for those spending less than 25% of total time in the office.
12	A circulation factor of 25% should be added to the sum of the Open Office Space spaces and is to be used in addition to the Net to Gross Multiplier. The circulation factor provides interior circulation between workstations in an open office plan.
13	Individual justification required.
14	Conference/training space size is based on the number of typical users and function, not on the PAL. Allocate 150 NSF for 1 - 7 persons and 300 NSF for 8 - 15 persons. Conference/training spaces may need to be located adjacent to each other to benefit from configurable partitions.
15	Coffee mess includes refrigerator, coffee maker, microwave, and sink. Provide at a rate of 1 per 35 people. This space is not provided if the unit is located on a single floor and a non-established mess is already provided.
16	Includes general office supplies (e.g. paper, files, pens, staples, etc.). Provide one per Unit, or Department/Division if Unit is not collocated. Provide one per floor if Unit is located on multiple floors.
17	To include fax, printer, copier, scanner. Additional equipment requires individual justification. Provide one per Unit, or Department/Division if Unit is not collocated. Provide one per floor if Unit is located on multiple floors.
18	Provides space for mail sorting. Provide only one per Unit, even if the Unit resides on multiple floors.
19	Provides a private locker (full height - 1' wide, 1.5' deep, 2.5' area in front to access) for all military personnel, civilians, and contractors. This applies to those members who do not otherwise have assigned locker space for their duty gear (pilots, MSO inspectors, boat crews, etc.)
20	Size per person. Minimum size 250 NSF, this includes a seating area (150 NSF) and a kitchenette (100 NSF). To be provided for shop personnel only.

700	HOUSING AND COMMUNITY					
	Physical Fitness Area	8	NSF	21,22		
	NON-ESTABLISHED MESS (No Food Service Specialist (FS))			23		
722.003	Mess Deck - Dining Area (8 seats)	120	NSF	24		0
722.006	Janitor's Closet	30	NSF			0
	ESTABLISHED MESS (Food Service Specialist (FS) Assigned)	See Note		25		
	SENTRY BOOTH					
730.252	Guard Booth	50	NSF	26		
	TOTAL HOUSING AND COMMUNITY					0

Notes

21	Minimum size 200, maximum size 1,200. Provide only if there is no fitness center located on site.
22	Shower and locker rooms with toilets are warranted if the site is isolated.
23	This space will be provided if the unit is isolated and there is not a Food Service Specialist billeted.
24	Includes a kitchenette, pantry and mess deck.
25	An Established Mess will be provided if the Unit is not collocated with an ISC or district that provides a galley. Requirements for this space can be found in the 700 series Space Allocation List.
26	Provide only if not collocated at a site that provides security.

SITE REQUIREMENTS

100	OPERATIONS AND TRAINING					
	BOAT SUPPORT					
	17-26' TANB				2	
	Depth Requirement	3.25	Feet			
	Mooring Length	36	Feet			
	Mooring Height	15	Feet			
	Mooring Width	12	Feet			
	Trailer	TBD	Feet			
	Boat Ramp	See Note		27		
	TOTAL OPERATIONS AND TRAINING					

Notes

27	A boat ramp is required to launch trailerable boats into the water. This requirement can be met off-site through the use of a public boat launch.

400	WAREHOUSE					
	Buoy Storage Yard	See Note		28		
	TOTAL WAREHOUSE					

Notes						
28	To be determined by the size and number of buoys required to be stored outside.					
800	**UTILITIES AND GROUND IMPROVEMENTS**					
	17-26' TANB				2	
	Electrical					
	VAC	TBD				
	Amp	TBD				
	Water	TBD	Gallons	29		
	PARKING					
	Boat Trailer Parking	See Note		30	2	
	GOVs	See Note		31	1	
	Personnel Parking	See Note		32	7	
	TOTAL UTILITIES AND GROUND IMPROVEMENTS					

Notes

29	Potable water is stored aboard the vessel in containers, a supply line is not necessary at mooring.
30	Requirements based on boat trailer size.
31	Size parking spaces per assigned vehicle.
32	Parking to be provided for 70% of assigned personnel. This a generalized criterion, and local site conditions (e.g. availability of mass transit), along with implemented strategies to reduce parking demand, should determine the final ratio. The turning radius needs to accommodate the largest vehicle and trailer accessing that area.
**	Consult the associated Process Guide for guidance on restroom and facility support space determination.

BASIC FACILITY REQUIREMENT (BFR)

ASSET CLASS: WPB 87' MARINE PROTECTOR CLASS CUTTER GANNET, FT LAUDERDALE

TOTAL NET AREA REQUIREMENT 965

Functional Statement:

The Mission of an 87' Marine Protector Class Patrol Boat is to provide law enforcement, defense operations, marine environmental protection, and SAR operations under the Command of a District.

l The 87' WPB contains a stern launching and recovery system using Rigid Hull Inflatable Boats (RHIBs) to conduct boardings, and has the capability to operate in heavy seas, up to Sea State 5. The crew size is 10 personnel (1 officer and 9 enlisted). The ship can accommodate 12 with any mix of males and females.

l To accommodate the mission support requirements, each WPB 87' will require facilities in the following space codes: 100 Operational and Training, 400 Supply, 600 Administrative, 700 Housing and Community, and 800 Utilities and Ground Improvements.

Space Codes:

l **100- Operational and Training.** An 87 WPB will require periodic access to training facilities, but these do not need to be dedicated. These can be provided at a gym facility, galley, club, or at local hotel or school. The 87' will require mooring facilities.

l **400- Supply.** Storage space is required for spares and tools. In addition, the 87' will require long-term storage and a staging area for receiving storage items.

l **600- Administrative.** One office is required on the shore side for each 87' Patrol Boat.

l **700- Housing and Community.** Housing and Community facilities required include a physical fitness area if the site is not collocated with an existing fitness center.

l **800- Utilities and Ground Improvements.** An 87' WPB requires shore ties and other utility connections as outlined in its Operational Logistics Support Plan (OLSP).

Space Code	Space Name	Maximum Allowance	Unit of Measure	Notes (See Below)	Required	Total
FACILITY REQUIREMENTS						
100	OPERATIONAL AND TRAINING					
171.001	Training Space			1		
171.003	12 students or less	300	NSF			0
171.004	13 to 24 students	600	NSF			0
171.005	25 to 36 students	900	NSF			0
	TOTAL OPERATIONAL AND TRAINING					

Notes

1 Personnel will require periodic access to training facilities, but these do not need to be dedicated and can be provided using various scenarios. Training Facilities are not sized for all-hands training. Spaces already accounted under the Station FT Lauderdale BFR.

400	SUPPLY			2		
213.481	Cutter Storage	250	NSF		1	250
213.483	Cutter Parts/Tool Storage	400	NSF		1	400
	Flammable Storage	40	NSF		1	40
	HAZMAT storage	25	NSF		1	25
	TOTAL SUPPLY					715

Notes

2 87' OLSP COMDTINST M4081.9 Chapter 6 Paragraph D

600	ADMINISTRATIVE					
	OPEN OFFICE SPACE					
	Cutter Office	250	NSF	3	1	250
	TOTAL ADMINISTRATIVE					250

Notes

3 Office space per cutter.

700	HOUSING AND COMMUNITY					
	Physical Fitness Area	8	NSF	4		0
	TOTAL HOUSING AND COMMUNITY					

Notes

4 Sized per user. Minimum size 200, maximum size 1,200. Provide only if there is no fitness center located on site. Space Accounted for under Station Ft Lauderdale BFR.

SITE REQUIREMENTS

100	OPERATIONAL AND TRAINING					
	BOAT SUPPORT					
	87' WPB					
	Depth Requirement (minimum (preferred))	11	Feet	5		
	Operational Draft	5.43	Feet			
	Mooring Length (alongside a single pier)	109	Feet	6		
	Mooring Length (finger pier on one side)	TBD	Feet			
	Mooring Width (nominal wind or currents)	TBD	Feet			
	Mooring Width (no wind or currents)	TBD	Feet			
	TOTAL OPERATIONAL AND TRAINING					

Notes

5 Minimum, at lowest predicted tide.

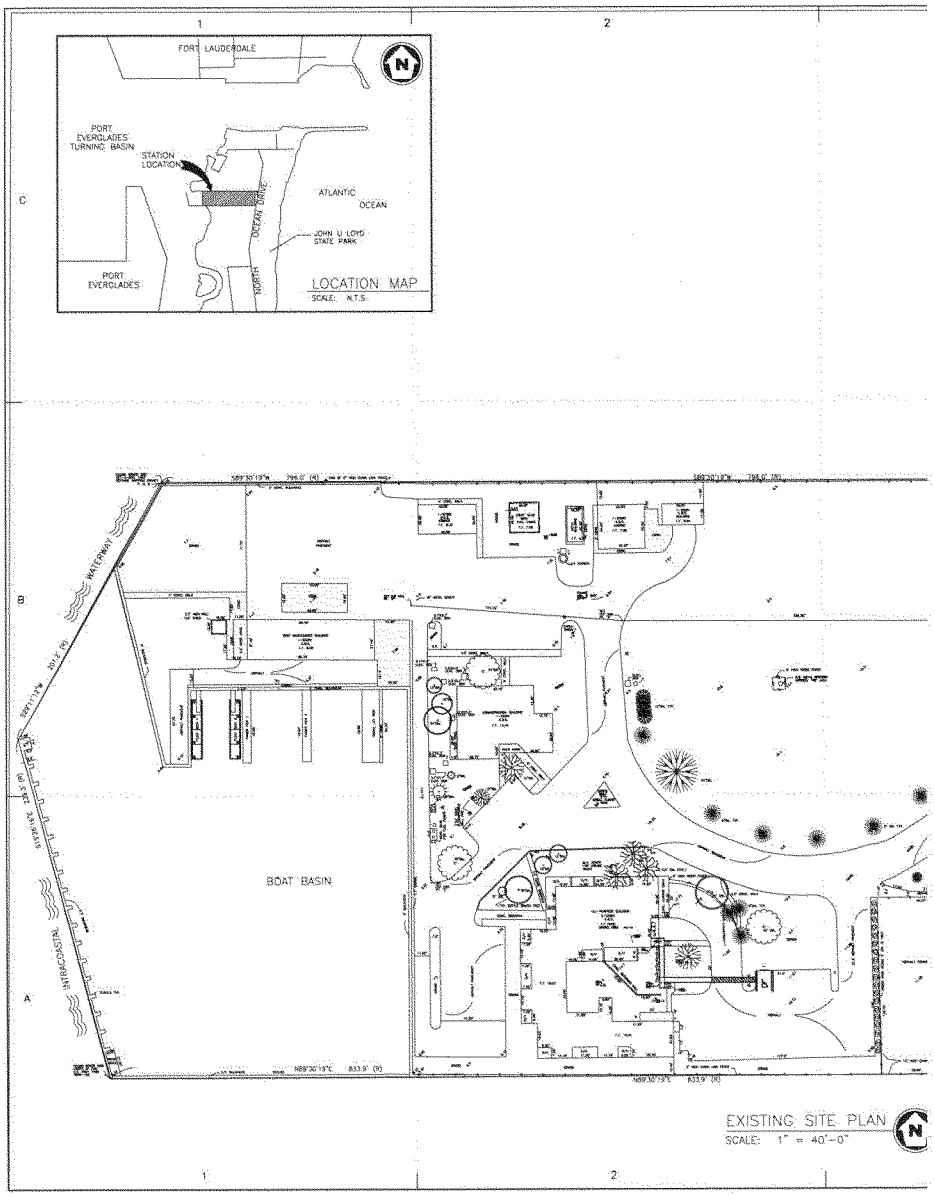
6 Minimum. Add 25-feet between cutters and 25-feet at ends of mooring.

800	UTILITIES AND GROUND IMPROVEMENTS					
	87' WPB					
	Sewage	363	Gallons	7		
	Fuel					
	Connection	TBD	Gallons	8		
	Telephone	4	Telephone line pairs	9		
	Grey Water	1	TBD			
	Bilge Water					
	Connection	92	GPD	7		
	Electrical					
	VAC	450	VAC	10		
	Amps	100	AMPS			
	Potable Water	400.9	GPD	11		
	Lighting		5-foot candles	12		
	Cable TV			13		
	Local Area Network (LAN)		TBD	14		
	PARKING					
	GOVs	See note		15	2	
	Long-Term Cutter Parking	See note		16	12	
	Personnel Parking	See note		17		
	TOTAL UTILITIES AND GROUND IMPROVEMENTS					

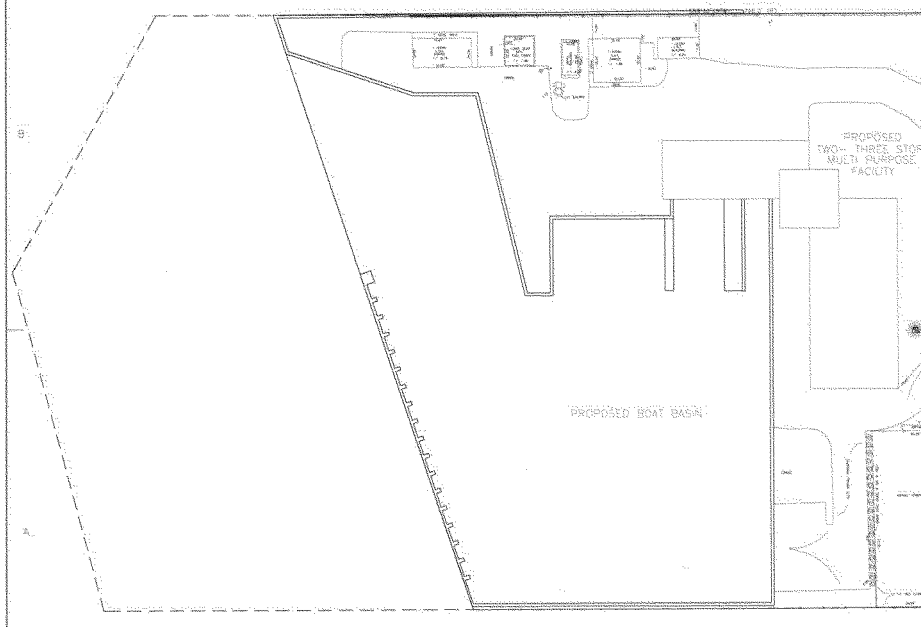
Notes

7	2.5" bronze valve to 4" flange
8	2.5" pipe, and 1.5" O pipe
9	Connection point is 0.5 meters forward of frame 16, 1.75 meters inboard port side.
10	3-phase. If transformer serves only shore tie, should be tapped-down as close as possible to 450 volts. If is also serves shoreside loads, 480 volts is acceptable. Should be identical to 110' WPB to permit accommodation of visiting PBs.
11	1 1/2 inch connection size.
12	For open working areas on a slip and in storage buildings while working.
13	1 commercial service, connection point is .5 meters forward of frame 16, 1.75 meters inboard port side.
14	Currently under development at TISCOM. CPB has two pair fiber optic cables, terminated in ST connectors plus two pair copper lines for data transmission.
15	Size parking spaces per assigned vehicle.
16	Provides long-term parking for assigned cutters while they are deployed. This can be provided off-site.
17	Parking to be provided for 70% of assigned personnel. This a generalized criterion, and local site conditions (e.g. availability of mass transit), along with implemented strategies to reduce parking demand, should determine the final ratio. The turning radius needs to accommodate the largest vehicle and trailer accessing that area.
**	Consult the associated Process Guide for guidance on restroom and facility support space determination.

Appendix C
EXISTING & RECOMMENDED SITE LAYOUT


FORT LAUDERDALE
PORT EVERGLADES TURNING BASIN
STATION LOCATION
ATLANTIC OCEAN
OCEAN DRIVE
JOHN U. LOYD STATE PARK
PORT EVERGLADES
NORTH
LOCATION MAP
SCALE: N.T.S.
WATERWAY
BOAT BASIN
INTRACOASTAL
EXISTING SITE PLAN
SCALE: 1" = 40'-0"

NOTE:
THE ATTACHED LAYOUT IS FOR ILLUSTRATION PURPOSES ONLY AND DOES NOT REPRESENT A FINAL FACILITY DESIGN OR APPROVAL.



Appendix D
COST ESTIMATE

COST ESTIMATE

DATE PREPARED 5/29/2009

PROJECT COST ESTIMATE -

ACTIVITY AND LOCATION	DESIGN/ENGINEERING CONTRACT NO.	PROJECT NUMBER
United States Coast Guard	N/A	N/A
PROJECT TITLE	**ESTIMATED BY**	
SECTOR MIAMI-STATION FT LAUDERDALE	Alejandro Holguin	

PROJECT TITLE

Construct New Split STA buildings @ Current Site, Cost does not include Water front infrastructure and support.

Item No.	Item Description	Quantity Unit	Quantity Number	Cost/Unit	Total Cost ($)	% Cost
1.0	DEMOLITION					
	Demo Sta Building RPFN 101	CF	219276	$0.40	$87,710	
	Bldg Foundation Demolition	SF	16897.0	$6	$100,537	
	Mob/Demob/Environmental	Ea	1.0	$50,000	$50,000	
				Subtotal	$238,248	1.28%
2.0	SITE WORK					
	Flag Pole	Ea	2.0	$6,000.00	$12,000	
	Pile Foundation	Ea	42.0	$15,000.00	$630,000	
	Soil Remediation	Ea	1.0	$25,000.00	$25,000	
	Concrete Sidewalks	SF	12000	$5.40	$64,800	
	Flexible Pavement	SF	36000	$2.50	$90,000	
	Landscaping	LS		$35,000.00	$35,000	
				Subtotal	$856,800	4.60%
3.0	EXTERIOR UTILITIES					
	Electrical Power	LS	1.0	$35,000	$35,000	
	Exterior Lighting	EA	36.0	$5,000	$180,000	
	Telephone	LS	1.0	$20,000	$20,000	
	Water	LS	1.0	$25,000	$25,000	
	Sanitary Sewer	LS	1.0	$15,000	$15,000	
				Subtotal	$275,000	1.48%
4.0	BUILDING CONSTRUCTION					
	Construct admin/OPS/Berthing	SF	18,000	$297	$5,534,000	
	Construct Industrial Shop facility	SF	12,000	$225	$2,700,000	
	Miscellaneous	LS	1.0	$55,000	$55,000	
				Subtotal	$9,289,000	49.90%
5.0	FURNISHINGS/EQUIPMENT					
	Building Outfitting	SF	17015.0	$7	$111,448	
				Subtotal	$111,448	0.60%
6.0	ELECTRONICS OUTFITTING					
	Telephone Equipment	LS	1.0	$120,000	$120,000	
	SW3 setup/cabling	LS	1.0	$190,000	$190,000	
				Subtotal	$310,000	1.67%
7.0	OTHER					
	Temporary Offices	Ea	1.0	$60,000	$60,000	
				Subtotal	$60,000	0.32%
				Subtotal	$11,140,496	59.85%
8.0	COST AMPLIFIERS					
	Escalation Factor to 2011(7% Per Year)				$2,333,504	12.57%
				Subtotal	$13,480,000	
	Location Factor			0.98	$13,210,400	
	Design Contingency			15%	$1,981,560	10.65%
	Construction Contingency			10%	$1,321,040	7.10%
	A/E and Survey Fees			10%	$1,321,040	7.10%
	Construction Surveillance (12K/Month)			6%	$118,894	0.64%
	LEED			5%	$660,520	3.55%
Project Total =>					$18,613,453	100%

Attachment B

Maximum Wave Amplification for Relocated Basin Alternatives:

Alternatives B through G

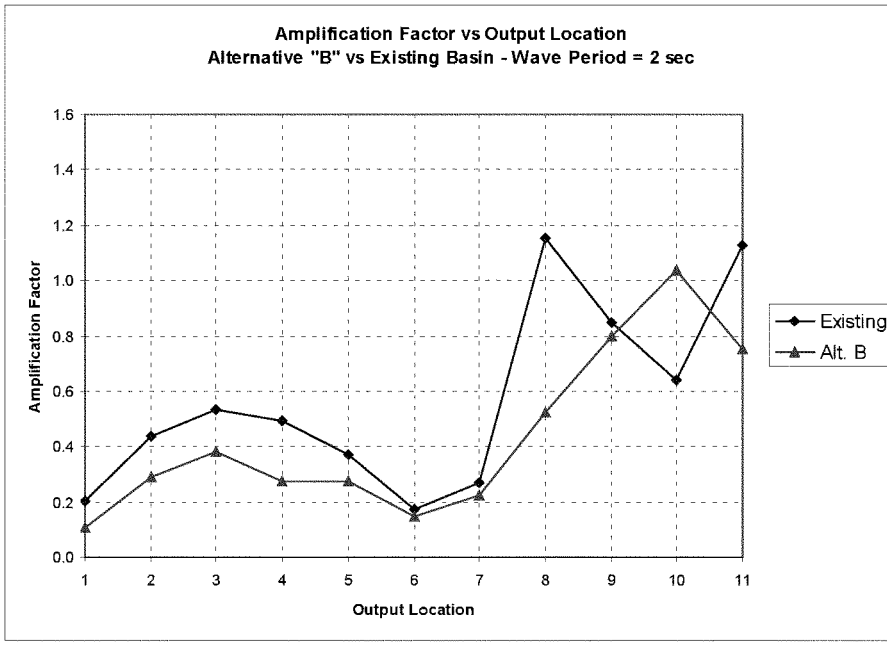


Figure B- 1. Maximum Amplification Factor – Alternative "B" vs Existing (Period = 2sec)

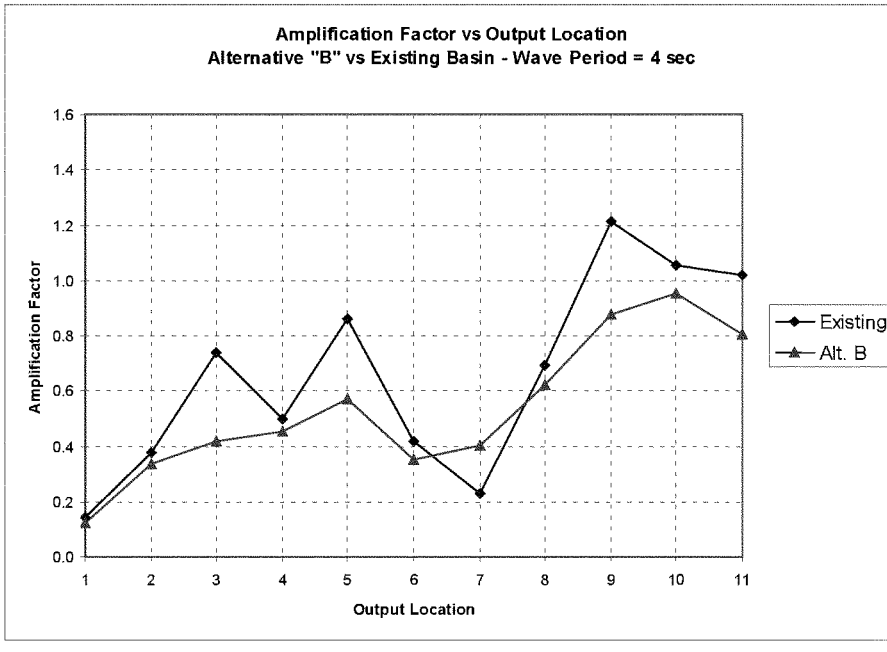


Figure B- 2. Maximum Amplification Factor – Alternative "B" vs Existing (Period = 4sec)

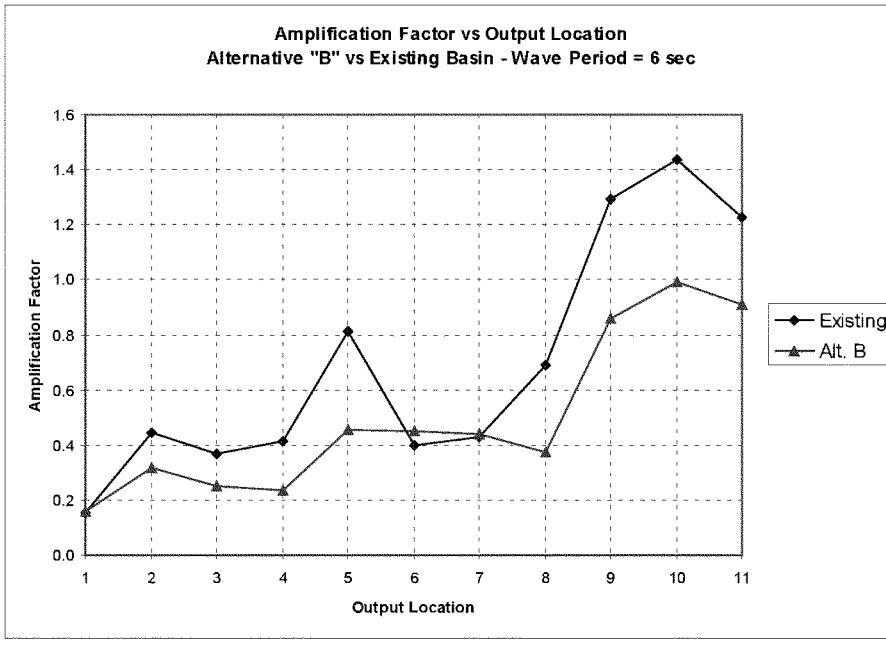


Figure B- 3. Maximum Amplification Factor – Alternative "B" vs Existing (Period = 6sec)

Figure B- 4. Maximum Amplification Factor – Alternative "B" vs Existing (Period = 8sec)

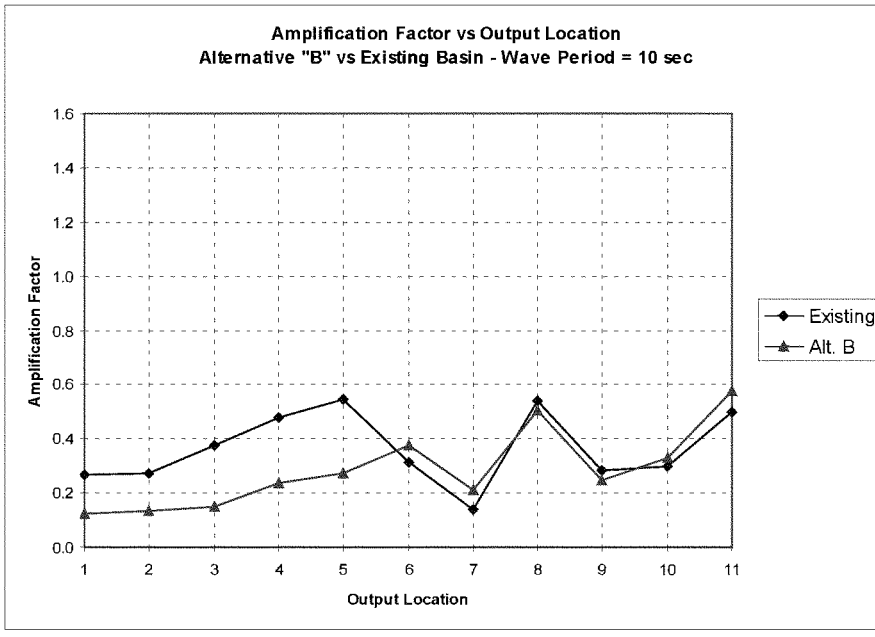


Figure B- 5. Maximum Amplification Factor – Alternative "B" vs Existing (Period = 10sec)

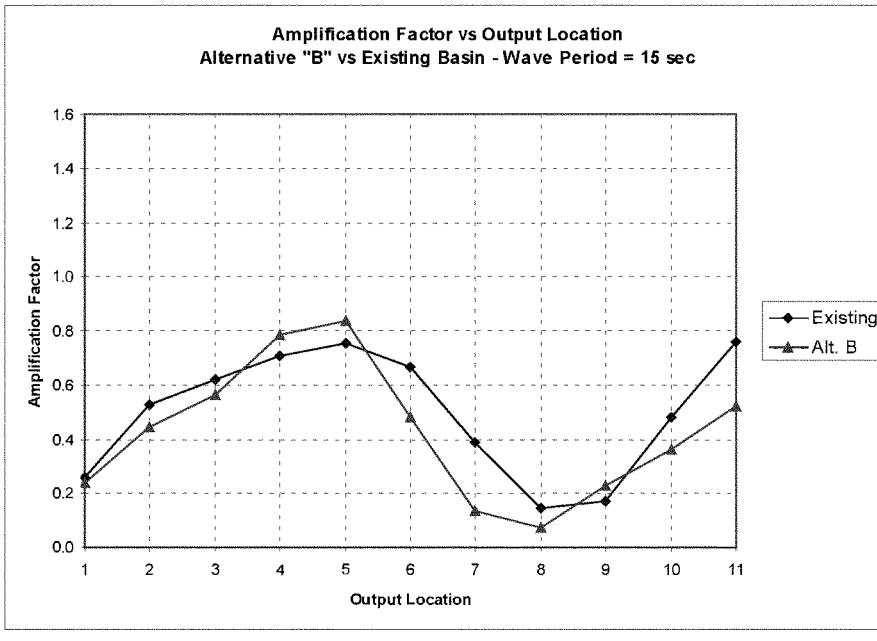


Figure B- 6. Maximum Amplification Factor – Alternative "B" vs Existing (Period = 15sec)

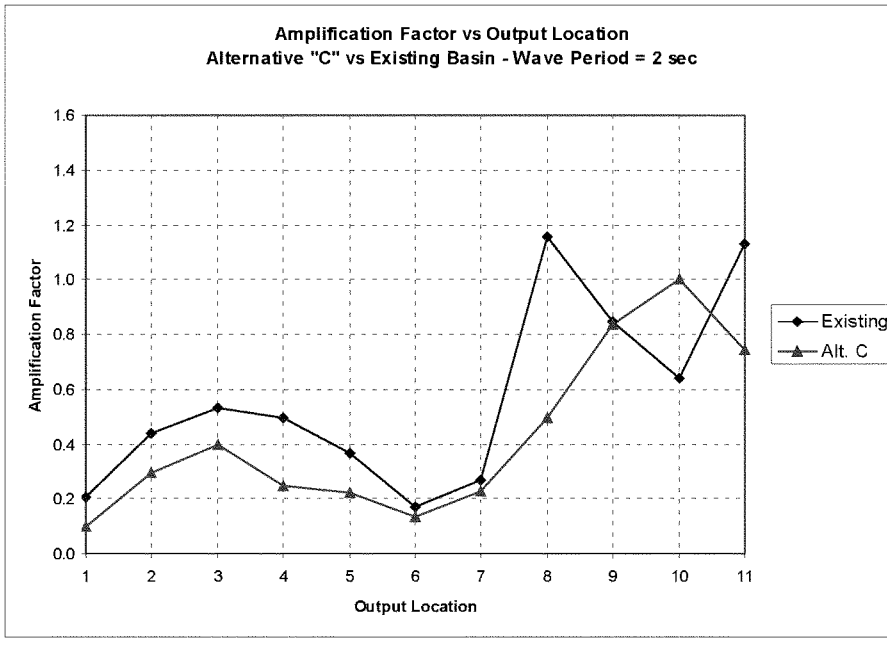


Figure B- 7. Maximum Amplification Factor – Alternative "C" vs Existing (Period = 2sec)

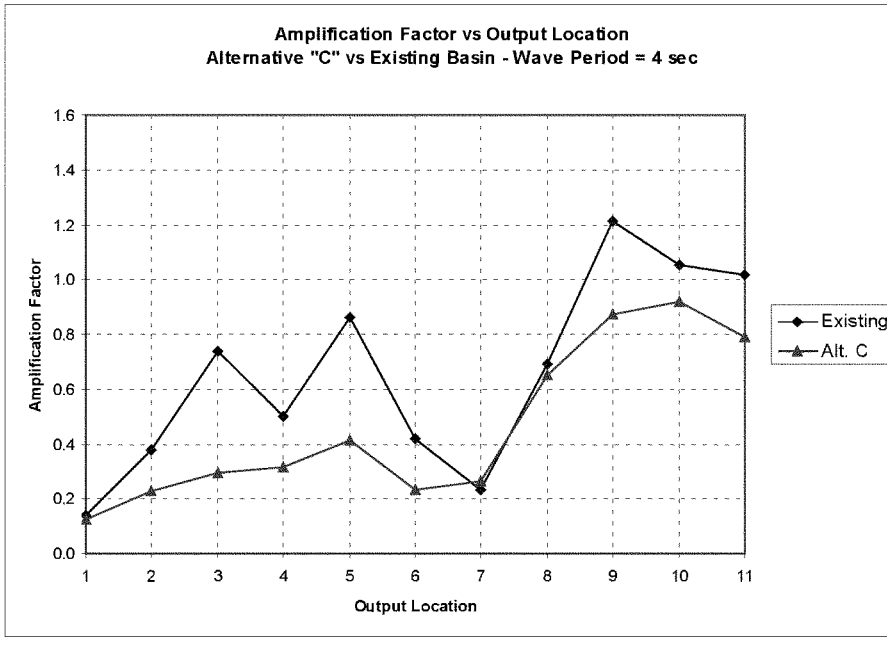


Figure B- 8. Maximum Amplification Factor – Alternative "C" vs Existing (Period = 4sec)

Figure B- 9. Maximum Amplification Factor – Alternative "C" vs Existing (Period = 6sec)

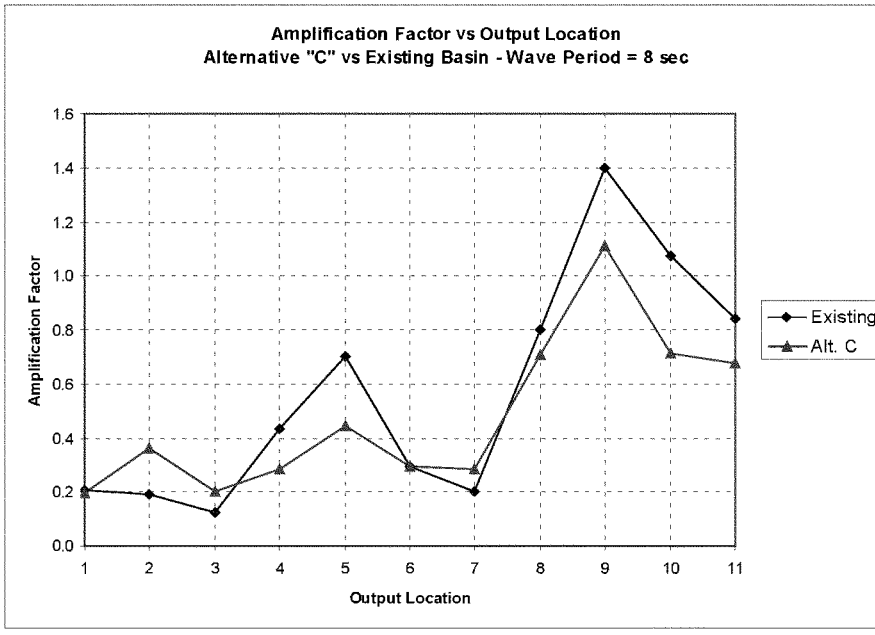


Figure B- 10. Maximum Amplification Factor – Alternative "C" vs Existing (Period = 8sec)

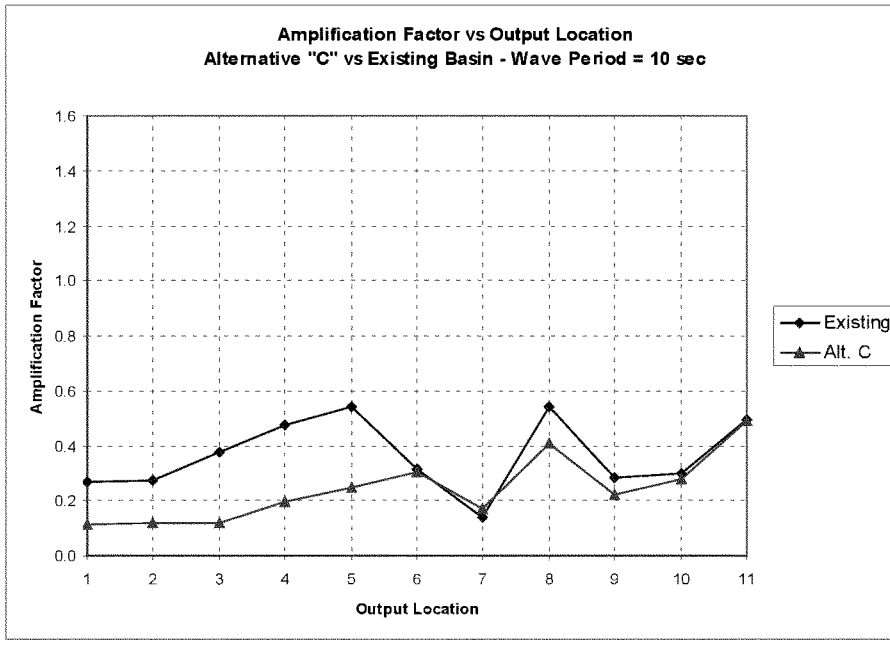


Figure B- 11. Maximum Amplification Factor – Alternative "C" vs Existing (Period = 10sec)

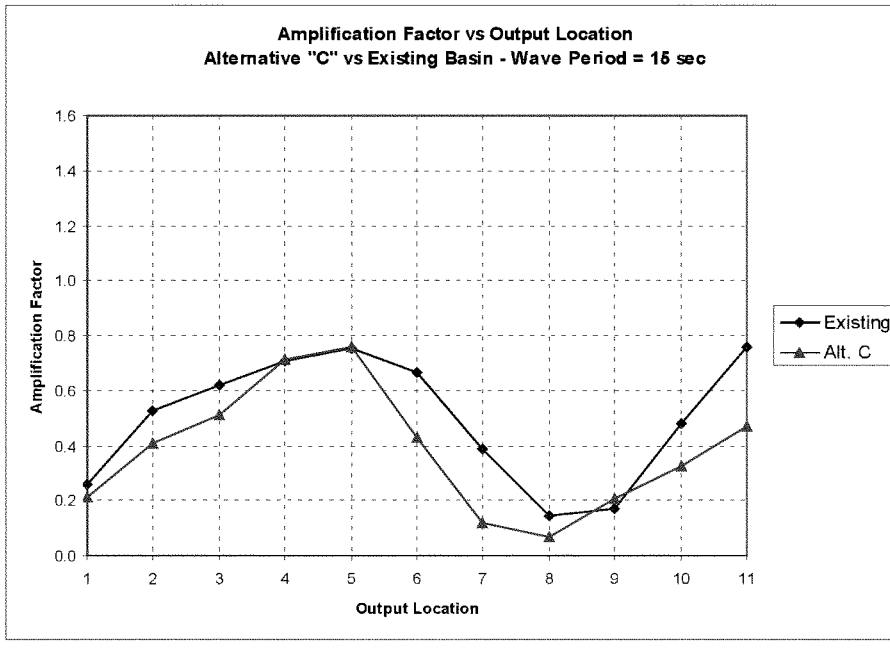


Figure B- 12. Maximum Amplification Factor – Alternative "C" vs Existing (Period = 15sec)

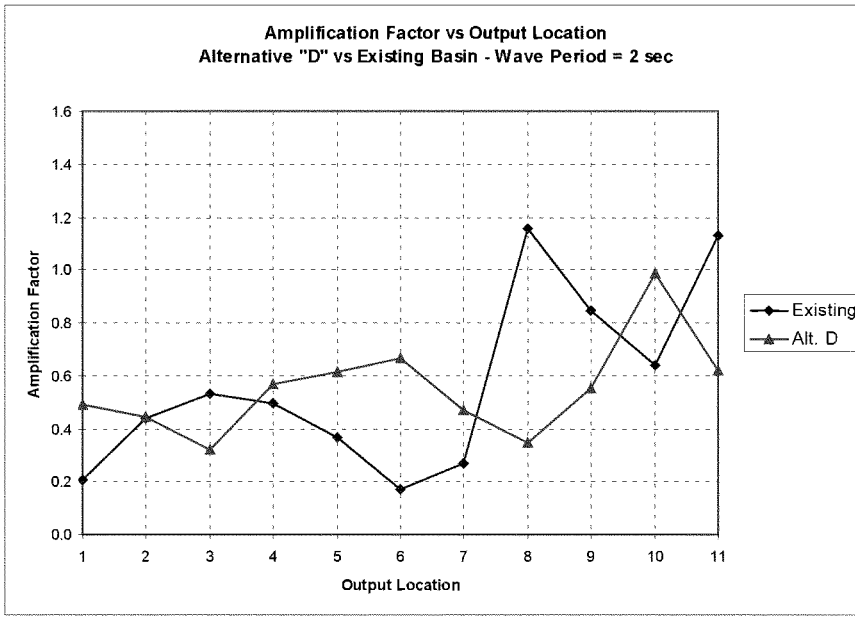


Figure B- 13. Maximum Amplification Factor – Alternative "D" vs Existing (Period = 2sec)

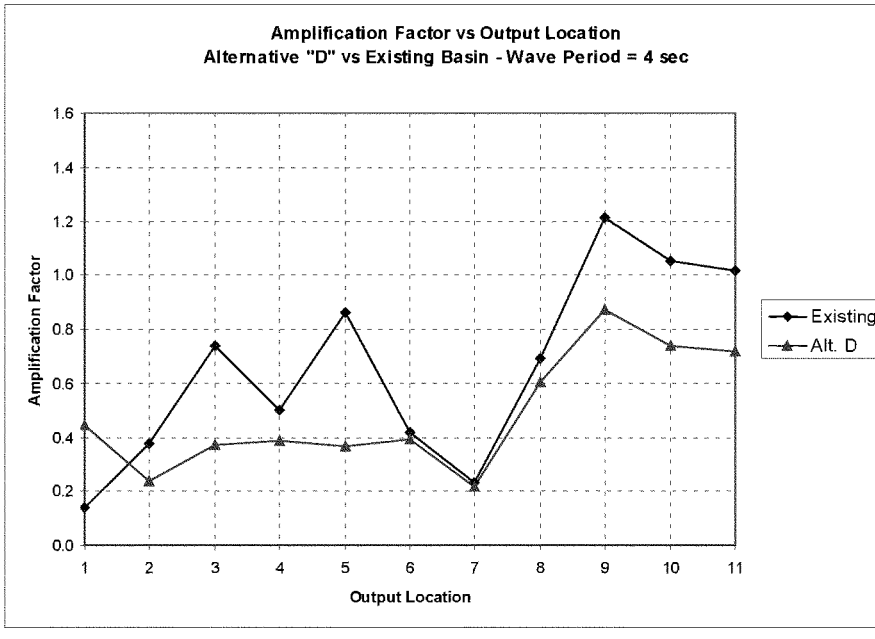


Figure B- 14. Maximum Amplification Factor – Alternative "D" vs Existing (Period = 4sec)

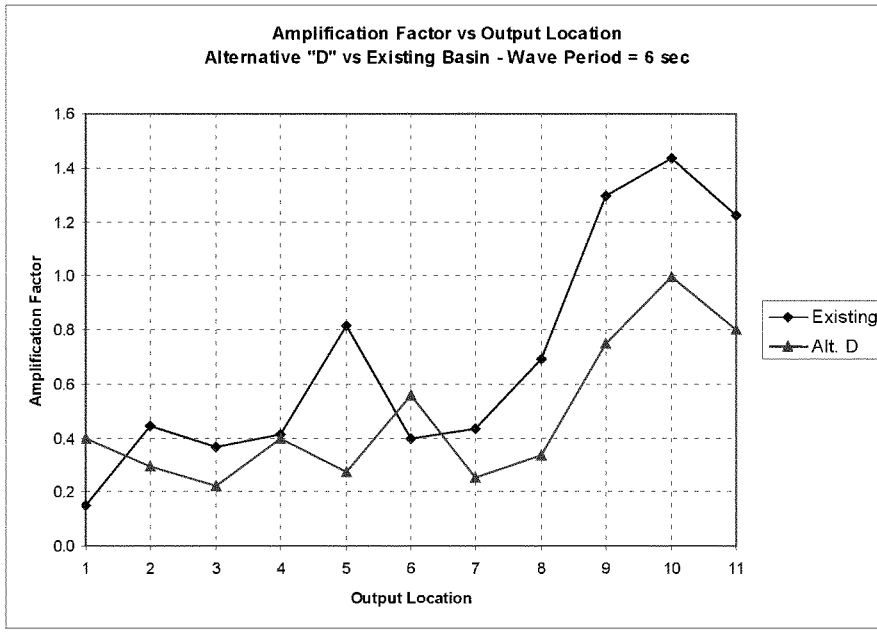


Figure B- 15. Maximum Amplification Factor – Alternative "D" vs Existing (Period = 6sec)

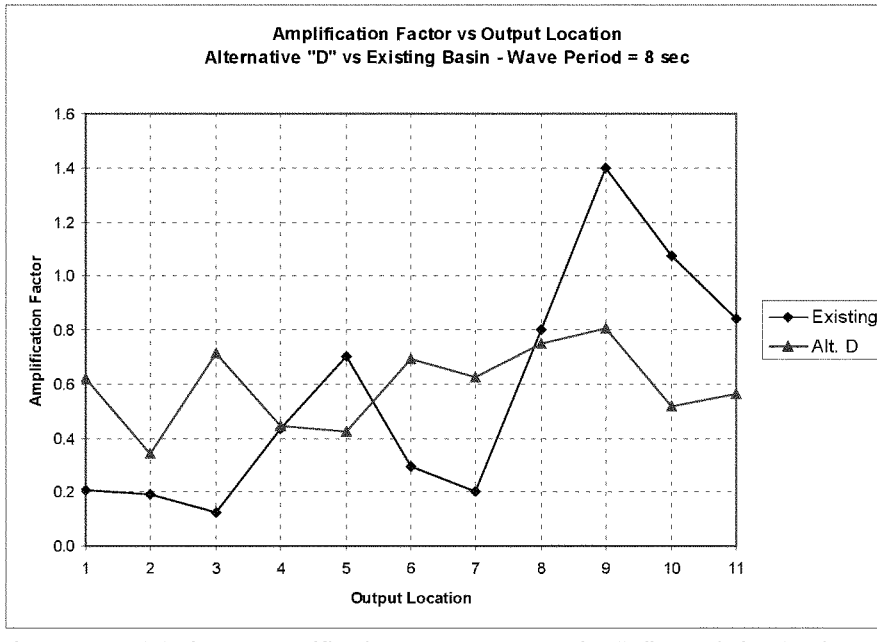


Figure B- 16. Maximum Amplification Factor – Alternative "D" vs Existing (Period = 8sec)

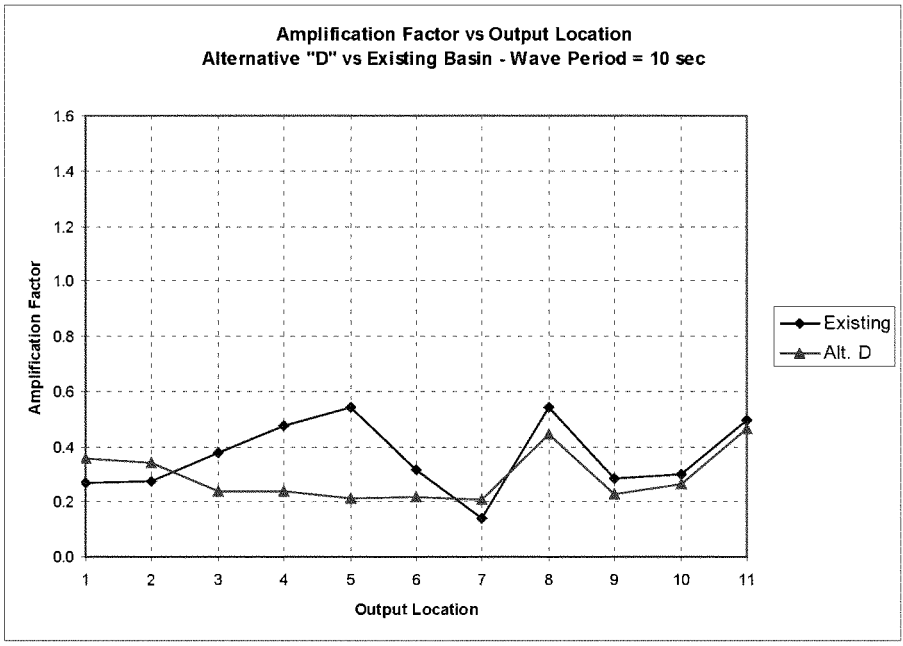


Figure B- 17. Maximum Amplification Factor – Alternative "D" vs Existing (Period = 10sec)

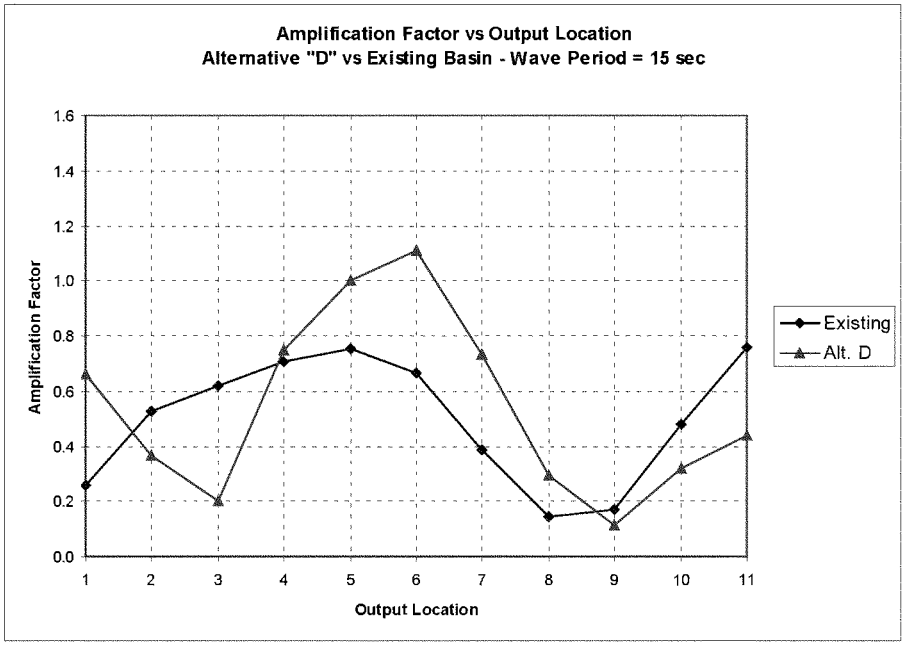


Figure B- 18. Maximum Amplification Factor – Alternative "D" vs Existing (Period = 15sec)

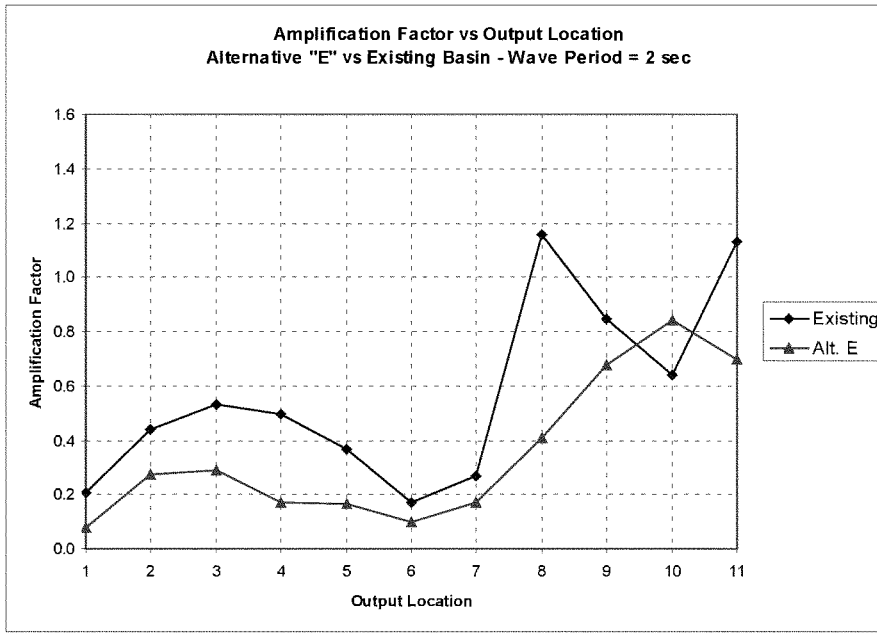


Figure B- 19. Maximum Amplification Factor – Alternative "E" vs Existing (Period = 2sec)

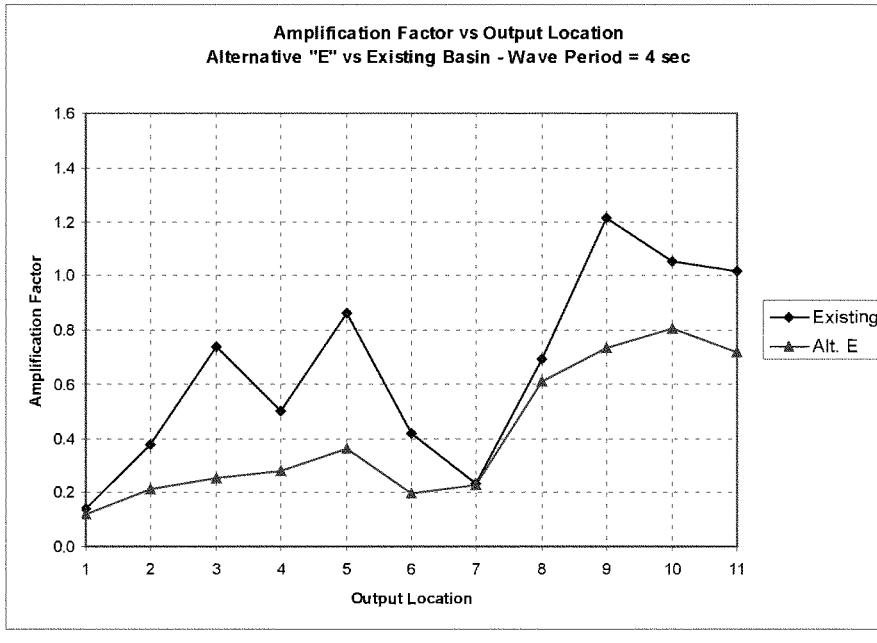


Figure B- 20. Maximum Amplification Factor – Alternative "E" vs Existing (Period = 4sec)

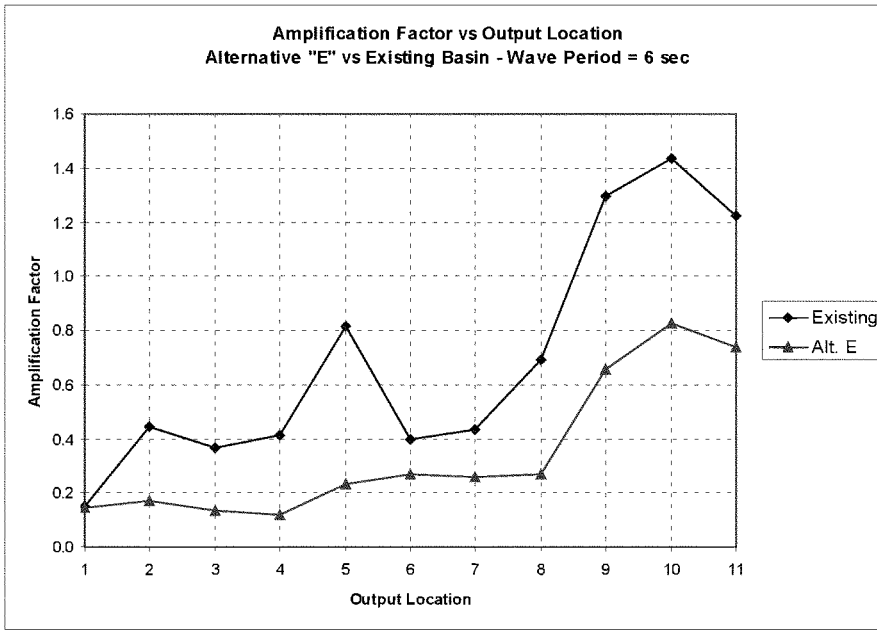


Figure B- 21. Maximum Amplification Factor – Alternative "E" vs Existing (Period = 6sec)

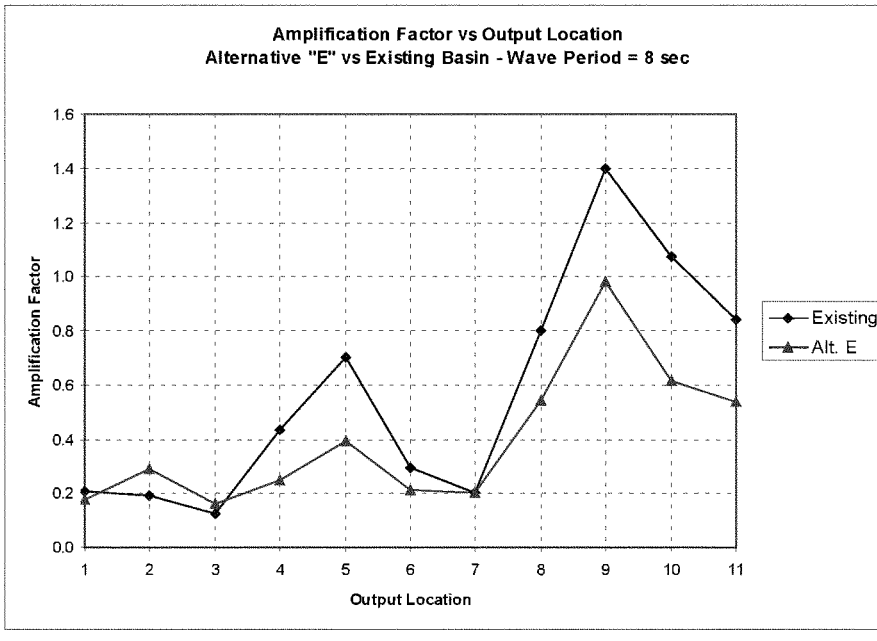


Figure B- 22. Maximum Amplification Factor – Alternative "E" vs Existing (Period = 8sec)

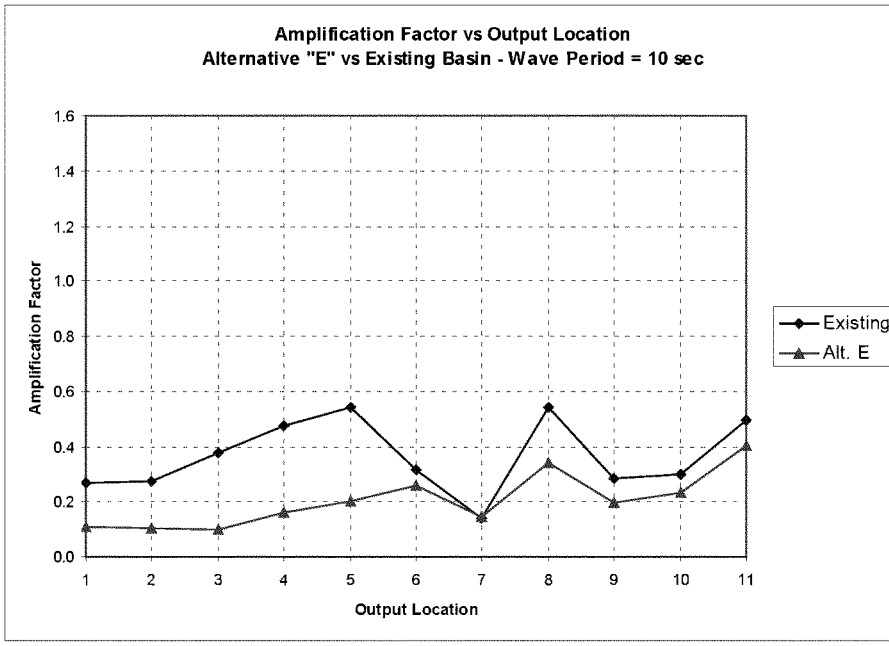


Figure B- 23. Maximum Amplification Factor – Alternative "E" vs Existing (Period = 10sec)

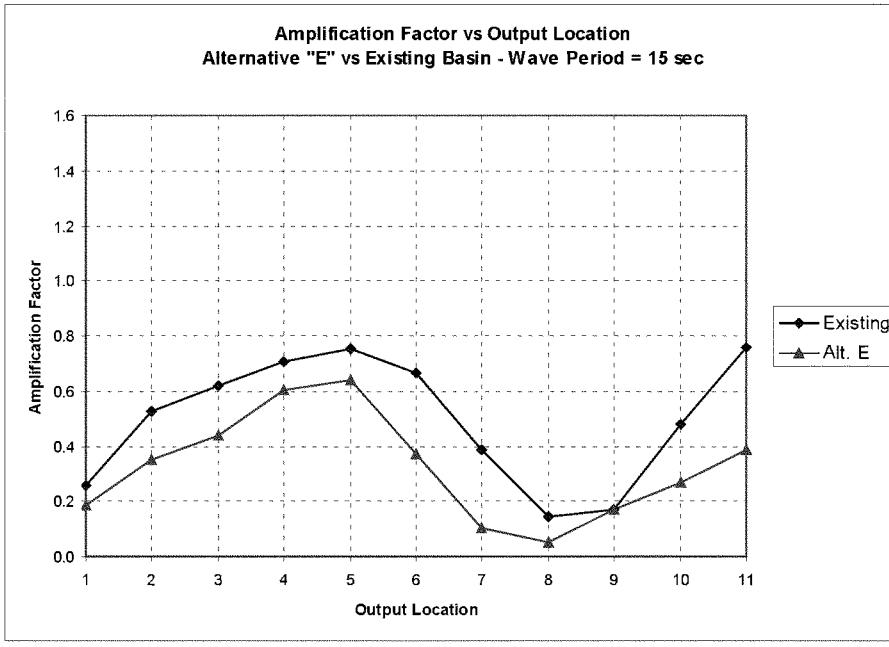


Figure B- 24. Maximum Amplification Factor – Alternative "E" vs Existing (Period = 15sec)

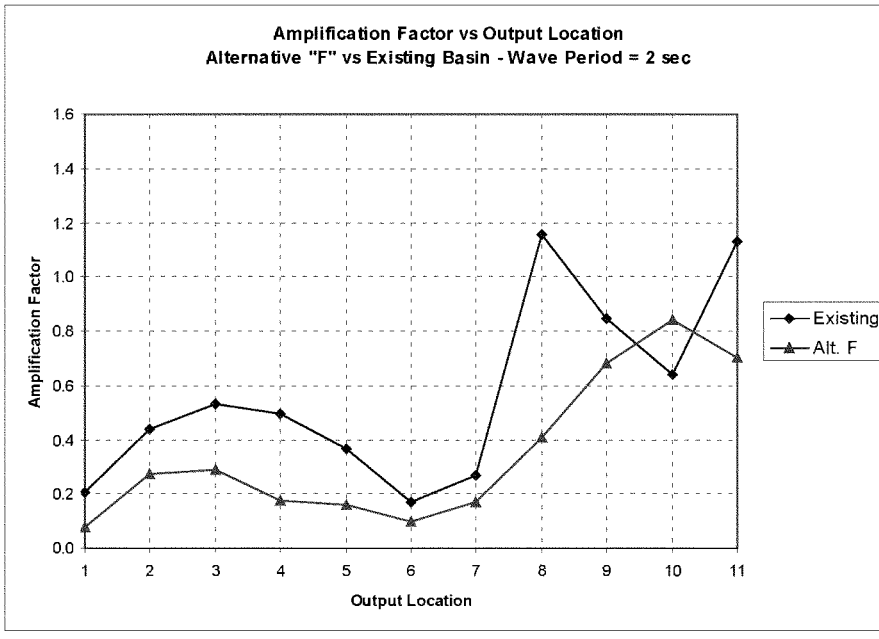


Figure B- 25. Maximum Amplification Factor – Alternative "F" vs Existing (Period = 2sec)

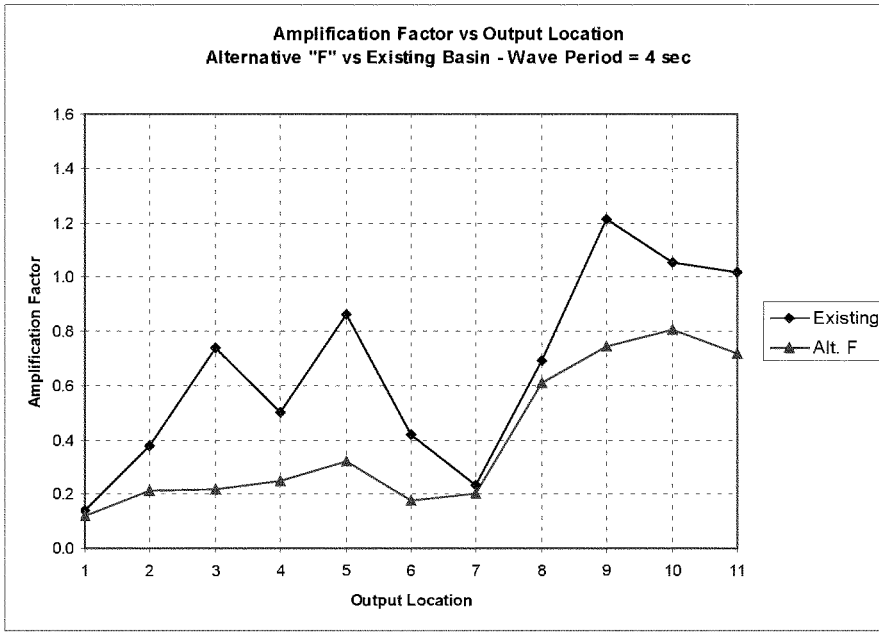


Figure B- 26. Maximum Amplification Factor – Alternative "F" vs Existing (Period = 4sec)

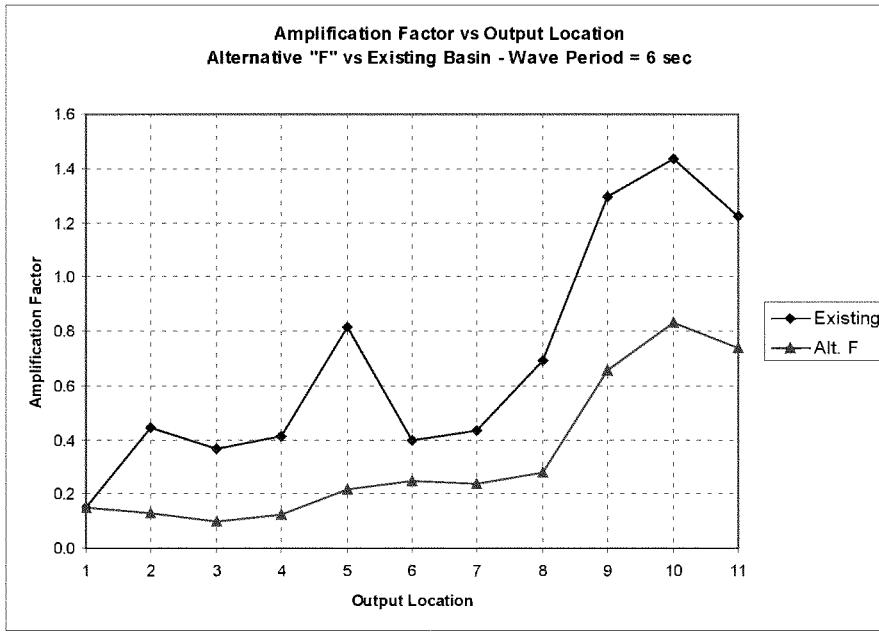


Figure B- 27. Maximum Amplification Factor – Alternative "F" vs Existing (Period = 6sec)

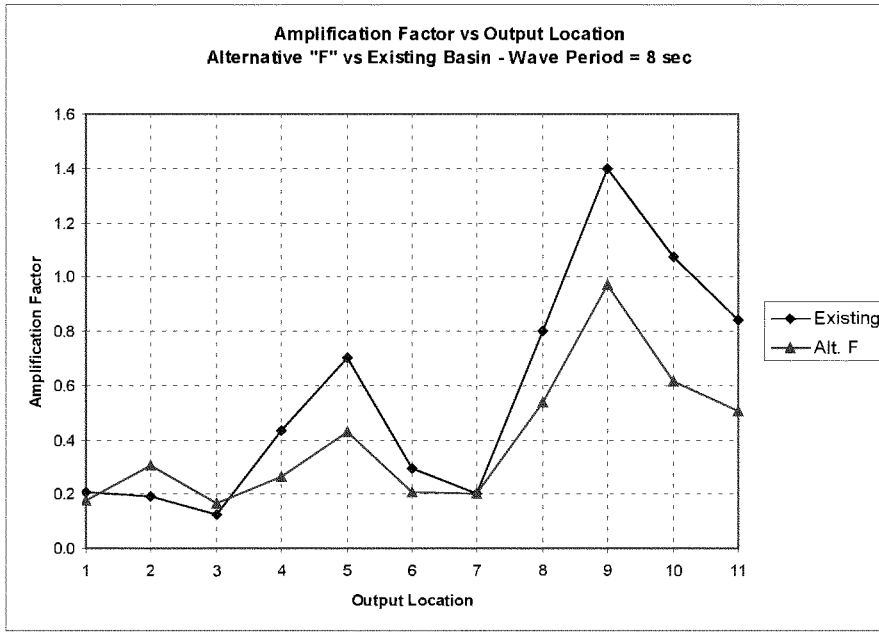


Figure B- 28. Maximum Amplification Factor – Alternative "F" vs Existing (Period = 8sec)

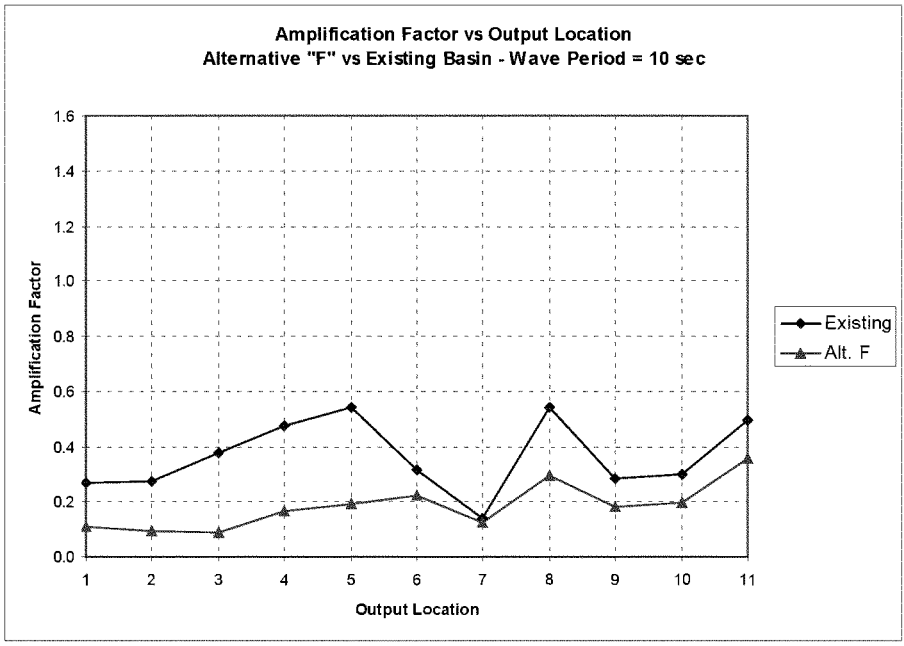


Figure B- 29. Maximum Amplification Factor – Alternative "F" vs Existing (Period = 10sec)

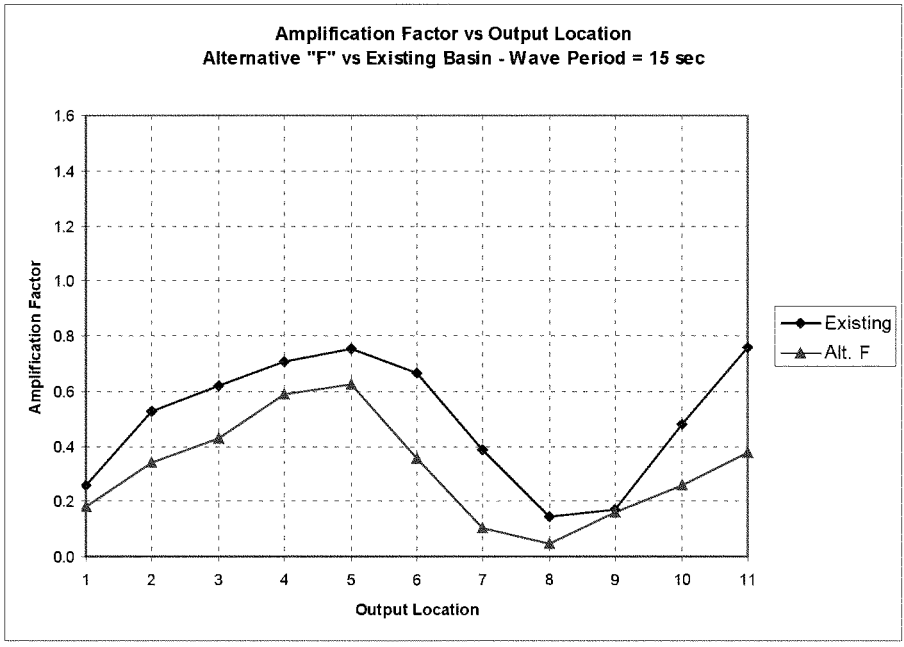


Figure B- 30. Maximum Amplification Factor – Alternative "F" vs Existing (Period = 15sec)

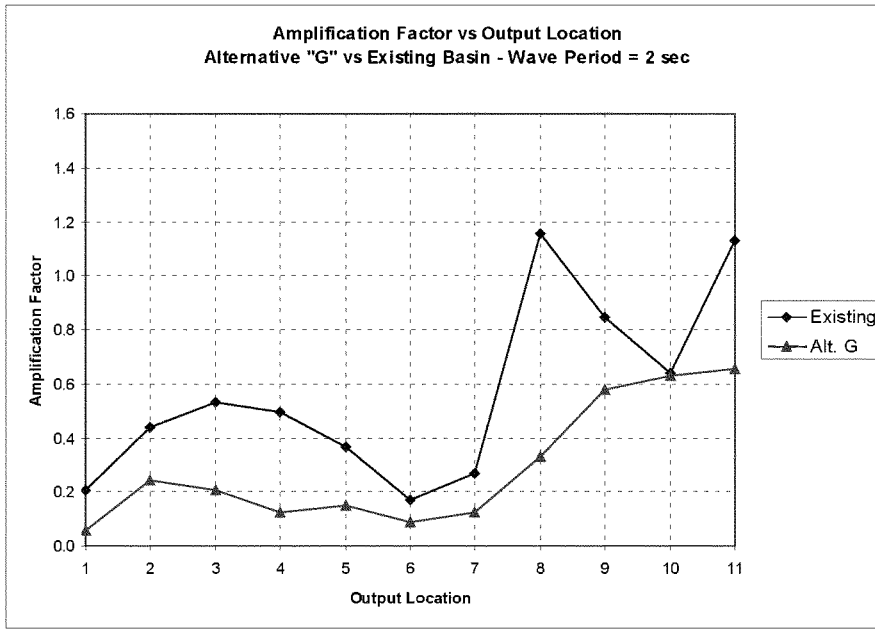


Figure B- 31. Maximum Amplification Factor – Alternative "G" vs Existing (Period = 2sec)

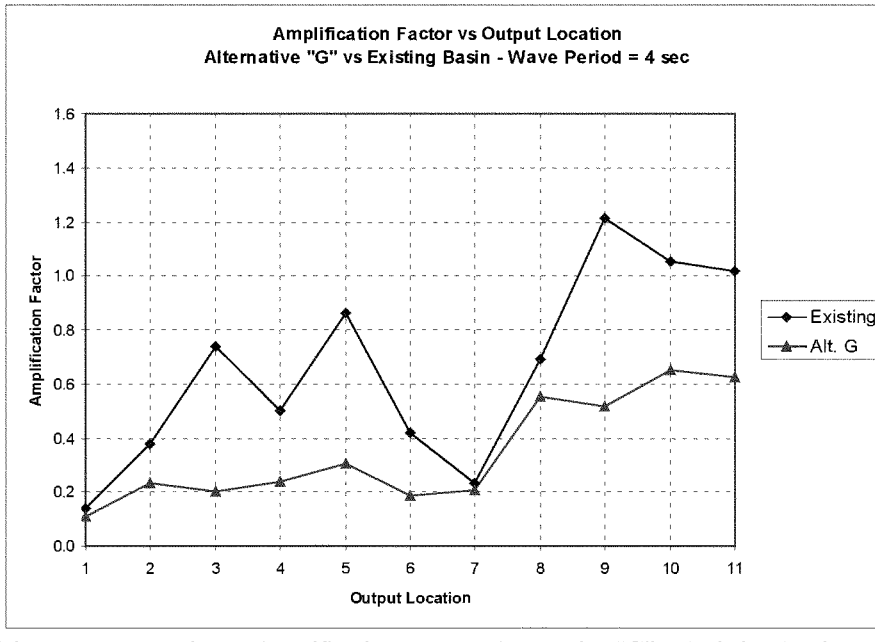


Figure B- 32. Maximum Amplification Factor – Alternative "G" vs Existing (Period = 4sec)

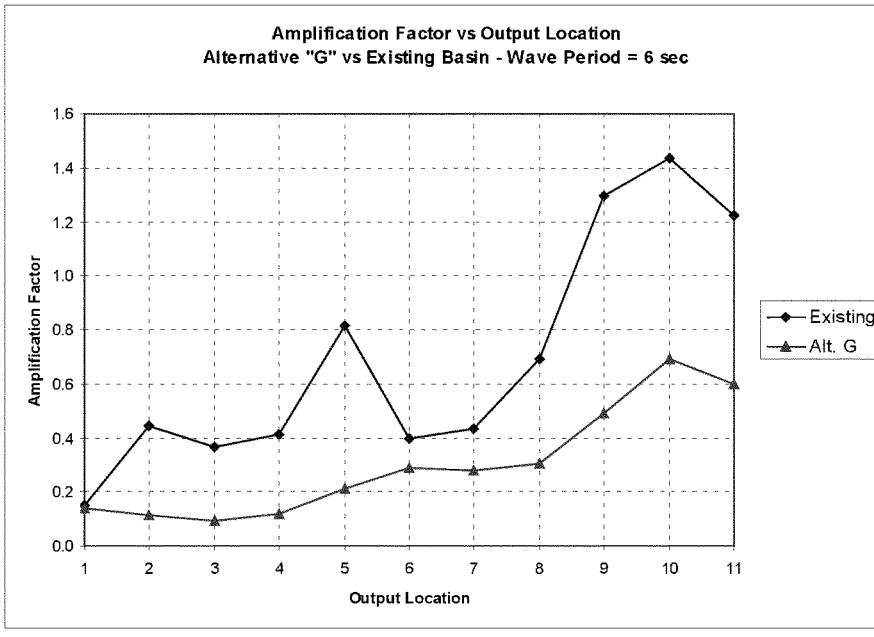


Figure B- 33. Maximum Amplification Factor – Alternative "G" vs Existing (Period = 6sec)

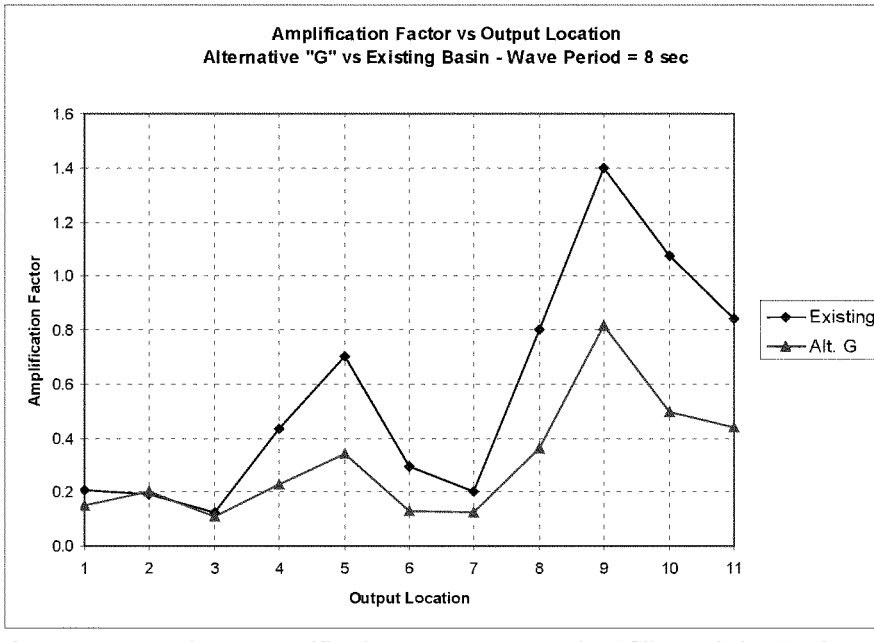


Figure B- 34. Maximum Amplification Factor – Alternative "G" vs Existing (Period = 8sec)

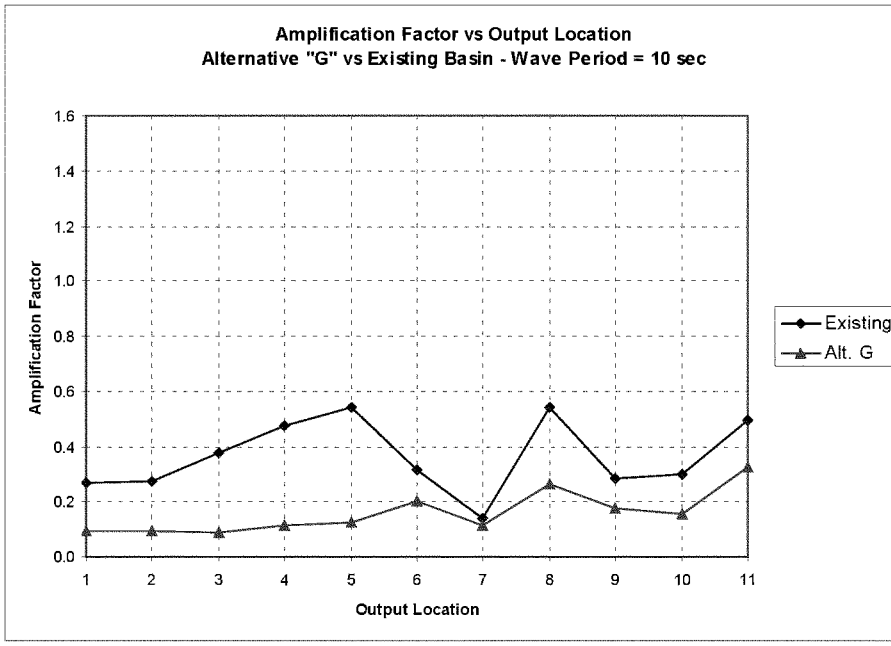


Figure B- 35. Maximum Amplification Factor – Alternative "G" vs Existing (Period = 10sec)

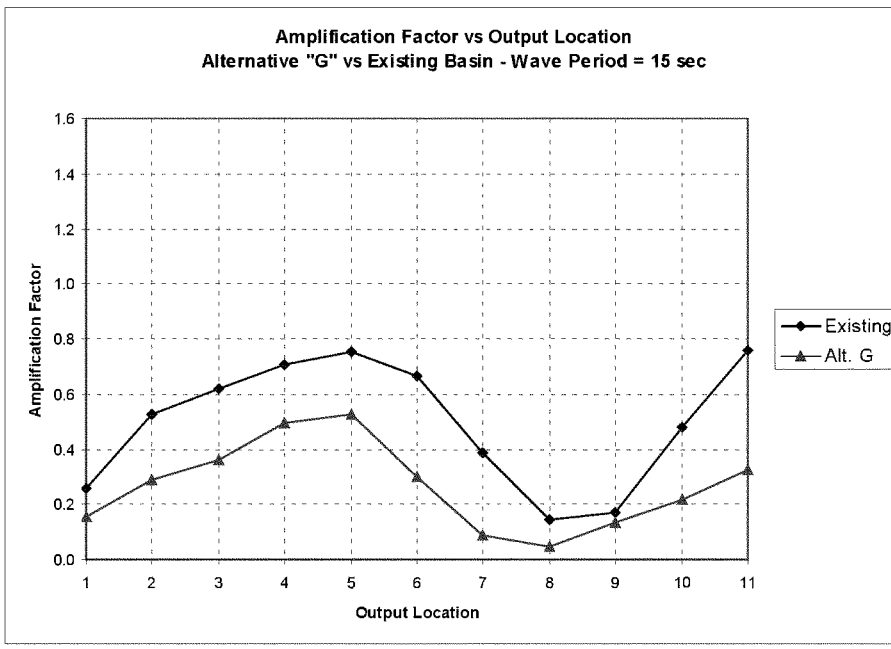


Figure B- 36. Maximum Amplification Factor – Alternative "G" vs Existing (Period = 15sec)

PORT EVERGLADES HARBOR, FLORIDA

SUB-APPENDIX C

PORT EVERGLADES HARBOR, FLORIDA
VESSEL SQUAT EVALUATION

Port Everglades Harbor Entrance Channel

Vessel Squat Evaluation

USACE – Jacksonville District
Last Revision: June 2011

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Attachment 1: Computational Parameters
Attachment 2: Iterative Squat Computations, Canal Method
Attachment 3: Iterative Squat Computations, Barrass Method
Attachment 4: Iterative Squat Computations, Eryuzlu et al. Method
Attachment 5: Iterative Squat Computations, Huuska/Guliev Method
Attachment 6: Iterative Squat Computations, Romisch Method

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General

A large part of port and harbor design today includes making modifications to accommodate the growth of vessel traffic and an increase in vessel size. While modification may include channel widening and basin expansion to accommodate wider beams and longer lengths, it will almost certainly include channel deepening to accommodate deeper drafts. Determining how much underkeel clearance (distance between the keel and the channel bottom) a design vessel requires for safe passage depends on many factors including the dimensions of the vessel, the anticipated speed of the vessel, and the physical conditions that the vessel will likely encounter. One major component of the total underkeel clearance for a given design vessel is the ship squat while underway.

Ship squat is the "sinkage" that a vessel experiences while underway. As the ship moves forward, water passes around the hull producing a hydrodynamic pressure change that results in a water level depression into which the ship sinks. While it translates into a vertical displacement, squat is actually the combined effect of sinkage (heave), trim (pitch), and heel (roll) caused by the forward motion of the vessel. Factors that influence squat include the geometry of the vessel, the geometry of the channel, the position of the vessel relative to the channel, and the forward velocity of the vessel. Due to its dependence on vessel speed, squat is generally only determined in a harbor's entrance channels. Within the port, vessel speeds drop to such a degree that squat is no longer a significant component of underkeel clearance requirements.

Design Parameters

Vessel Geometry

The design vessel for the Port Everglades Harbor study is an S-Class Post-Panamax containership. An example of this vessel is the Susan Maersk, an 8,680 TEU capacity vessel with a length over all (LOA) of 1,138 feet. Dimensions and response parameters for the Susan Maersk were obtained from the Vertical Ship Motion Study for Savannah, GA (USACE, 2010) and are presented in Table 1.

Table 1. S-Class Dimensions and Response Parameters

Description	Symbol	Dimension
Length Between Perpendiculars	L_{pp}	1,088.1 feet
Beam	B	140.4 feet
Draft (Full)	T	48 feet
Block Coefficient	C_B	0.65
Longitudinal Center of Gravity	LCG	544.0 feet
Vertical Center of Gravity	KG	60 feet
Metacentric Height	GM	2.57 feet
Roll Damping Factor, fraction percent	R	0.036

Channel Geometry

Channel geometry plays a large role in how much squat a vessel will experience. In general there are three types of channels: canal, trench, and fairway (Figure 1). Of these three, canal and trench channels are considered to be restricted. Fairways are unrestricted. The Port Everglades Harbor entrance channel is a restricted, trench style channel. Key dimensions of a trench style channel are presented in Figure 2.

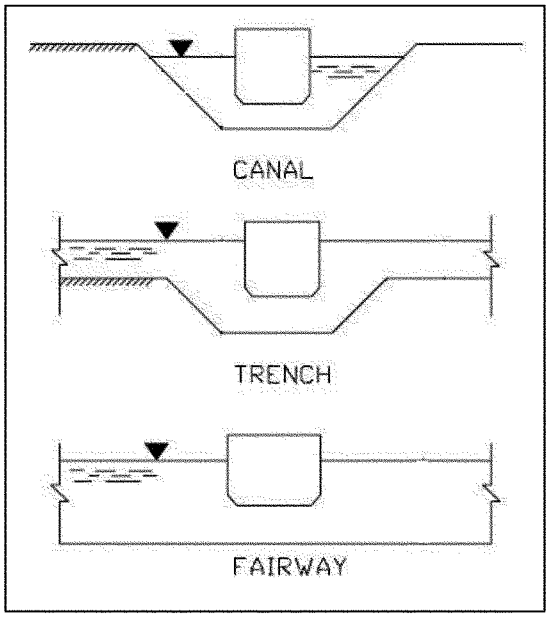

Figure 1. Navigation Channel Types

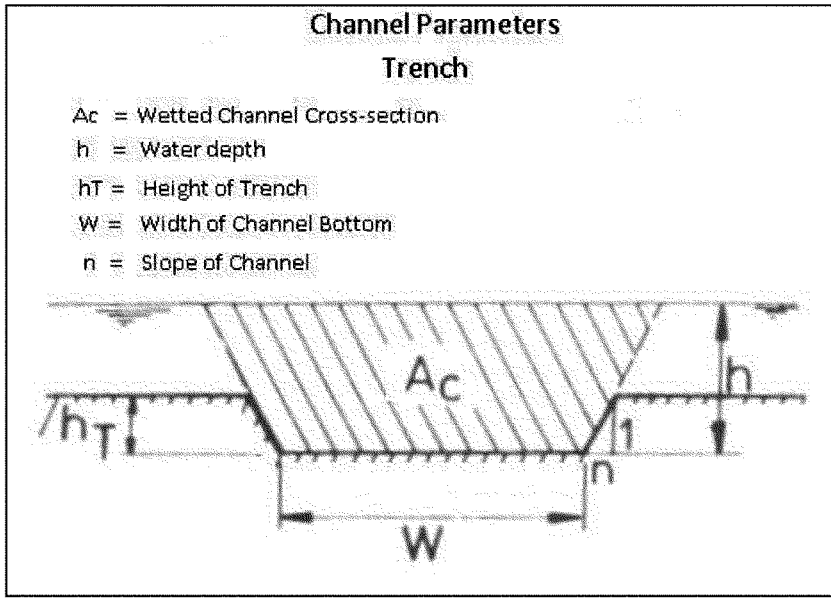

Figure 2. Channel Geometry Parameters

Velocity

The velocity of the vessel is another important factor in how much squat it will experience. At Port Everglades, the proximity of the Gulf Stream creates a unique water current environment immediately outside the entrance, along the vessel approach. The Gulf Stream moves to the north, across the path of approaching vessels. Immediately shoreward of the Gulf Stream, there is an opposing current, flowing southward, that changes its position within an east to west envelope, and varies in strength. This opposing current environment requires ships' pilots to move forward at 12 to 8 knots of speed (decreasing from the outer marker to the eastern tip of the jetties), to maintain directional control of the vessel during the critical last stages of the entrance transit. This speed, and consequent enormous momentum, must then be immediately damped and removed as the vessel enters the jetties. The necessary shedding of momentum requires three tugs that meet the vessel just as it approaches the eastern end of the jetties. Based on the velocity requirements for these conditions, an average velocity of 10 knots was used for determining squat.

Empirical Squat Formulas

A number of empirical formulas are available for estimating squat. Formulations have been developed for both deep and shallow water and can further be broken down into those that apply to restricted or unrestricted channels. Port Everglades Harbor can be defined as shallow water (relative to open ocean depths) with a restricted, trench type entrance channel.

Two primary sources of guidance were consulted for determining squat in the Port Everglades entrance channel, EM 1110-2-1613: Hydraulic Design of Deep-Draft Navigation Projects (USACE, 2006) and Permanent International Association of Navigation Congresses: Approach Channels, A Guide for Design (PIANC, 1997). Supplemental information was obtained from USACE Coastal Engineering Technical Notes CHETN I-63 (Demirbilek and Sargent, 1999), CHETN IX-14 (Briggs et al., 2004), and CHETN I-72 (Briggs, 2006). From these sources five empirical methods were found that applied to the shallow water, trench type Port Everglades entrance channel:

- Canal Method (USACE, 2006)
- Barrass (1981)
- Eryuzlu et al. (1994)
- Huuska/Guliev (1979/1971)
- Romisch (1989)

Computational Parameters

Many empirical squat formulas, including those discussed here, share common computational parameters. Attachment 1 provides a summary table of computational parameters that were used in this study.

Canal Method

The simple canal method presented in EM 1110-2-1613 depends on certain idealized assumptions including a rectangular channel cross-section, rectangular ship cross-section, and uniform return flow throughout the channel. It is considered to provide a good first approximation for channel design.

The governing equation is based on the Bernoulli Effect and can be expressed as:

$$F_h = \sqrt{\frac{2\frac{z}{h}\left(1-\frac{A_S}{A_C}-\frac{z}{h}\right)^2}{1-\left(1-\frac{A_S}{A_C}-\frac{z}{h}\right)^2}}$$

Where

F_h	= Depth froude number
z	= Squat
h	= Water depth
A_s	= Wetted ship cross-section (= 0.98BT; Briggs, 2006)
A_c	= Wetted channel cross-section

The depth Froude number can also be defined as:

$$F_h = \frac{V}{\sqrt{gh}}$$

Where

V	= Ship speed
g	= Acceleration due to gravity

Squat is determined by setting the two equations equal to each other, assuming an initial amount of squat, and solving iteratively until a final squat value is converged upon. For Port Everglades, squat was determined for vessel drafts ranging from 39 feet to 48 feet. Attachment 2 provides computational results for squat at Port Everglades using the Canal method.

Barrass Method

The Barrass method, based on validation with full-scale measurements, is expressed as:

$$z = \frac{C_B S_2^{2/3} V_k^{2.08}}{30}$$

Where

z	= Squat
S_2	= Blockage Ration; $A_s/(A_c-A_s)$
C_B	= Block Coefficient
V_k	= Ship speed in knots

Attachment 3 provides Barrass method computational results for vessel drafts ranging from 39 feet to 48 feet.

Eryuzlu et al. Method

The Eryuzlu et al. method, based on a series of physical model tests and field measurements is expressed as:

$$z = 0.298\frac{h^2}{T}\left(\frac{V}{\sqrt{gT}}\right)^{2.289}\left(\frac{h}{T}\right)^{-2.972}K_b$$

Where

z	= Squat
h	= Water depth
T	= Ship Draft
V	= Ship speed
g	= Acceleration due to gravity
K_b	= Correction factor for channel width, given by:

$$K_b = \begin{cases} \frac{3.1}{\sqrt{W/B}} & \frac{W}{B} < 9.61 \\ 1 & \frac{W}{B} \geq 9.61 \end{cases}$$

Where

W	= Channel width at bottom
B	= Ship Beam

Attachment 4 provides Eryuzlu et al. computational results for vessel drafts ranging from 39 feet to 48.

Huuska/Guliev Method

The Huuska/Guliev method is an extension of a previously developed unrestricted channel computation (Hooft, 1974), which was modified by adding a correction factor for channel width. This method is expressed as:

$$z = 2.4\frac{\nabla}{L_{pp}^2}\frac{F_h^2}{\sqrt{1-F_h^2}}K_s$$

Where

z	= Squat
∇	= Ship volume displacement (= $C_B L_{PP} BT$)
L_{pp}	= Ship length between perpendiculars
F_h	= Depth Froude number
K_s	= Correction factor for channel width, given by:

$$K_s = \begin{cases} 7.45s_1 + 0.76 & s_1 > 0.03 \\ 1 & s_1 \leq 0.03 \end{cases}$$

Where

$$s_1 = \frac{A_s/A_c}{K_1}$$

K_1 = Correction Factor; Figure 3

Attachment 5 provides Huuska/Guliev computational results for vessel drafts ranging from 39 feet to 48 feet.

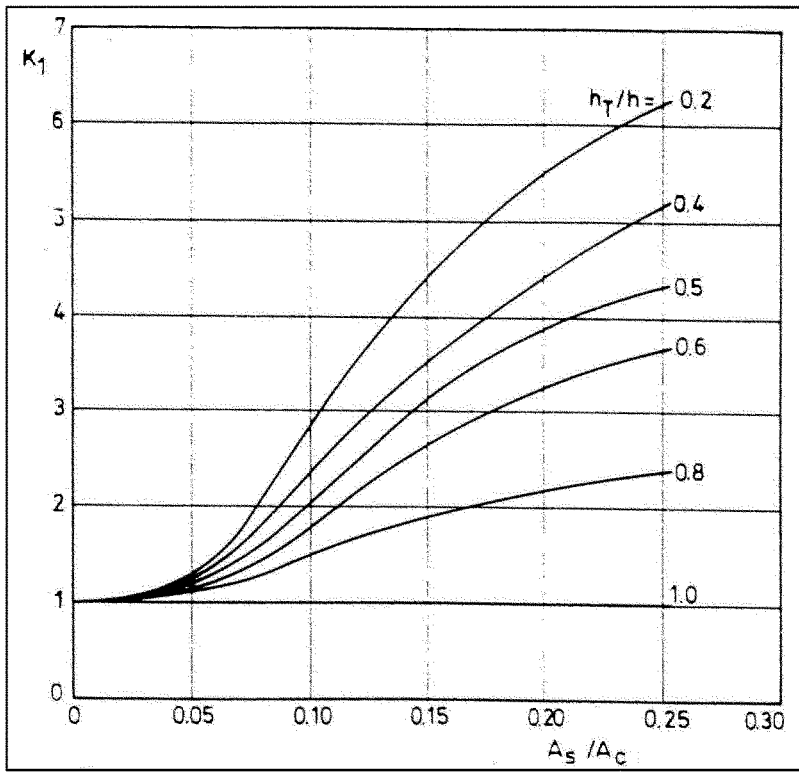

Figure 3. Correction Factor, K_1 (Huuska, 1976)

Romisch Method

The Romisch method, based on physical model experiments, is expressed as:

$$z = C_V C_F K_{\Delta T} T$$

Where

z	= Squat
C_V	= Correction factor for ship speed
C_F	= Correction factor for ship shape
$K_{\Delta T}$	= Correction factor for squat at ship critical speed
T	= Ship draft

The values of the correction factors are defined as:

$$C_V = 8\left(\frac{V}{V_{cr}}\right)^2\left[\left(\frac{V}{V_{cr}} - 0.5\right)^4 + 0.0625\right]$$

$$C_F = \left(\frac{10C_B}{L_{pp}/B}\right)^2$$

$$K_{\Delta T} = 0.155\sqrt{\frac{h}{T}}$$

Where

V	= Ship speed
V_{CR}	= Ship critical speed
C_B	= Block Coefficient
L_{PP}	= Ship length between perpendiculars
B	= Ship beam
h	= Water depth

A ship's critical velocity, V_{CR}, is based on the channel configuration. For restricted, trench style channels, the critical velocity is given by:

$$V_{CR} = C_{mT}\left[K_{ch}\left(1 - \frac{h_T}{h}\right) + K_c\left(\frac{h_T}{h}\right)\right]$$

Where

C_{mT} = wave celerity based on the relevant water depth
h_T = height of the trench (see Figure 2)
K_{ch} = correction factor on critical speed (restricted/unrestricted)
K_c = correction factor on critical speed (canal)

Above parameters are defined as:

$$C_{mT} = \sqrt{g h_{mT}}$$

$$h_{mT} = h - \frac{h_T}{h}(h - h_m)$$

$$h_m = \frac{A_C}{W_{top}} \quad and \quad W_{top} = W + 2nh; n = channel\ side\ slope$$

$$K_c = \left[2sin\left(\frac{Arcsin(1-S)}{3}\right)\right]^{1.5} \ (USACE, 2010); \ S = \frac{A_S}{A_C}$$

$$K_{ch} = 0.58\left[\left(\frac{h}{T}\right)\left(\frac{L_{PP}}{B}\right)\right]^{0.125}$$

Where

h_{mT} = relevant water depth
h_m = mean water depth

Attachment 6 provides Romisch computational results for vessel drafts ranging from 39 feet to 48 feet.

Results

Of the five methods presented, the Canal Theory and Barrass methods result in the most conservative estimates of squat. The three remaining methods are less conservative, but show excellent agreement with one another for all vessel drafts considered. Because the Canal Theory is considered to be a first approximation for channel design and is open for refinement, it was not considered for the final determination of squat at Port Everglades. Of the remaining four methods, all are considered to be acceptable means of estimating squat. Therefore, it was decided that squat at Port Everglades would be determined as an average of the three methods that provided the most consistent results. A summary of all squat results for vessel drafts ranging from 39 feet to 48 feet is provided in Table 2, including the average squat value to be applied to the project design. Results for each of the five methods are also show graphically in Figure 4.

Table 2. Vessel Squat, All Cases

Draft (feet)	Squat (feet)					
	Canal Method	Barrass Method	Eryuzlu et al. Method	Huuska/Guliev Method	Romisch Method	Average* Squat
39	5.91	3.82	2.53	2.59	2.79	2.64
40	5.77	3.82	2.53	2.59	2.71	2.61
41	5.68	3.83	2.53	2.59	2.63	2.58
42	5.61	3.83	2.53	2.54	2.55	2.54
43	5.51	3.84	2.52	2.54	2.49	2.52
44	5.45	3.84	2.52	2.54	2.42	2.49
45	5.38	3.85	2.52	2.53	2.36	2.47
46	5.31	3.86	2.52	2.53	2.30	2.45
47	5.25	3.86	2.51	2.48	2.24	2.41
48	5.18	3.86	2.51	2.48	2.19	2.39
* Represents the average of three methods (Eryuzlu et al., Huuska/Gulieve, and Romisch)						

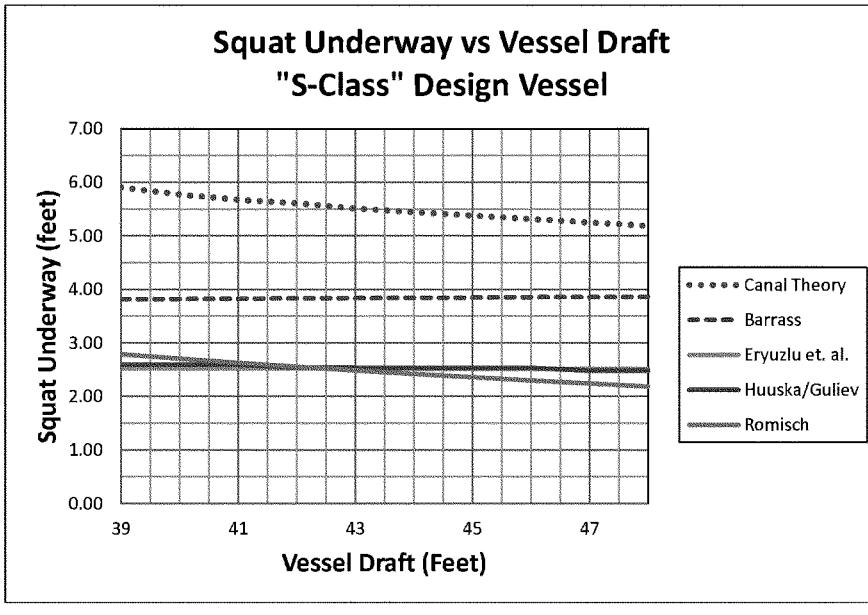

Figure 4. Vessel Squat, All Cases

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Attachment 1

Computational Parameters

Parameter	Symbol	Value (English Units)	Value (Metric Units)
Vessel Geometry:			
Length Between Perpendiculars	L_{PP}	1,088.1 ft	331.7 m
Beam	B	140.4 ft	42.8 m
Draft*	T	48 ft	18 m
Block Coefficient	C_B	0.65	0.65
Longitudinal Center of Gravity	LCG	544.0 ft	165.8 m
Vertical Center of Gravity	KG	60.0 ft	18.3 m
Metacentric Height	GM	2.6 ft	0.8 m
Roll Damping Factor, fraction percent	R	0.036	0.036
Channel Geometry:			
Channel Bottom Width	W	500 ft	152.4 m
Channel Top Width (Assumes Vertical Rock Slope)	W_{top}	500 ft	152.4 m
Ave. Depth of Water Exterior of Trench	$(h - h_T)$	10 ft	3.048 m
Slope of Trench Wall	n	1	1
Vessel Speed:			
Velocity	V	16.9 ft/s	5.14 m/s
Velocity (knots)	V_k	10 knots	10 knots

* The vessel draft value shown is the maximum for this S-Class vessel. As the vessel may not be operating at maximum draft at Port Everglades, squat must be calculated for a range of vessel drafts. This parameter becomes variable.

Attachment 2

Iterative Squat Computations

Canal Method

Canal Theory

Iterative Computations

Assumed Squat, z (meters)	Vessel Draft, T (meters)	Vessel Draft, T (feet)	Wave Allowance* (meters)	Resultant Depth, h (meters)	Resultant Depth, h (feet)	z/h	As/Ac	Froude # (w/squat) F_h	Froude # (w/Velocity) F_h	Difference	Iterated Squat, z (meters)	Iterated Squat, z (feet)
1.82	11.89	39	1.19	14.90	48.87	0.12	0.22	0.43	0.43	-0.002	1.82	5.97
1.81	11.89	39	1.19	14.89	48.84	0.12	0.22	0.43	0.43	-0.001	1.81	5.94
1.80	11.89	39	1.19	14.88	48.81	0.12	0.22	0.43	0.43	0.000	1.80	5.91
1.79	11.89	39	1.19	14.87	48.77	0.12	0.22	0.43	0.43	0.001	1.79	5.87
1.78	11.89	39	1.19	14.86	48.74	0.12	0.22	0.42	0.43	0.001	1.78	5.84
1.78	12.19	40	1.22	15.19	49.84	0.12	0.23	0.42	0.42	-0.001	1.78	5.84
1.77	12.19	40	1.22	15.18	49.81	0.12	0.23	0.42	0.42	0.000	1.77	5.81
1.76	12.19	40	1.22	15.17	49.77	0.12	0.23	0.42	0.42	0.000	1.76	5.77
1.75	12.19	40	1.22	15.16	49.74	0.12	0.23	0.42	0.42	0.001	1.75	5.74
1.74	12.19	40	1.22	15.15	49.71	0.11	0.23	0.42	0.42	0.002	1.74	5.71
1.75	12.50	41	1.25	15.50	50.84	0.11	0.23	0.42	0.42	-0.001	1.75	5.74
1.74	12.50	41	1.25	15.49	50.81	0.11	0.23	0.42	0.42	0.000	1.74	5.71
1.73	12.50	41	1.25	15.48	50.78	0.11	0.23	0.42	0.42	0.000	1.73	5.68
1.72	12.50	41	1.25	15.47	50.74	0.11	0.23	0.42	0.42	0.001	1.72	5.64
1.71	12.50	41	1.25	15.46	50.71	0.11	0.23	0.42	0.42	0.002	1.71	5.61
1.73	12.80	42	1.28	15.81	51.88	0.11	0.23	0.41	0.41	-0.002	1.73	5.68
1.72	12.80	42	1.28	15.80	51.84	0.11	0.23	0.41	0.41	-0.001	1.72	5.64
1.71	12.80	42	1.28	15.79	51.81	0.11	0.23	0.41	0.41	0.000	1.71	5.61
1.70	12.80	42	1.28	15.78	51.78	0.11	0.23	0.41	0.41	0.001	1.70	5.58
1.69	12.80	42	1.28	15.77	51.74	0.11	0.23	0.41	0.41	0.001	1.69	5.54
1.70	13.11	43	1.31	16.12	52.88	0.11	0.23	0.41	0.41	-0.001	1.70	5.58
1.69	13.11	43	1.31	16.11	52.84	0.10	0.23	0.41	0.41	0.000	1.69	5.54
1.68	13.11	43	1.31	16.10	52.81	0.10	0.23	0.41	0.41	0.000	1.68	5.51
1.67	13.11	43	1.31	16.09	52.78	0.10	0.23	0.41	0.41	0.001	1.67	5.48
1.66	13.11	43	1.31	16.08	52.75	0.10	0.23	0.41	0.41	0.002	1.66	5.45
1.68	13.41	44	1.34	16.43	53.91	0.10	0.23	0.41	0.41	-0.001	1.68	5.51
1.67	13.41	44	1.34	16.42	53.88	0.10	0.23	0.41	0.41	-0.001	1.67	5.48
1.66	13.41	44	1.34	16.41	53.85	0.10	0.23	0.41	0.41	0.000	1.66	5.45
1.65	13.41	44	1.34	16.40	53.81	0.10	0.23	0.40	0.41	0.001	1.65	5.41
1.64	13.41	44	1.34	16.39	53.78	0.10	0.23	0.40	0.41	0.002	1.64	5.38
1.66	13.72	45	1.37	16.75	54.95	0.10	0.23	0.40	0.40	-0.002	1.66	5.45
1.65	13.72	45	1.37	16.74	54.91	0.10	0.23	0.40	0.40	-0.001	1.65	5.41
1.64	13.72	45	1.37	16.73	54.88	0.10	0.23	0.40	0.40	0.000	1.64	5.38
1.63	13.72	45	1.37	16.72	54.85	0.10	0.23	0.40	0.40	0.001	1.63	5.35
1.62	13.72	45	1.37	16.71	54.81	0.10	0.23	0.40	0.40	0.002	1.62	5.31
1.64	14.02	46	1.40	17.06	55.98	0.10	0.23	0.40	0.40	-0.002	1.64	5.38
1.63	14.02	46	1.40	17.05	55.95	0.10	0.23	0.40	0.40	-0.001	1.63	5.35
1.62	14.02	46	1.40	17.04	55.91	0.10	0.23	0.40	0.40	0.000	1.62	5.31
1.61	14.02	46	1.40	17.03	55.88	0.09	0.23	0.40	0.40	0.001	1.61	5.28
1.60	14.02	46	1.40	17.02	55.85	0.09	0.23	0.40	0.40	0.002	1.60	5.25
1.62	14.33	47	1.43	17.38	57.01	0.09	0.23	0.40	0.39	-0.001	1.62	5.31
1.61	14.33	47	1.43	17.37	56.98	0.09	0.23	0.39	0.39	-0.001	1.61	5.28
1.60	14.33	47	1.43	17.36	56.95	0.09	0.23	0.39	0.39	0.000	1.60	5.25
1.59	14.33	47	1.43	17.35	56.92	0.09	0.23	0.39	0.39	0.001	1.59	5.22
1.19	14.63	48	1.46	17.28	56.70	0.07	0.24	0.36	0.40	0.038	1.19	3.90
1.60	14.63	48	1.46	17.69	58.05	0.09	0.23	0.39	0.39	-0.001	1.60	5.25
1.59	14.63	48	1.46	17.68	58.02	0.09	0.23	0.39	0.39	0.000	1.59	5.22
1.58	14.63	48	1.46	17.67	57.98	0.09	0.23	0.39	0.39	0.000	1.58	5.18
1.57	14.63	48	1.46	17.66	57.95	0.09	0.23	0.39	0.39	0.001	1.57	5.15
1.56	14.63	48	1.46	17.65	57.92	0.09	0.23	0.39	0.39	0.002	1.56	5.12

* Based on USACE and PIANC guidance, a wave allowance of 10% of the vessel draft is assumed.

Attachment 3

Iterative Squat Computations

Barrass Method

Barrass Method									
Iterative Computations									
Assumed Squat, z (meters)	Vessel Draft, T (meters)	Vessel Draft, T (feet)	Wave Allowance* (meters)	Resultant Depth, h (meters)	Resultant Depth, h (feet)	$A_c - A_s$	S_z	Calculated Squat, z (meters)	Calculated Squat, z (feet)
1.18	11.89	39	1.19	14.26	46.77	1674.08	0.30	1.16	3.81
1.17	11.89	39	1.19	14.25	46.74	1672.55	0.30	1.16	3.81
1.16	11.89	39	1.19	14.24	46.71	1671.03	0.30	1.16	3.82
1.15	11.89	39	1.19	14.23	46.67	1669.50	0.30	1.16	3.82
1.14	11.89	39	1.19	14.22	46.64	1667.98	0.30	1.16	3.82
1.18	12.19	40	1.22	14.59	47.87	1712.39	0.30	1.16	3.82
1.17	12.19	40	1.22	14.58	47.84	1710.87	0.30	1.16	3.82
1.16	12.19	40	1.22	14.57	47.81	1709.34	0.30	1.17	3.82
1.15	12.19	40	1.22	14.56	47.77	1707.82	0.30	1.17	3.82
1.14	12.19	40	1.22	14.55	47.74	1706.29	0.30	1.17	3.83
1.19	12.50	41	1.25	14.94	49.00	1752.23	0.30	1.17	3.82
1.18	12.50	41	1.25	14.93	48.97	1750.70	0.30	1.17	3.82
1.17	12.50	41	1.25	14.92	48.94	1749.18	0.30	1.17	3.83
1.16	12.50	41	1.25	14.91	48.91	1747.66	0.30	1.17	3.83
1.15	12.50	41	1.25	14.90	48.87	1746.13	0.30	1.17	3.83
1.19	12.80	42	1.28	15.27	50.10	1790.54	0.30	1.17	3.83
1.18	12.80	42	1.28	15.26	50.07	1789.02	0.30	1.17	3.83
1.17	12.80	42	1.28	15.25	50.04	1787.49	0.30	1.17	3.83
1.16	12.80	42	1.28	15.24	50.01	1785.97	0.30	1.17	3.84
1.15	12.80	42	1.28	15.23	49.97	1784.45	0.30	1.17	3.84
1.19	13.11	43	1.31	15.61	51.20	1828.86	0.30	1.17	3.83
1.18	13.11	43	1.31	15.60	51.17	1827.33	0.30	1.17	3.84
1.17	13.11	43	1.31	15.59	51.14	1825.81	0.30	1.17	3.84
1.16	13.11	43	1.31	15.58	51.11	1824.28	0.30	1.17	3.84
1.15	13.11	43	1.31	15.57	51.07	1822.76	0.30	1.17	3.84
1.19	13.41	44	1.34	15.94	52.30	1867.17	0.30	1.17	3.84
1.18	13.41	44	1.34	15.93	52.27	1865.65	0.30	1.17	3.84
1.17	13.41	44	1.34	15.92	52.24	1864.12	0.30	1.17	3.84
1.16	13.41	44	1.34	15.91	52.21	1862.60	0.30	1.17	3.85
1.15	13.41	44	1.34	15.90	52.17	1861.07	0.30	1.17	3.85
1.19	13.72	45	1.37	16.28	53.40	1905.48	0.30	1.17	3.85
1.18	13.72	45	1.37	16.27	53.37	1903.96	0.30	1.17	3.85
1.17	13.72	45	1.37	16.26	53.34	1902.44	0.30	1.17	3.85
1.16	13.72	45	1.37	16.25	53.31	1900.91	0.30	1.17	3.85
1.15	13.72	45	1.37	16.24	53.27	1899.39	0.30	1.17	3.85
1.19	14.02	46	1.40	16.61	54.50	1943.80	0.30	1.17	3.85
1.18	14.02	46	1.40	16.60	54.47	1942.27	0.30	1.17	3.85
1.17	14.02	46	1.40	16.59	54.44	1940.75	0.30	1.18	3.86
1.16	14.02	46	1.40	16.58	54.41	1939.23	0.30	1.18	3.86
1.15	14.02	46	1.40	16.57	54.37	1937.70	0.30	1.18	3.86
1.20	14.33	47	1.43	16.96	55.64	1983.64	0.30	1.17	3.85
1.19	14.33	47	1.43	16.95	55.60	1982.11	0.30	1.18	3.86
1.18	14.33	47	1.43	16.94	55.57	1980.59	0.30	1.18	3.86
1.17	14.33	47	1.43	16.93	55.54	1979.06	0.30	1.18	3.86
1.19	14.63	48	1.46	17.28	56.70	2020.43	0.30	1.18	3.86
1.20	14.63	48	1.46	17.29	56.74	2021.95	0.30	1.18	3.86
1.19	14.63	48	1.46	17.28	56.70	2020.43	0.30	1.18	3.86
1.18	14.63	48	1.46	17.27	56.67	2018.90	0.30	1.18	3.86
1.17	14.63	48	1.46	17.26	56.64	2017.38	0.30	1.18	3.87
1.16	14.63	48	1.46	17.25	56.61	2015.85	0.30	1.18	3.87

* Based on USACE and PIANC guidance, a wave allowance of 10% of the vessel draft is assumed.

Attachment 4

Iterative Squat Computations

Eryuzlu et al. Method

Eryuzlu et. al.

Iterative Computations

Assumed Squat, z (meters)	Vessel Draft, T (meters)	Vessel Draft, T (feet)	Wave Allowance* (meters)	Resultant Depth, h (meters)	Resultant Depth, h (feet)	Froude # F_h	W/B	K_s	Calculated Squat, z (meters)	Calculated Squat, z (feet)
0.79	11.89	39	1.19	13.87	45.49	0.4411	3.56	1.64	0.77	2.52
0.78	11.89	39	1.19	13.86	45.46	0.4412	3.56	1.64	0.77	2.53
0.77	11.89	39	1.19	13.85	45.43	0.4414	3.56	1.64	0.77	2.53
0.76	11.89	39	1.19	13.84	45.39	0.4415	3.56	1.64	0.77	2.54
0.75	11.89	39	1.19	13.83	45.36	0.4417	3.56	1.64	0.77	2.54
0.79	12.19	40	1.22	14.20	46.59	0.4358	3.56	1.64	0.77	2.52
0.78	12.19	40	1.22	14.19	46.56	0.4360	3.56	1.64	0.77	2.53
0.77	12.19	40	1.22	14.18	46.53	0.4361	3.56	1.64	0.77	2.53
0.76	12.19	40	1.22	14.17	46.49	0.4363	3.56	1.64	0.77	2.53
0.75	12.19	40	1.22	14.16	46.46	0.4364	3.56	1.64	0.77	2.54
0.79	12.50	41	1.25	14.54	47.69	0.4308	3.56	1.64	0.77	2.52
0.78	12.50	41	1.25	14.53	47.66	0.4309	3.56	1.64	0.77	2.52
0.77	12.50	41	1.25	14.52	47.63	0.4311	3.56	1.64	0.77	2.53
0.76	12.50	41	1.25	14.51	47.59	0.4312	3.56	1.64	0.77	2.53
0.75	12.50	41	1.25	14.50	47.56	0.4314	3.56	1.64	0.77	2.54
0.79	12.80	42	1.28	14.87	48.79	0.4259	3.56	1.64	0.77	2.52
0.78	12.80	42	1.28	14.86	48.76	0.4260	3.56	1.64	0.77	2.52
0.77	12.80	42	1.28	14.85	48.73	0.4262	3.56	1.64	0.77	2.53
0.76	12.80	42	1.28	14.84	48.69	0.4263	3.56	1.64	0.77	2.53
0.75	12.80	42	1.28	14.83	48.66	0.4265	3.56	1.64	0.77	2.53
0.79	13.11	43	1.31	15.21	49.89	0.4212	3.56	1.64	0.77	2.52
0.78	13.11	43	1.31	15.20	49.86	0.4213	3.56	1.64	0.77	2.52
0.77	13.11	43	1.31	15.19	49.83	0.4214	3.56	1.64	0.77	2.52
0.76	13.11	43	1.31	15.18	49.79	0.4216	3.56	1.64	0.77	2.53
0.75	13.11	43	1.31	15.17	49.76	0.4217	3.56	1.64	0.77	2.53
0.79	13.41	44	1.34	15.54	50.99	0.4166	3.56	1.64	0.77	2.51
0.78	13.41	44	1.34	15.53	50.96	0.4167	3.56	1.64	0.77	2.52
0.77	13.41	44	1.34	15.52	50.93	0.4169	3.56	1.64	0.77	2.52
0.76	13.41	44	1.34	15.51	50.89	0.4170	3.56	1.64	0.77	2.53
0.75	13.41	44	1.34	15.50	50.86	0.4171	3.56	1.64	0.77	2.53
0.79	13.72	45	1.37	15.88	52.09	0.4122	3.56	1.64	0.77	2.51
0.78	13.72	45	1.37	15.87	52.06	0.4123	3.56	1.64	0.77	2.52
0.77	13.72	45	1.37	15.86	52.03	0.4124	3.56	1.64	0.77	2.52
0.76	13.72	45	1.37	15.85	51.99	0.4126	3.56	1.64	0.77	2.52
0.75	13.72	45	1.37	15.84	51.96	0.4127	3.56	1.64	0.77	2.53
0.79	14.02	46	1.40	16.21	53.19	0.4079	3.56	1.64	0.77	2.51
0.78	14.02	46	1.40	16.20	53.16	0.4080	3.56	1.64	0.77	2.51
0.77	14.02	46	1.40	16.19	53.13	0.4081	3.56	1.64	0.77	2.52
0.76	14.02	46	1.40	16.18	53.09	0.4083	3.56	1.64	0.77	2.52
0.75	14.02	46	1.40	16.17	53.06	0.4084	3.56	1.64	0.77	2.52
0.79	14.33	47	1.43	16.55	54.29	0.4037	3.56	1.64	0.76	2.51
0.78	14.33	47	1.43	16.54	54.26	0.4039	3.56	1.64	0.77	2.51
0.77	14.33	47	1.43	16.53	54.23	0.4040	3.56	1.64	0.77	2.51
0.76	14.33	47	1.43	16.52	54.19	0.4041	3.56	1.64	0.77	2.52
1.19	14.63	48	1.46	17.28	56.70	0.3950	3.56	1.64	0.73	2.38
0.79	14.63	48	1.46	16.88	55.39	0.3997	3.56	1.64	0.76	2.51
0.78	14.63	48	1.46	16.87	55.36	0.3998	3.56	1.64	0.76	2.51
0.77	14.63	48	1.46	16.86	55.33	0.3999	3.56	1.64	0.77	2.51
0.76	14.63	48	1.46	16.85	55.29	0.4001	3.56	1.64	0.77	2.52
0.75	14.63	48	1.46	16.84	55.26	0.4002	3.56	1.64	0.77	2.52

* Based on USACE and PIANC guidance, a wave allowance of 10% of the vessel draft is assumed.

Attachment 5

Iterative Squat Computations

Huuska/Guliev Method

Huuska/Guliev

Iterative Computations

Assumed Squat, z (meters)	Vessel Draft, T (meters)	Vessel Draft, T (feet)	Wave Allowance* (meters)	Resultant Depth, h (meters)	Resultant Depth, h (feet)	h_T/h	A_x/A_{cs}	K_1	S_1	K_b	Froude # F_h	Calculated Squat, z (meters)	Calculated Squat, z (feet)
0.81	11.89	39	1.19	13.89	45.56	0.78	0.24	2.30	0.10	1.52	0.4407	0.79	2.59
0.80	11.89	39	1.19	13.88	45.52	0.78	0.24	2.30	0.10	1.52	0.4409	0.79	2.59
0.79	11.89	39	1.19	13.87	45.49	0.78	0.24	2.30	0.10	1.52	0.4411	0.79	2.59
0.78	11.89	39	1.19	13.86	45.46	0.78	0.24	2.30	0.10	1.52	0.4412	0.79	2.60
0.77	11.89	39	1.19	13.85	45.43	0.78	0.24	2.30	0.10	1.53	0.4414	0.79	2.60
0.81	12.19	40	1.22	14.22	46.66	0.79	0.24	2.30	0.10	1.52	0.4355	0.79	2.59
0.80	12.19	40	1.22	14.21	46.62	0.79	0.24	2.30	0.10	1.52	0.4357	0.79	2.59
0.79	12.19	40	1.22	14.20	46.59	0.79	0.24	2.30	0.10	1.53	0.4358	0.79	2.59
0.78	12.19	40	1.22	14.19	46.56	0.79	0.24	2.30	0.10	1.53	0.4360	0.79	2.59
0.77	12.19	40	1.22	14.18	46.53	0.79	0.24	2.30	0.10	1.53	0.4361	0.79	2.60
0.81	12.50	41	1.25	14.56	47.76	0.79	0.24	2.30	0.10	1.53	0.4305	0.79	2.58
0.80	12.50	41	1.25	14.55	47.72	0.79	0.24	2.30	0.10	1.53	0.4306	0.79	2.59
0.79	12.50	41	1.25	14.54	47.69	0.79	0.24	2.30	0.10	1.53	0.4308	0.79	2.59
0.78	12.50	41	1.25	14.53	47.66	0.79	0.24	2.30	0.10	1.53	0.4309	0.79	2.59
0.77	12.50	41	1.25	14.52	47.63	0.79	0.24	2.30	0.10	1.53	0.4311	0.79	2.60
0.79	12.80	42	1.28	14.87	48.79	0.80	0.24	2.40	0.10	1.50	0.4259	0.77	2.53
0.78	12.80	42	1.28	14.86	48.76	0.79	0.24	2.40	0.10	1.50	0.4260	0.77	2.54
0.77	12.80	42	1.28	14.85	48.73	0.79	0.24	2.40	0.10	1.50	0.4262	0.77	2.54
0.76	12.80	42	1.28	14.84	48.69	0.79	0.24	2.40	0.10	1.50	0.4263	0.77	2.54
0.75	12.80	42	1.28	14.83	48.66	0.79	0.24	2.40	0.10	1.50	0.4265	0.78	2.55
0.79	13.11	43	1.31	15.21	49.89	0.80	0.24	2.40	0.10	1.50	0.4212	0.77	2.53
0.78	13.11	43	1.31	15.20	49.86	0.80	0.24	2.40	0.10	1.50	0.4213	0.77	2.54
0.77	13.11	43	1.31	15.19	49.83	0.80	0.24	2.40	0.10	1.50	0.4214	0.77	2.54
0.76	13.11	43	1.31	15.18	49.79	0.80	0.24	2.40	0.10	1.50	0.4216	0.77	2.54
0.75	13.11	43	1.31	15.17	49.76	0.80	0.24	2.40	0.10	1.50	0.4217	0.78	2.54
0.79	13.41	44	1.34	15.54	50.99	0.80	0.24	2.40	0.10	1.50	0.4166	0.77	2.53
0.78	13.41	44	1.34	15.53	50.96	0.80	0.24	2.40	0.10	1.50	0.4167	0.77	2.53
0.77	13.41	44	1.34	15.52	50.93	0.80	0.24	2.40	0.10	1.50	0.4169	0.77	2.54
0.76	13.41	44	1.34	15.51	50.89	0.80	0.24	2.40	0.10	1.50	0.4170	0.77	2.54
0.75	13.41	44	1.34	15.50	50.86	0.80	0.24	2.40	0.10	1.50	0.4171	0.77	2.54
0.79	13.72	45	1.37	15.88	52.09	0.81	0.24	2.40	0.10	1.50	0.4122	0.77	2.53
0.78	13.72	45	1.37	15.87	52.06	0.81	0.24	2.40	0.10	1.50	0.4123	0.77	2.53
0.77	13.72	45	1.37	15.86	52.03	0.81	0.24	2.40	0.10	1.50	0.4124	0.77	2.53
0.76	13.72	45	1.37	15.85	51.99	0.81	0.24	2.40	0.10	1.50	0.4126	0.77	2.54
0.75	13.72	45	1.37	15.84	51.96	0.81	0.24	2.40	0.10	1.50	0.4127	0.77	2.54
0.79	14.02	46	1.40	16.21	53.19	0.81	0.24	2.40	0.10	1.50	0.4079	0.77	2.53
0.78	14.02	46	1.40	16.20	53.16	0.81	0.24	2.40	0.10	1.50	0.4080	0.77	2.53
0.77	14.02	46	1.40	16.19	53.13	0.81	0.24	2.40	0.10	1.50	0.4081	0.77	2.53
0.76	14.02	46	1.40	16.18	53.09	0.81	0.24	2.40	0.10	1.50	0.4083	0.77	2.54
0.75	14.02	46	1.40	16.17	53.06	0.81	0.24	2.40	0.10	1.50	0.4084	0.77	2.54
0.78	14.33	47	1.43	16.54	54.26	0.82	0.24	2.50	0.10	1.47	0.4039	0.76	2.48
0.77	14.33	47	1.43	16.53	54.23	0.82	0.24	2.50	0.10	1.47	0.4040	0.76	2.48
0.76	14.33	47	1.43	16.52	54.19	0.82	0.24	2.50	0.10	1.47	0.4041	0.76	2.48
0.75	14.33	47	1.43	16.51	54.16	0.82	0.24	2.50	0.10	1.47	0.4042	0.76	2.49
1.19	14.63	48	1.46	17.28	56.70	0.82	0.23	2.50	0.09	1.45	0.3950	0.73	2.39
0.79	14.63	48	1.46	16.88	55.39	0.82	0.24	2.50	0.10	1.47	0.3997	0.75	2.48
0.78	14.63	48	1.46	16.87	55.36	0.82	0.24	2.50	0.10	1.47	0.3998	0.76	2.48
0.77	14.63	48	1.46	16.86	55.33	0.82	0.24	2.50	0.10	1.47	0.3999	0.76	2.48
0.76	14.63	48	1.46	16.85	55.29	0.82	0.24	2.50	0.10	1.47	0.4001	0.76	2.48
0.75	14.63	48	1.46	16.84	55.26	0.82	0.24	2.50	0.10	1.47	0.4002	0.76	2.49

* Based on USACE and PIANC guidance, a wave allowance of 10% of the vessel draft is assumed.

Attachment 6

Iterative Squat Computations

Romisch Method

Romisch

Iterative Computations

Assumed Squat, z (meters)	Vessel Draft, T (meters)	Vessel Draft, T (feet)	Wave Allowance* (meters)	Resultant Depth, h (meters)	Resultant Depth, h (feet)	h_m A_c/W_{bp}	K_m	K_c	h_c/h	A_w/A_c	H_{eff}	C	C_{eff}	V_{cr}	K_{kr}	C_P	C_V	Calculated Squat, z (meters)	Calculated Squat, z (feet)
0.82	11.89	39	1.19	13.90	45.59	13.90	0.76	0.43	0.78	0.24	13.90	11.68	11.68	5.90	0.17	0.70	0.50	0.85	2.78
0.81	11.89	39	1.19	13.89	45.56	13.89	0.76	0.43	0.78	0.24	13.89	11.67	11.67	5.90	0.17	0.70	0.50	0.85	2.78
0.80	11.89	39	1.19	13.88	45.52	13.88	0.76	0.43	0.78	0.24	13.88	11.67	11.67	5.89	0.17	0.70	0.50	0.85	2.79
0.79	11.89	39	1.19	13.87	45.49	13.87	0.76	0.43	0.78	0.24	13.87	11.66	11.66	5.89	0.17	0.70	0.50	0.85	2.79
0.78	11.89	39	1.19	13.86	45.46	13.86	0.76	0.43	0.78	0.24	13.86	11.66	11.66	5.89	0.17	0.70	0.50	0.85	2.80
0.80	12.19	40	1.22	14.21	46.62	14.21	0.76	0.43	0.79	0.24	14.21	11.81	11.81	5.94	0.17	0.70	0.48	0.82	2.70
0.79	12.19	40	1.22	14.20	46.59	14.20	0.76	0.43	0.79	0.24	14.20	11.80	11.80	5.94	0.17	0.70	0.48	0.82	2.70
0.78	12.19	40	1.22	14.19	46.56	14.19	0.76	0.43	0.79	0.24	14.19	11.80	11.80	5.93	0.17	0.70	0.48	0.83	2.71
0.77	12.19	40	1.22	14.18	46.53	14.18	0.76	0.43	0.79	0.24	14.18	11.79	11.79	5.93	0.17	0.70	0.49	0.83	2.71
0.76	12.19	40	1.22	14.17	46.49	14.17	0.76	0.43	0.78	0.24	14.17	11.79	11.79	5.93	0.17	0.70	0.49	0.83	2.72
0.78	12.50	41	1.25	14.53	47.66	14.53	0.76	0.43	0.79	0.24	14.53	11.94	11.94	5.98	0.17	0.70	0.47	0.80	2.62
0.77	12.50	41	1.25	14.52	47.63	14.52	0.76	0.43	0.79	0.24	14.52	11.93	11.93	5.98	0.17	0.70	0.47	0.80	2.63
0.76	12.50	41	1.25	14.51	47.59	14.51	0.76	0.43	0.79	0.24	14.51	11.93	11.93	5.97	0.17	0.70	0.47	0.80	2.63
0.75	12.50	41	1.25	14.50	47.56	14.50	0.76	0.43	0.79	0.24	14.50	11.93	11.93	5.97	0.17	0.70	0.47	0.80	2.64
0.74	12.50	41	1.25	14.49	47.53	14.49	0.76	0.43	0.79	0.24	14.49	11.92	11.92	5.97	0.17	0.70	0.47	0.81	2.64
0.77	12.80	42	1.28	14.85	48.73	14.85	0.76	0.43	0.79	0.24	14.85	12.07	12.07	6.02	0.17	0.70	0.46	0.78	2.55
0.76	12.80	42	1.28	14.84	48.69	14.84	0.76	0.43	0.79	0.24	14.84	12.07	12.07	6.02	0.17	0.70	0.46	0.78	2.55
0.75	12.80	42	1.28	14.83	48.66	14.83	0.76	0.43	0.79	0.24	14.83	12.06	12.06	6.02	0.17	0.70	0.46	0.78	2.55
0.74	12.80	42	1.28	14.82	48.63	14.82	0.76	0.43	0.79	0.24	14.82	12.06	12.06	6.01	0.17	0.70	0.46	0.78	2.56
0.73	12.80	42	1.28	14.81	48.60	14.81	0.76	0.43	0.79	0.24	14.81	12.05	12.05	6.01	0.17	0.70	0.46	0.78	2.56
0.75	13.11	43	1.31	15.17	49.76	15.17	0.76	0.43	0.80	0.24	15.17	12.20	12.20	6.06	0.17	0.70	0.44	0.76	2.48
0.74	13.11	43	1.31	15.16	49.73	15.16	0.76	0.43	0.80	0.24	15.16	12.19	12.19	6.06	0.17	0.70	0.45	0.76	2.48
0.73	13.11	43	1.31	15.15	49.70	15.15	0.76	0.43	0.80	0.24	15.15	12.19	12.19	6.06	0.17	0.70	0.45	0.76	2.49
0.72	13.11	43	1.31	15.14	49.66	15.14	0.76	0.43	0.80	0.24	15.14	12.19	12.19	6.05	0.17	0.70	0.45	0.76	2.49
0.71	13.11	43	1.31	15.13	49.63	15.13	0.76	0.43	0.80	0.24	15.13	12.18	12.18	6.05	0.17	0.70	0.45	0.76	2.50
0.74	13.41	44	1.34	15.49	50.83	15.49	0.76	0.43	0.80	0.24	15.49	12.33	12.33	6.10	0.17	0.70	0.43	0.74	2.41
0.73	13.41	44	1.34	15.48	50.80	15.48	0.76	0.43	0.80	0.24	15.48	12.32	12.32	6.10	0.17	0.70	0.43	0.74	2.42
0.72	13.41	44	1.34	15.47	50.76	15.47	0.76	0.43	0.80	0.24	15.47	12.32	12.32	6.10	0.17	0.70	0.44	0.74	2.42
0.71	13.41	44	1.34	15.46	50.73	15.46	0.76	0.43	0.80	0.24	15.46	12.32	12.32	6.09	0.17	0.70	0.44	0.74	2.42
0.70	13.41	44	1.34	15.45	50.70	15.45	0.76	0.43	0.80	0.24	15.45	12.31	12.31	6.09	0.17	0.70	0.44	0.74	2.43
0.72	13.72	45	1.37	15.81	51.86	15.81	0.76	0.43	0.81	0.24	15.81	12.45	12.45	6.14	0.17	0.70	0.42	0.72	2.35
0.71	13.72	45	1.37	15.80	51.83	15.80	0.76	0.43	0.81	0.24	15.80	12.45	12.45	6.14	0.17	0.70	0.42	0.72	2.36
0.70	13.72	45	1.37	15.79	51.80	15.79	0.76	0.43	0.81	0.24	15.79	12.44	12.44	6.14	0.17	0.70	0.42	0.72	2.36
0.69	13.72	45	1.37	15.78	51.76	15.78	0.76	0.43	0.81	0.24	15.78	12.44	12.44	6.13	0.17	0.70	0.43	0.72	2.36
0.68	13.72	45	1.37	15.77	51.73	15.77	0.76	0.43	0.81	0.24	15.77	12.44	12.44	6.13	0.17	0.70	0.43	0.72	2.37
0.71	14.02	46	1.40	16.13	52.93	16.13	0.76	0.43	0.81	0.24	16.13	12.58	12.58	6.19	0.17	0.70	0.41	0.70	2.29
0.70	14.02	46	1.40	16.12	52.90	16.12	0.76	0.43	0.81	0.24	16.12	12.58	12.58	6.18	0.17	0.70	0.41	0.70	2.30
0.69	14.02	46	1.40	16.11	52.86	16.11	0.76	0.43	0.81	0.24	16.11	12.57	12.57	6.18	0.17	0.70	0.41	0.70	2.30
0.68	14.02	46	1.40	16.10	52.83	16.10	0.76	0.43	0.81	0.24	16.10	12.57	12.57	6.18	0.17	0.70	0.42	0.70	2.30
0.67	14.02	46	1.40	16.09	52.80	16.09	0.76	0.43	0.81	0.24	16.09	12.56	12.56	6.17	0.17	0.70	0.42	0.70	2.31
0.70	14.33	47	1.43	16.46	54.00	16.46	0.76	0.43	0.81	0.24	16.46	12.71	12.71	6.23	0.17	0.70	0.40	0.68	2.24
0.69	14.33	47	1.43	16.45	53.96	16.45	0.76	0.43	0.81	0.24	16.45	12.70	12.70	6.22	0.17	0.70	0.40	0.68	2.24
0.68	14.33	47	1.43	16.44	53.93	16.44	0.76	0.43	0.81	0.24	16.44	12.70	12.70	6.22	0.17	0.70	0.40	0.68	2.24
0.67	14.33	47	1.43	16.43	53.90	16.43	0.76	0.43	0.81	0.24	16.43	12.69	12.69	6.22	0.17	0.70	0.41	0.68	2.25
1.19	14.63	48	1.46	17.28	56.70	17.28	0.76	0.44	0.82	0.23	17.28	13.02	13.02	6.43	0.17	0.70	0.36	0.62	2.04
0.69	14.63	48	1.46	16.78	55.06	16.78	0.76	0.43	0.82	0.24	16.78	12.83	12.83	6.27	0.17	0.70	0.39	0.67	2.18
0.68	14.63	48	1.46	16.77	55.03	16.77	0.76	0.43	0.82	0.24	16.77	12.83	12.83	6.27	0.17	0.70	0.39	0.67	2.19
0.67	14.63	48	1.46	16.76	55.00	16.76	0.76	0.43	0.82	0.24	16.76	12.82	12.82	6.26	0.17	0.70	0.40	0.67	2.19
0.66	14.63	48	1.46	16.75	54.97	16.75	0.76	0.43	0.82	0.24	16.75	12.82	12.82	6.26	0.17	0.70	0.40	0.67	2.19
0.65	14.63	48	1.46	16.74	54.93	16.74	0.76	0.43	0.82	0.24	16.74	12.82	12.82	6.26	0.17	0.70	0.40	0.67	2.20

* Based on USACE and PIANC guidance, a wave allowance of 10% of the vessel draft is assumed.

PORT EVERGLADES HARBOR, FLORIDA

SUB-APPENDIX D

RMA MODELING OF PORT EVERGLADES HARBOR

RMA-2 HYDRODYNAMIC MODELING OF PORT EVERGLADES HARBOR

Hydrodynamic Modeling Approach - The objective of the Port Everglades Feasibility Study hydrodynamic modeling effort was to gain insight into the magnitude of potential changes to tidal flushing in the harbor and estuary. Direct modeling of salinity would require use of a three-dimensional model, such as RMA-10, that is capable of simulating complex flows where vertical variations of variables are important and where the effect of fluid density is included. Since the cost and time requirements to develop a fully three-dimensional stratified hydrodynamic model were not practicable in light of the study plan, a less intensive two-dimensional modeling effort was chosen as an alternative approach. Predicted changes in tidal flushing can provide an indirect indicator of the magnitude of potential changes in salinity. Comparison of changes in the tidally driven hydrodynamics under a constant freshwater inflow regime is considered sufficient in this case to meet the limited modeling objective.

Model Description - Hydrodynamic modeling of Port Everglades was done using RMA-2 version 4.52, which is a two-dimensional depth-averaged finite-element hydrodynamic numerical model. RMA-2 computes water surface elevations and horizontal velocity components for subcritical, free-surface flow in two-dimensional flow fields. The Surface Water Modeling System (SMS) version 7.0 was employed in pre- and post-processing of the RMA-2 model and results.

Calibration and Verification - Due to limited funding and study time frames, the Port Everglades RMA-2 model was not calibrated to field measured parameters such as velocities, flows, or heads. Nevertheless, the relative difference in the computed solutions for the respective model configurations is useful as an indicator of the magnitude of potential changes in flows.

Model Geometry - The finite element mesh geometry for the Port Everglades RMA-2 model was developed using SMS. A finite element mesh is composed of computational nodal points where each point has a Cartesian coordinate (x, y) and a depth (z). The nodes are connected to form the triangular and quadrilateral elements of the mesh. The plan layout of the model mesh was developed from several sources of georeferenced aerial photography in combination with USGS quadrangle maps and NOAA navigational charts. The mesh elements are configured in such a way that both the Existing-Condition and With-Plan channel alignments and depths can be represented. The mesh contains

56,528 computational nodes and 19,476 elements. The full computational mesh is shown in Figure 1. Recent bathymetric survey data of the existing Federal channels were imported into the mesh through an automatic interpolation process. This process assigns nodal z-values for the Existing-Condition mesh configuration. Bathymetry for areas without survey coverage was hand sculpted using information from the navigational charts and best professional judgment. For the With-Plan mesh geometry, the existing condition mesh was modified to include the proposed new channel alignments and depths. Figures 2 & 3 show the Existing-Condition and With-Plan bathymetry, respectively, for the inshore portion of the mesh. Figures 4 and 5 show the Existing-Condition and With-Plan bathymetry, respectively, for the northern area of the port including the entrance channel. Figures 6 and 7 show the Existing-Condition and With-Plan bathymetry, respectively, for the southern area of the port including the Dania Cut-off Canal.

RMA-2 Boundary Conditions - Boundary conditions for the Port Everglades model include transient head boundaries on the ocean side and on the Intracoastal Waterway (IWW) to simulate tidal forces. Steady-state volumetric flows at locations corresponding to major canals were included to simulate freshwater inflows. The Florida Power and Light power plant cooling canal was also included to simulate an average condition pumped flow within the model domain. The model control file runs the model for 750 time-steps with each time-step representing a 30-minute increment of the tidal cycle. The first 15 time steps are used for model spin-up and the remaining 735 time-steps represent approximately 15 days of simulation time, or about 30 tidal cycles. The transient head input data files used to simulate the forcing tides were developed with the tide prediction software "XTide". Tide elevations corresponding to the run-control time series were extracted from the XTide data. The XTide data was generated from input parameters corresponding to a spring tide that occurred in September 2000, thereby simulating high flow conditions. The four XTide stations are shown in the Table 1.

Tidal Boundary Location in Mesh	XTide Station Name
Ocean Side North	Lauderdale by the Sea
Ocean Side South	North Miami Beach
IWW North	Bahia Mar Yacht Club
IWW South	Hollywood Beach

Table 1

The transient head time series for these boundaries are shown in Figures 8-11. Constant inflows of 500 and 200 cubic feet per second were applied as flow boundaries at the Dania Cut-off Canal and New River, respectively.

RMA-2 Model Results and Analysis - Computed average flows across selected channel locations were compared between the Existing-Condition and With-Plan model results. The average flow, or flux, is computed by multiplying the average RMA-2 nodal velocities (feet per second) by the corresponding channel cross-sectional area (square feet) to give the average flow across the flux line in cubic feet per second. Figure 12 shows the locations of 14 flux lines within the model domain. At these flux lines, results from the two RMA-2 simulations can be examined. Differences between the two solution sets were computed by subtracting the With-plan solution from the Existing-Condition solution. Table 2 shows the percent change in computed flow across these flux lines. The percent change is relative to the computed flow under the Existing Condition run. Positive values indicate an increase in With-Plan flow compared to the Existing-Condition flow, and negative values represent a reduction in flow, respectively.

Line #	Line Location in model.	% Change
Line 1	IWW east of New River	0.1
Line 2	IWW south of New River	0.0
Line 3	IWW A1A bridge north of port	0.3
Line 4	Port Everglades Entrance Channel	-0.4
Line 5	IWW north of small notch	-0.4
Line 6	IWW north of FPL outflow	-0.2
Line 7	Turning Notch mangroves tidal creek	-1.7
Line 8	Lloyd Park tidal creek north	-0.7
Line 9	IWW south of Dania Cutoff Canal (DCC)	3.2
Line 10	DCC mangroves tidal creek	-5.5
Line 11	Lloyd Park tidal creek south	-0.8
Line 12	DCC west of new birth	0.0
Line 13	IWW north of West Lake	0.4
Line 14	West Lake	0.3

Table 2

The following inferences can be drawn from the computed changes in flow:

Changes of less than 1 percent are within the computational error of the model and represent virtually no change.

The increase of approximately 3 percent in Line 9 would be expected due to the increase in cross-sectional area of the channel to be dredged in the With-Plan configuration.
The small reductions in flow in the tidal creeks (Lines 7 and 10) result from the slight reductions in velocity in the nearby areas where the channel cross-sections are being increased. These changes are not considered to be significant. Computed flows through the Port Everglades entrance channel are virtually unaffected by the changes in mesh geometry in the port areas.

In addition to the flux lines, time-series plots of water-surface elevation and depth-averaged velocity were prepared for a point midway along each line (See Figures 13-40). Each plot shows the computed velocity under the Existing Condition and With-Plan mesh configurations as well as the difference between the two. Differences between the two solution sets were computed by subtracting the With-plan solution from the Existing-Condition solution. Changes in these individual parameters are consistent with the changes in the flux lines shown in Table 2. Note that for Observation Points 7 & 10 (figures 26 & 36), the velocity doesn't slow to near zero as would be expected during slack tide. This is due to the location of the observation points near flow boundaries that provide a constant base velocity.

Conclusion - The Port Everglades Feasibility Study hydrodynamic modeling was undertaken as a cost-effective screening tool to gain insight into the magnitude of potential changes to tidal flushing in the project area. This screening exercise indicates that changes in the tidally driven hydrodynamics of the project area are predicted to be minimal.

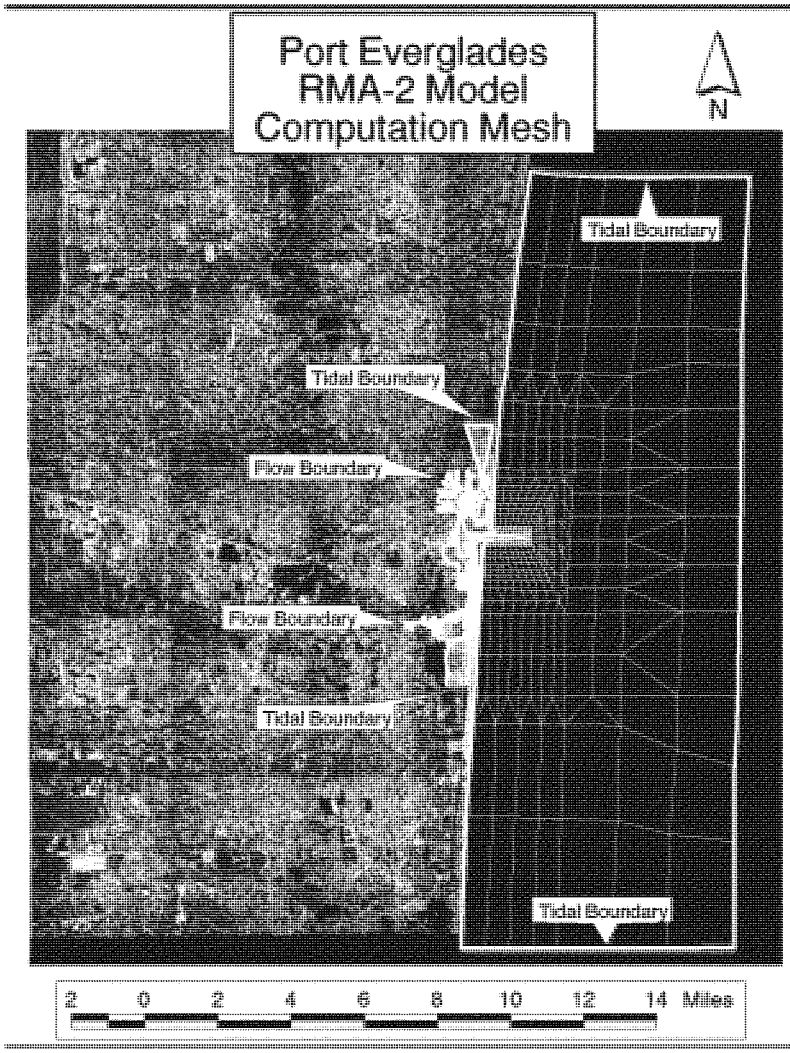

Port Everglades
RMA-2 Model
Computation Mesh
N
Tidal Boundary
Tidal Boundary
Flow Boundary
Flow Boundary
Tidal Boundary
Tidal Boundary
2 0 2 4 6 8 10 12 14 Miles

Figure 1

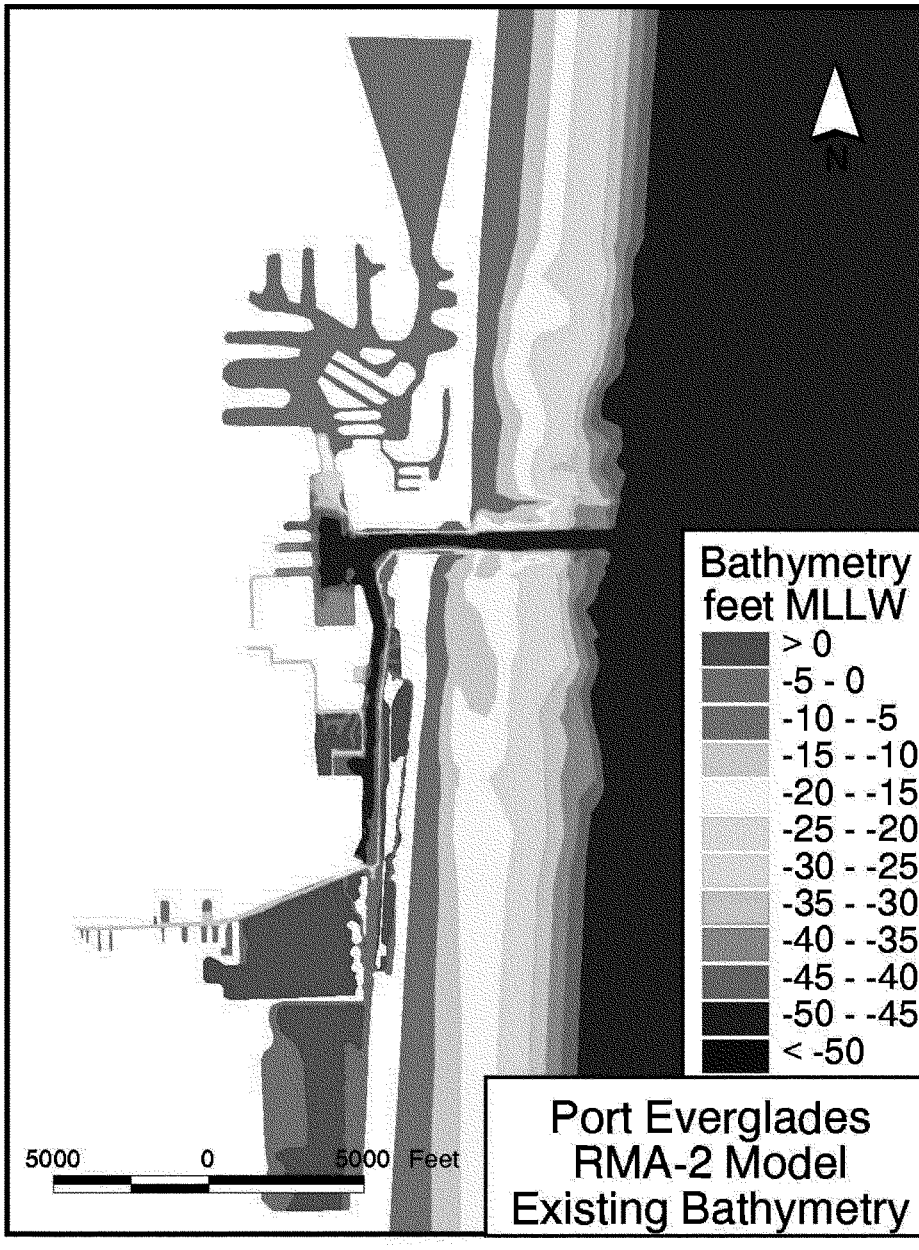

N
Bathymetry
feet MLLW
> 0
-5 - 0
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
< -50
5000
0
5000 Feet
Port Everglades
RMA-2 Model
Existing Bathymetry

Figure 2

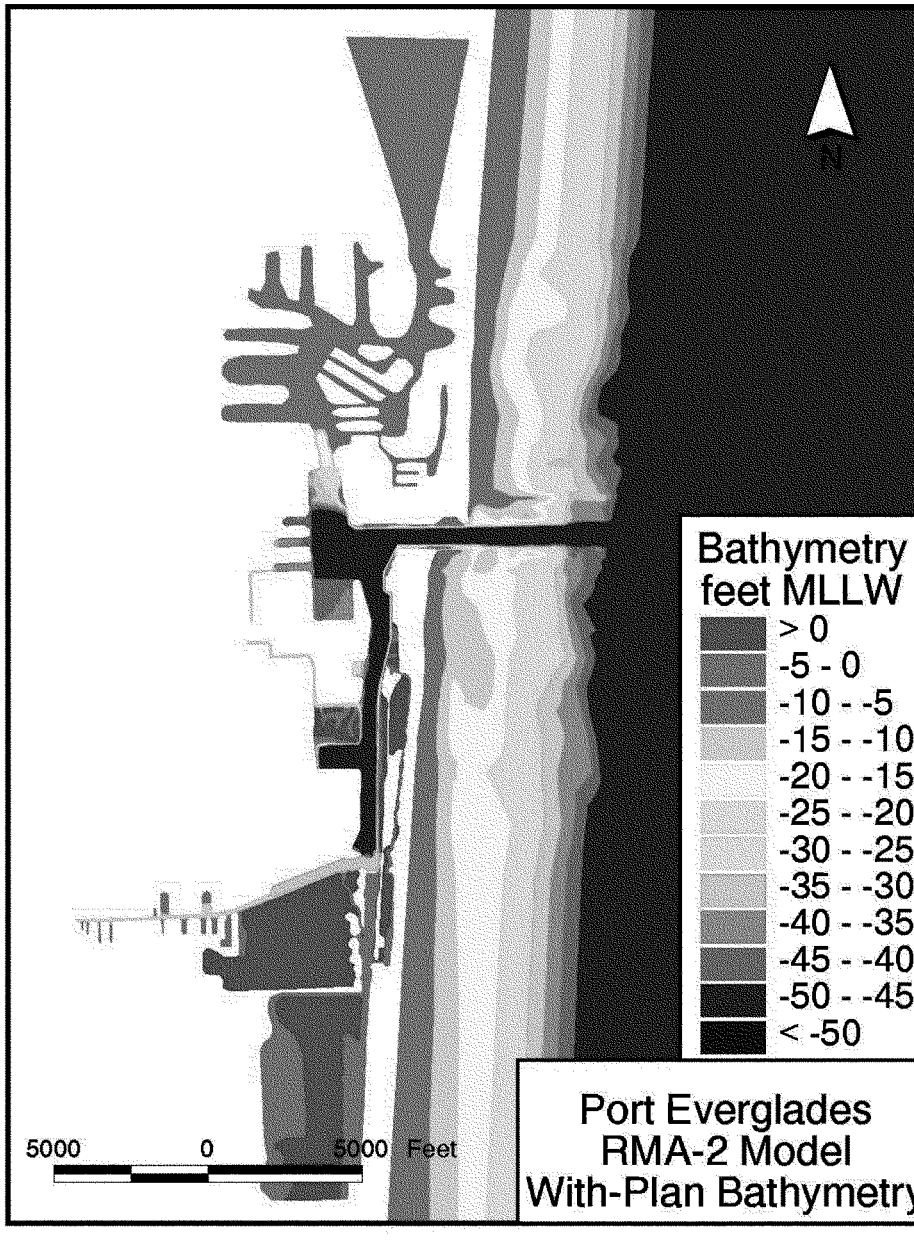

N
Bathymetry
feet MLLW
> 0
-5 - 0
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
< -50
5000
0
5000 Feet
Port Everglades
RMA-2 Model
With-Plan Bathymetry

Figure 3

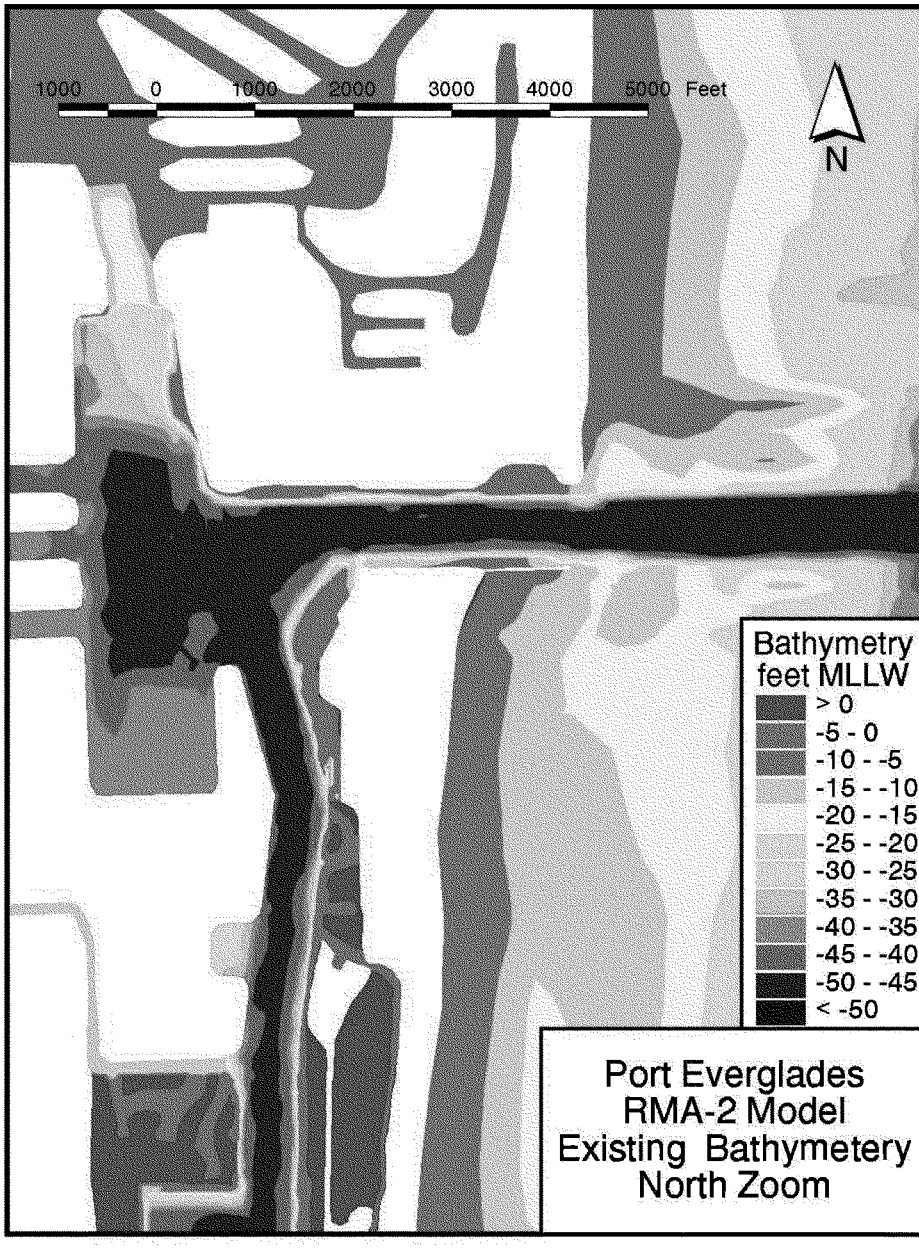

1000 0 1000 2000 3000 4000 5000 Feet
N
Bathymetry
feet MLLW
> 0
-5 - 0
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
< -50
Port Everglades
RMA-2 Model
Existing Bathymetery
North Zoom

Figure 4

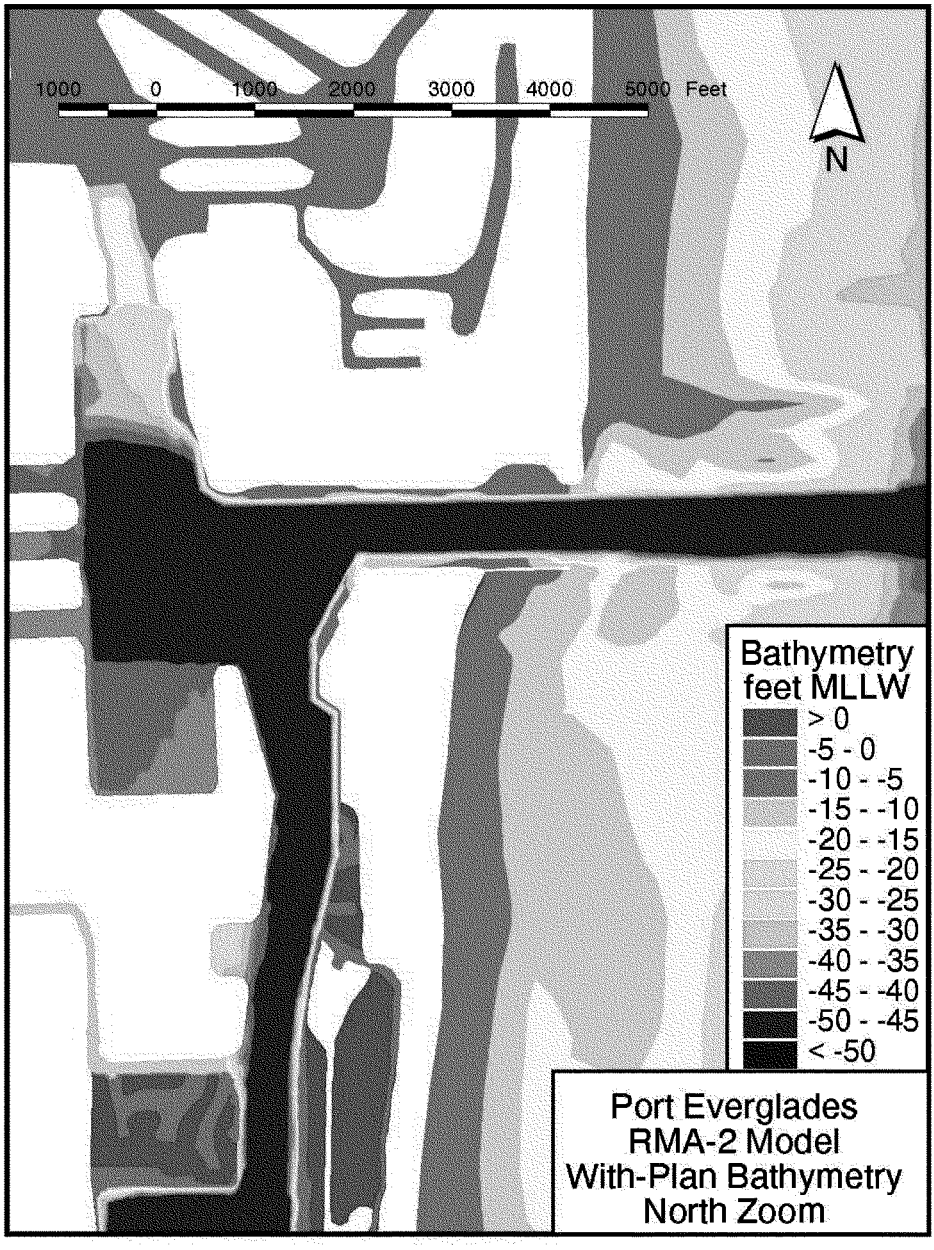

1000 0 1000 2000 3000 4000 5000 Feet
N
Bathymetry
feet MLLW
> 0
-5 - 0
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
< -50
Port Everglades
RMA-2 Model
With-Plan Bathymetry
North Zoom

Figure 5

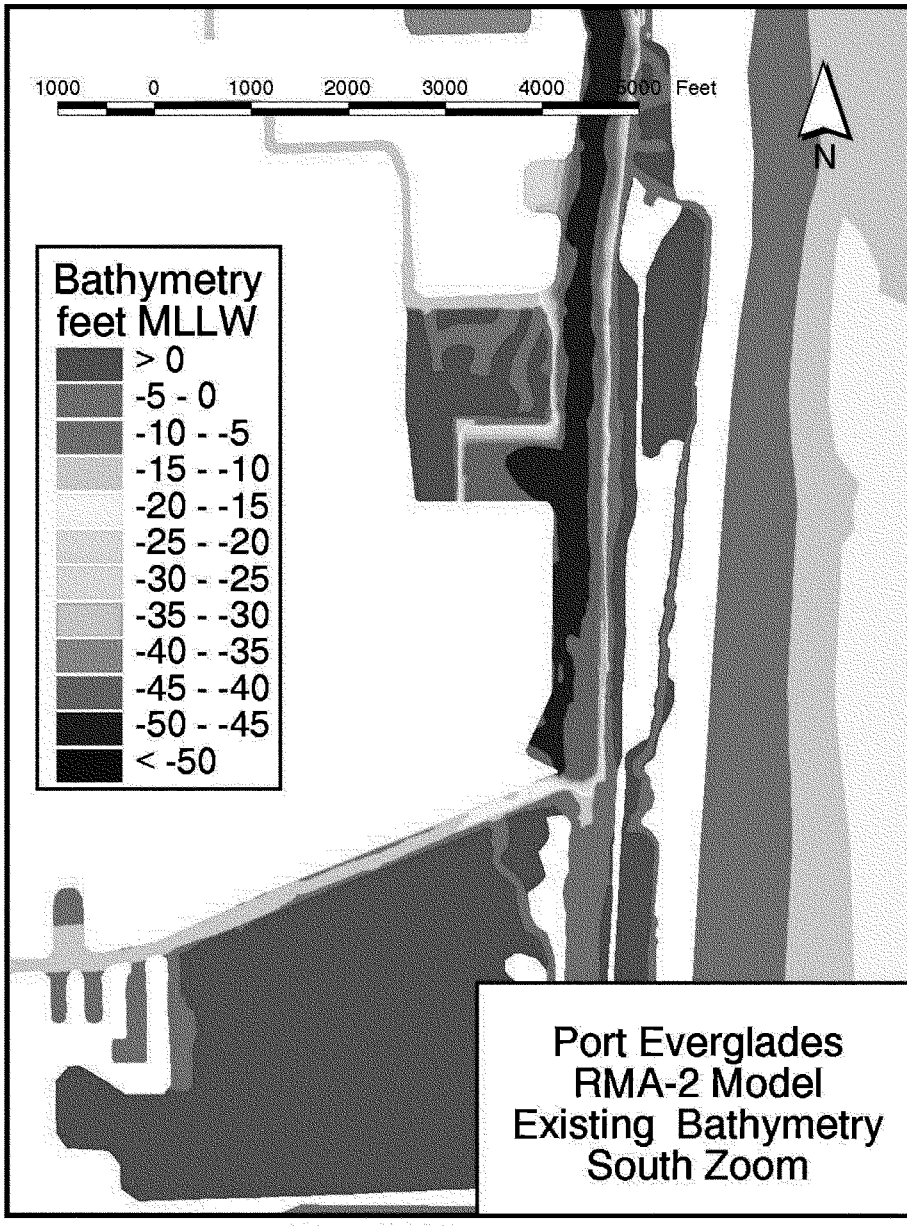

1000 0 1000 2000 3000 4000 5000 Feet
N
Bathymetry
feet MLLW
> 0
-5 - 0
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
< -50
Port Everglades
RMA-2 Model
Existing Bathymetry
South Zoom

Figure 6

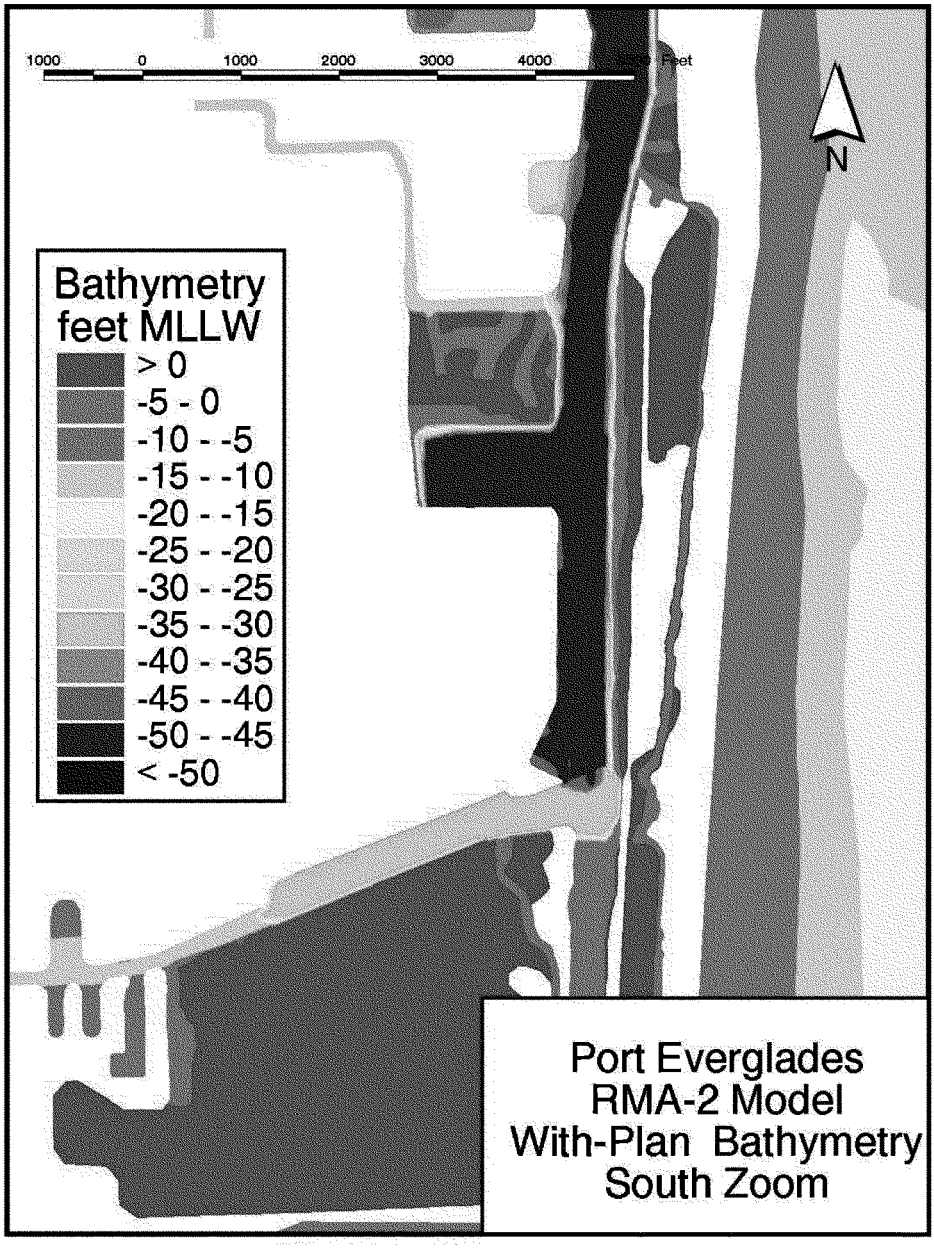

1000
0
1000
2000
3000
4000
Feet
N
Bathymetry
feet MLLW
> 0
-5 - 0
-10 - -5
-15 - -10
-20 - -15
-25 - -20
-30 - -25
-35 - -30
-40 - -35
-45 - -40
-50 - -45
< -50
Port Everglades
RMA-2 Model
With-Plan Bathymetry
South Zoom

Figure 7

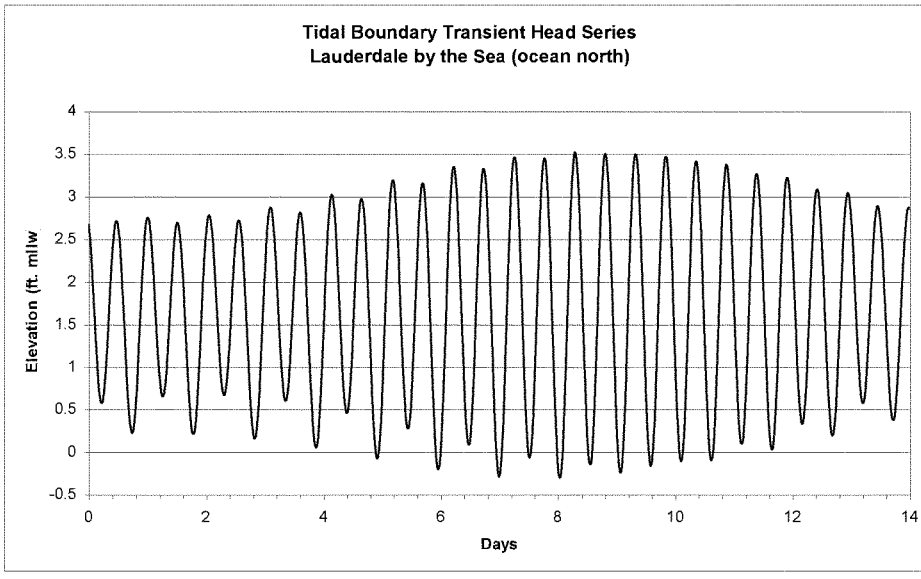


Figure 8

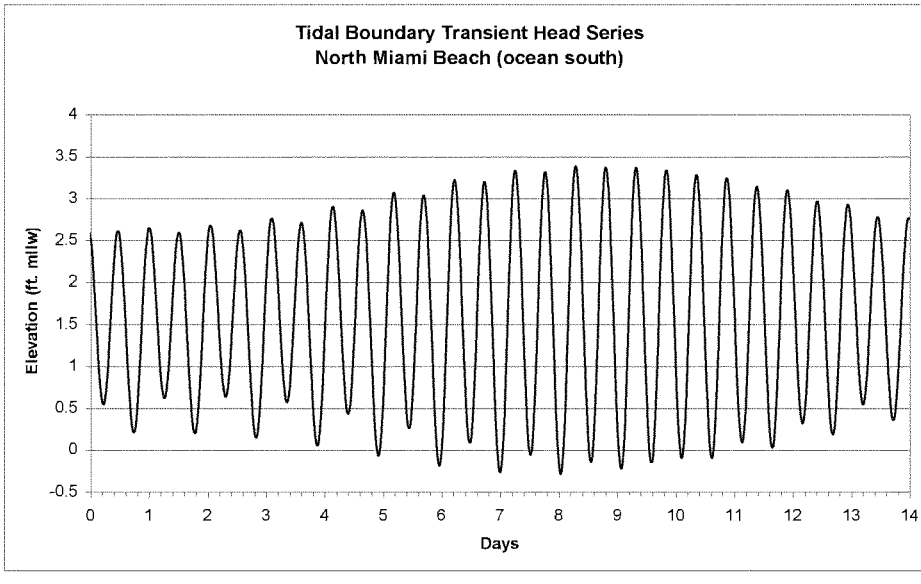


Figure 9

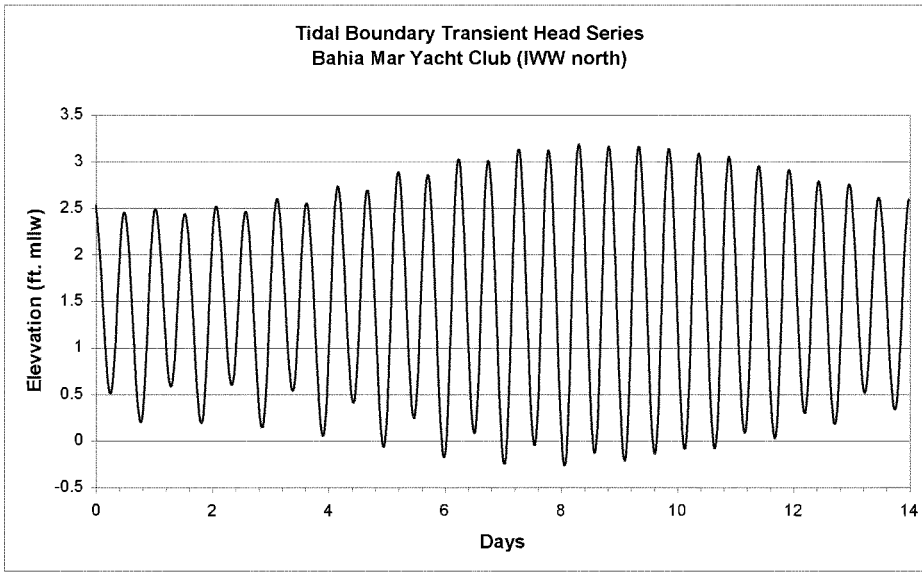


Figure 10

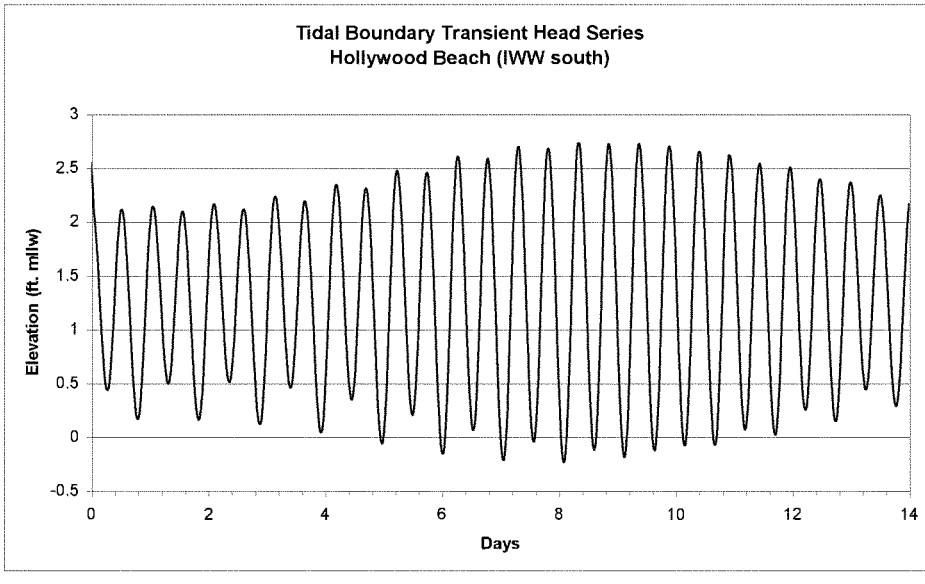


Figure 11

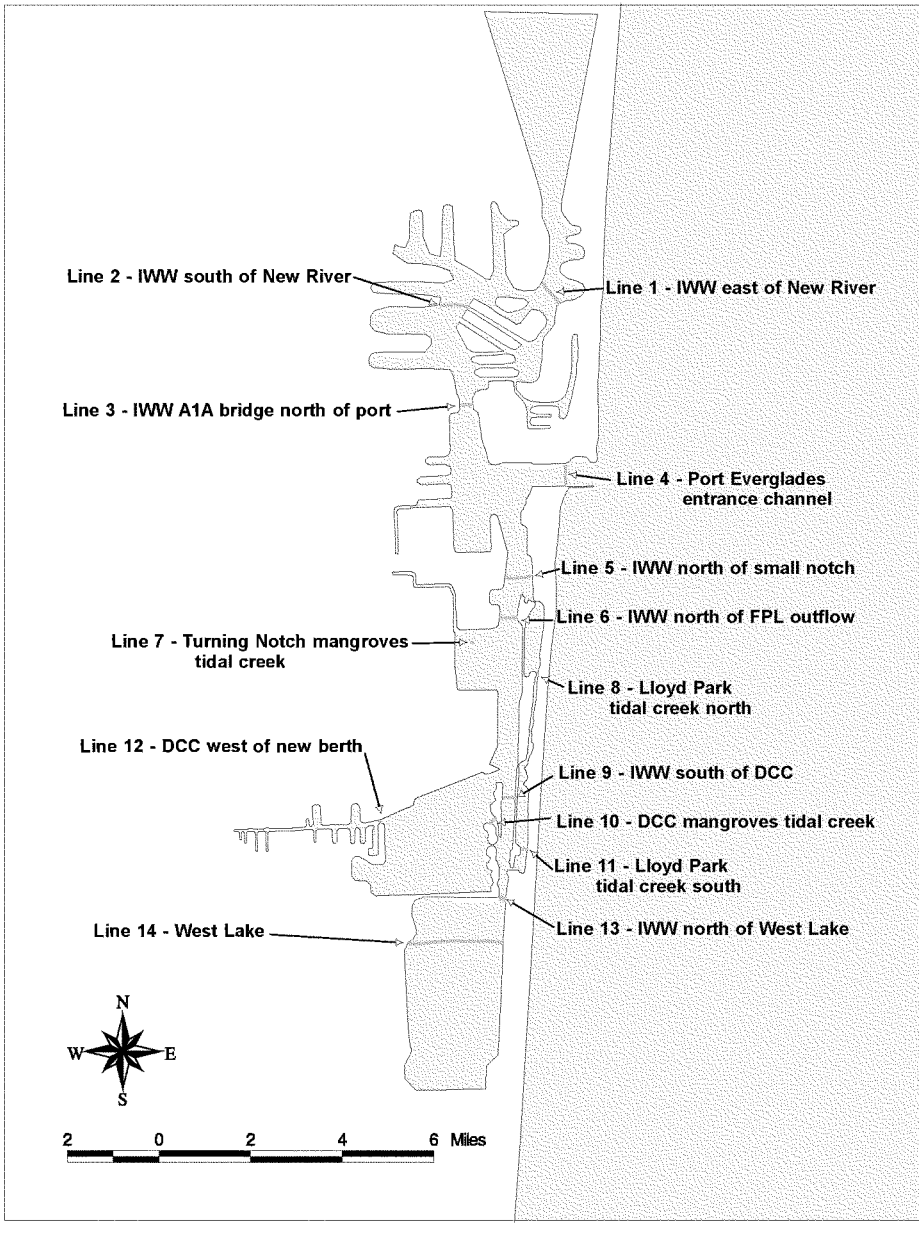

Line 2 - IWW south of New River
Line 1 - IWW east of New River
Line 3 - IWW A1A bridge north of port
Line 4 - Port Everglades entrance channel
Line 5 - IWW north of small notch
Line 6 - IWW north of FPL outflow
Line 7 - Turning Notch mangroves tidal creek
Line 8 - Lloyd Park tidal creek north
Line 12 - DCC west of new berth
Line 9 - IWW south of DCC
Line 10 - DCC mangroves tidal creek
Line 11 - Lloyd Park tidal creek south
Line 14 - West Lake
Line 13 - IWW north of West Lake
N
W
E
S
2 0 2 4 6 Miles

Figure 12

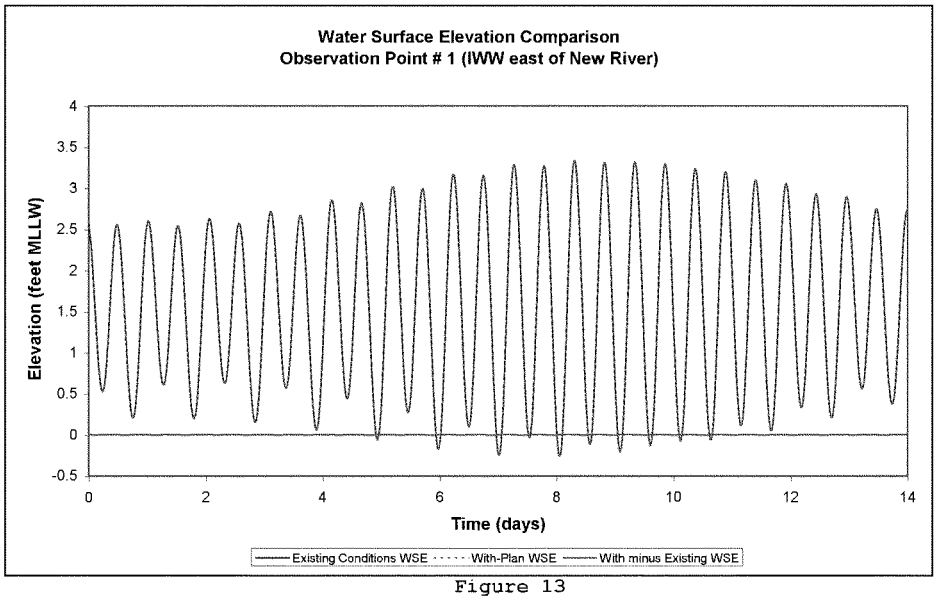


Figure 13

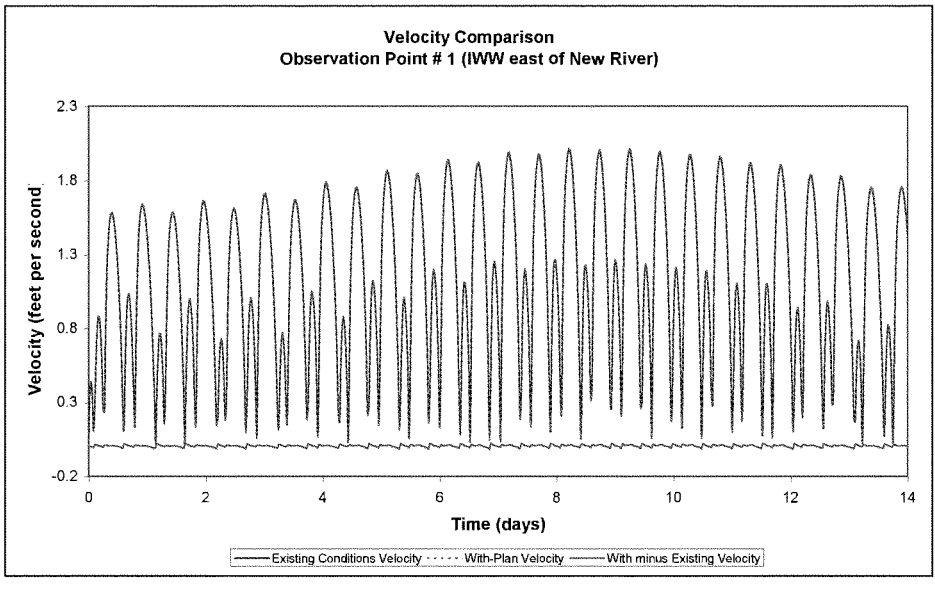


Figure 14

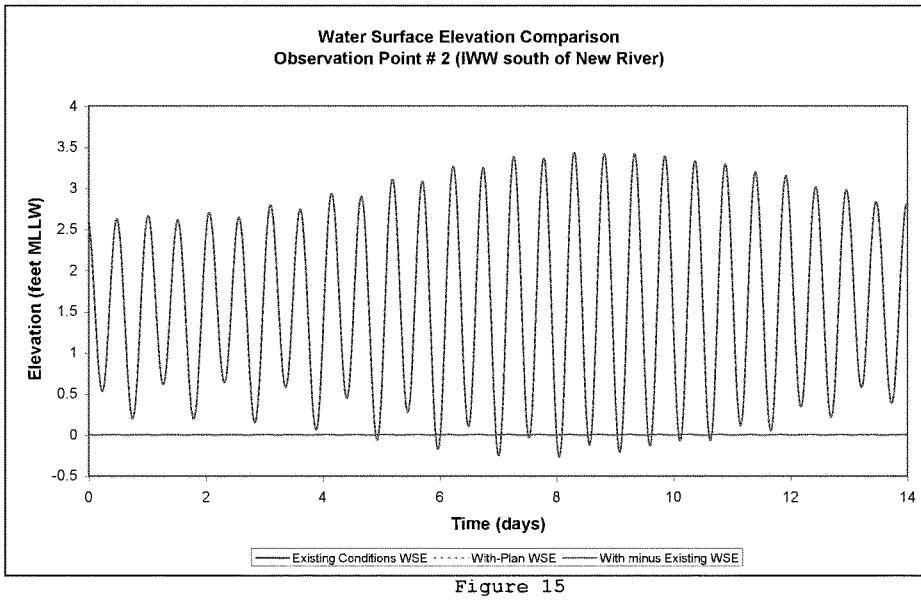
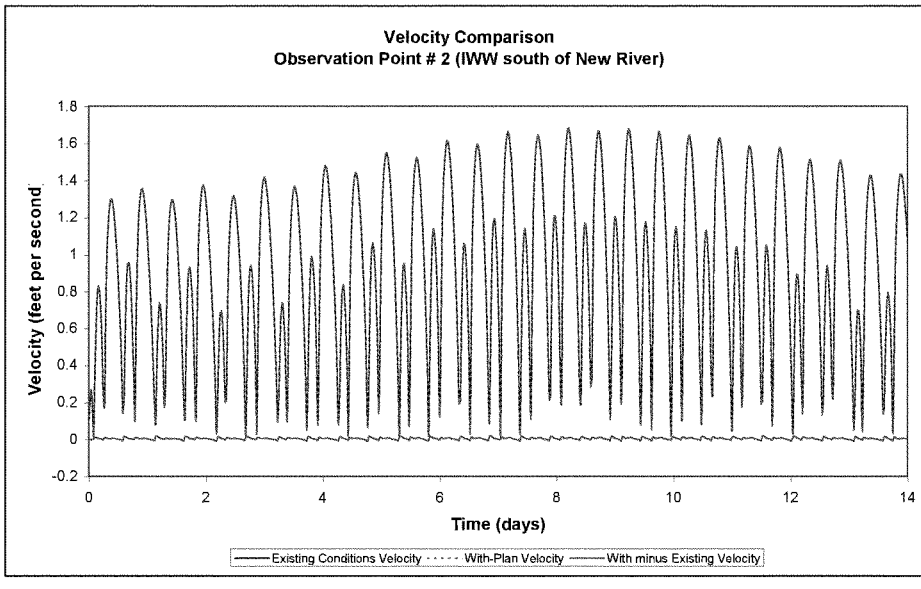


Figure 15



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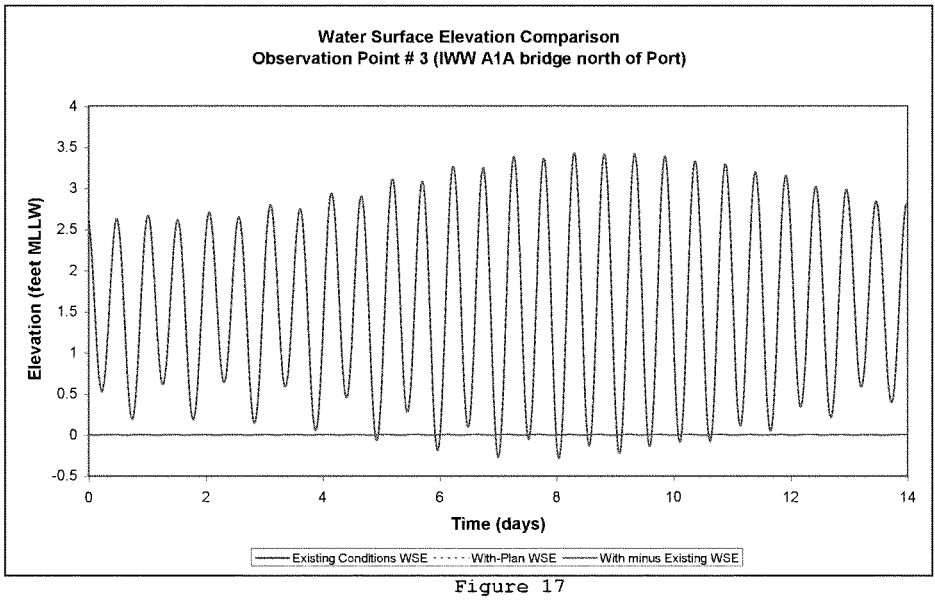

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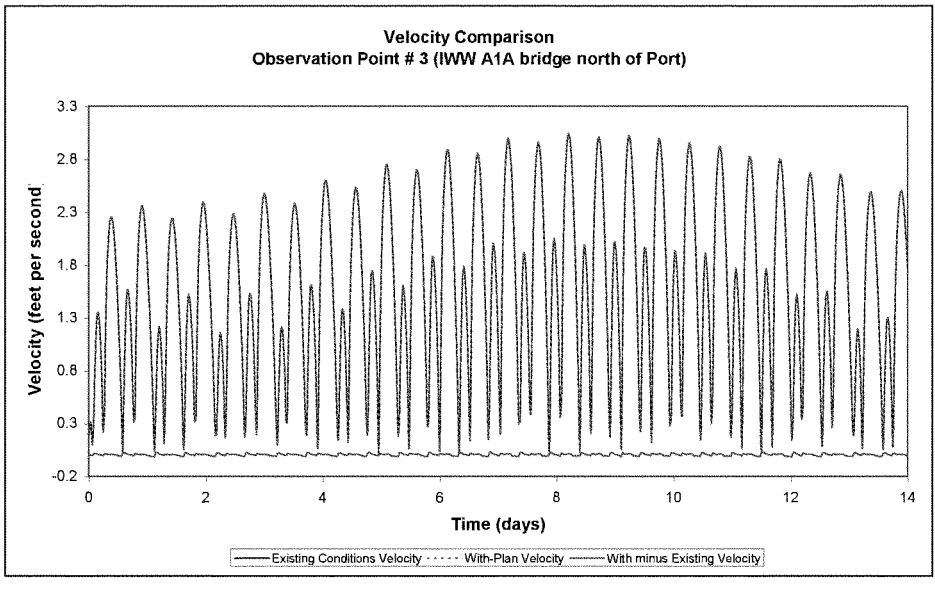

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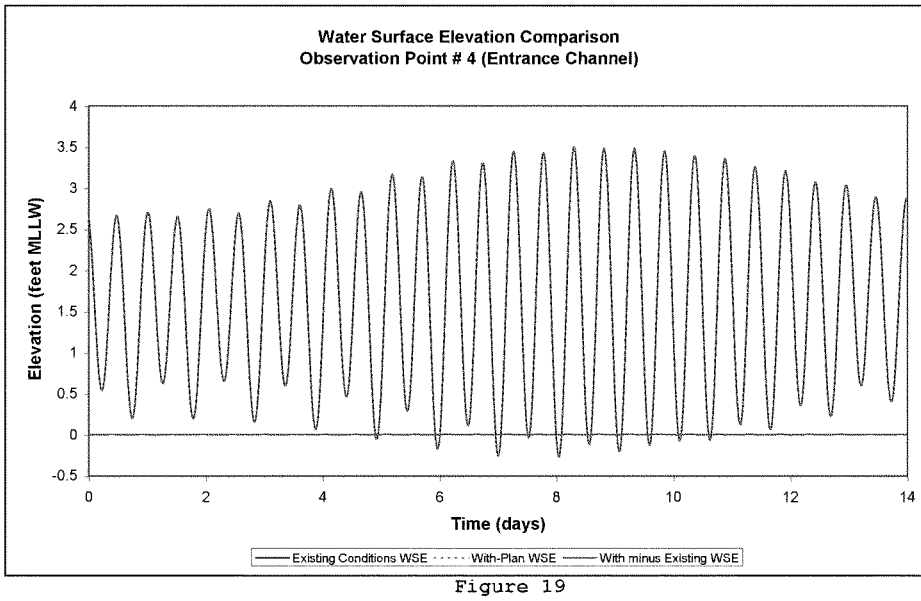

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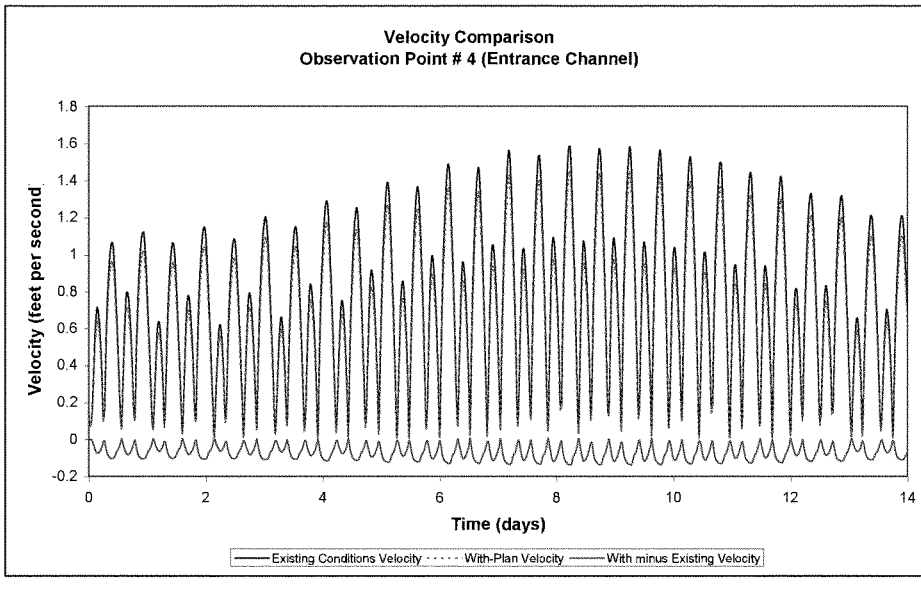

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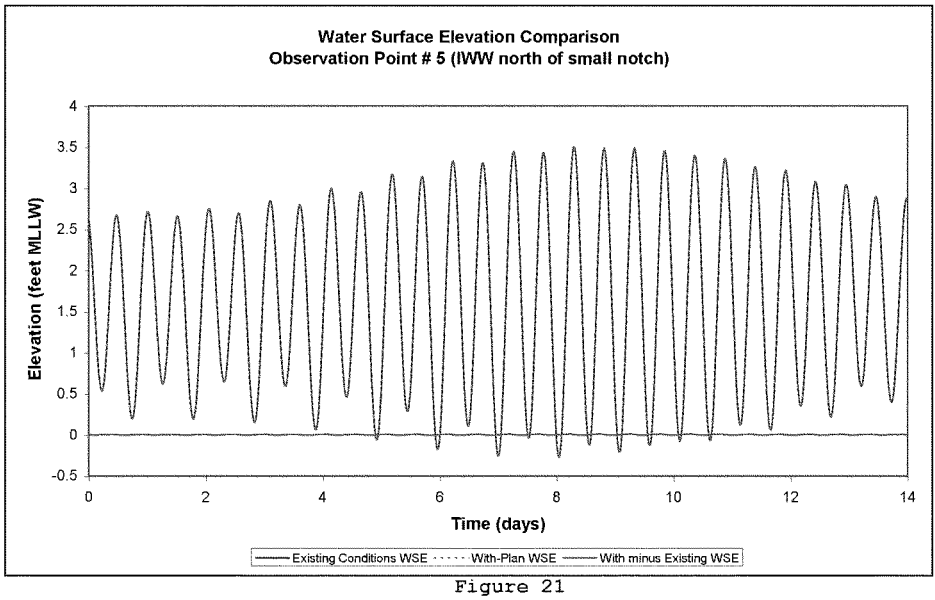

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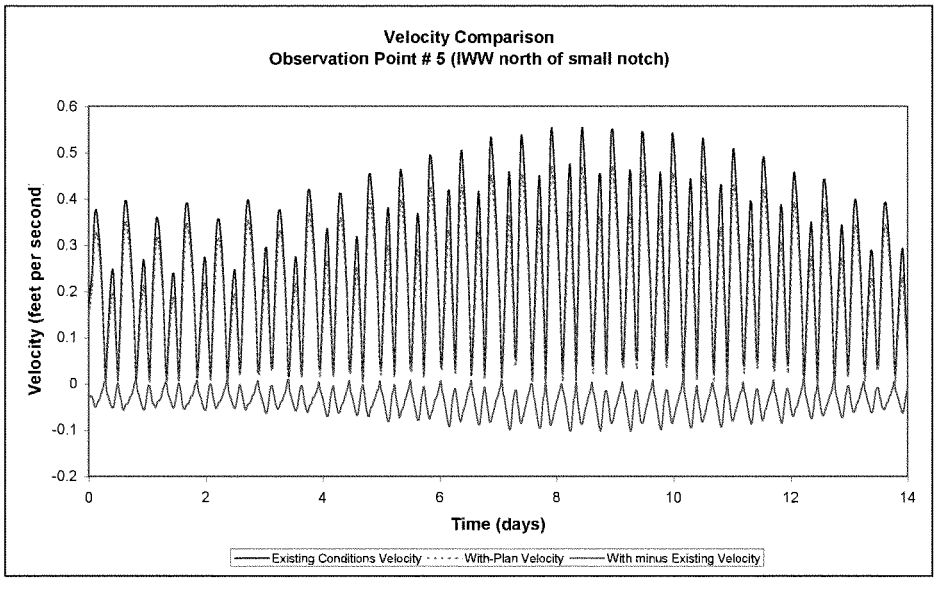

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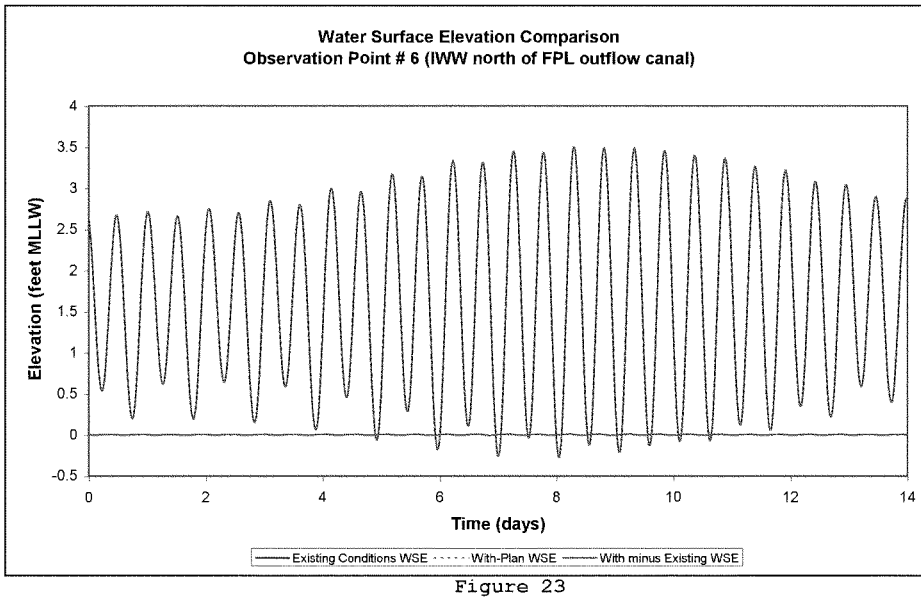

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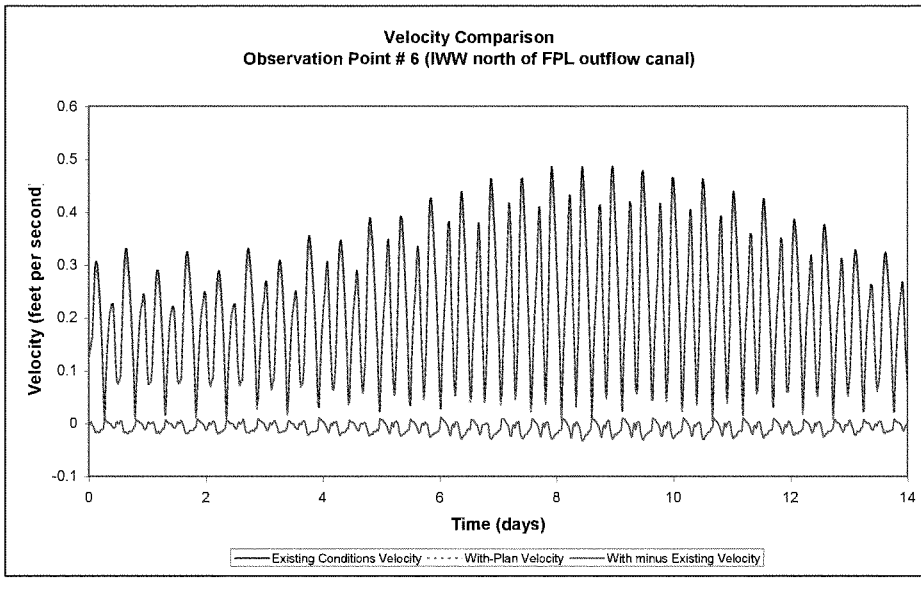

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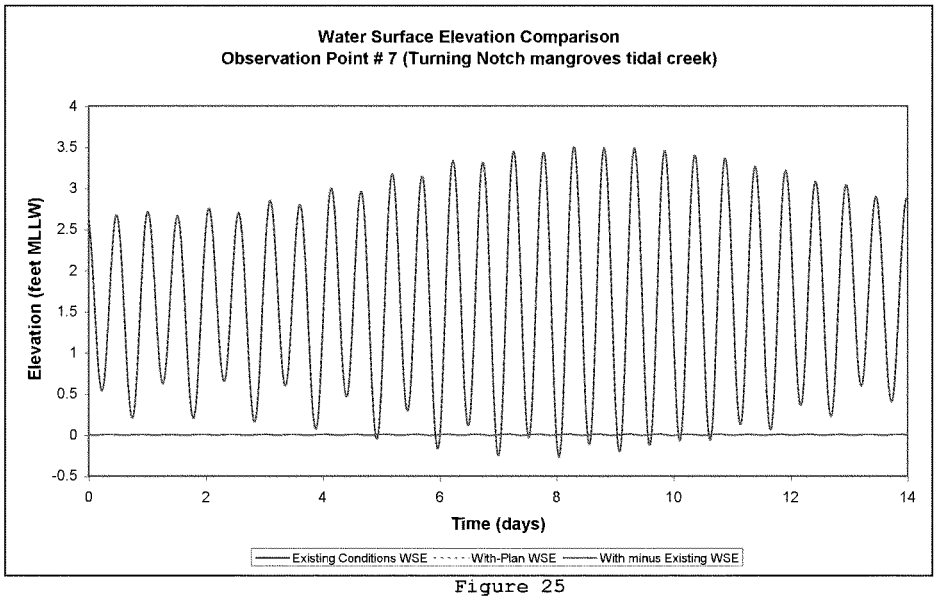

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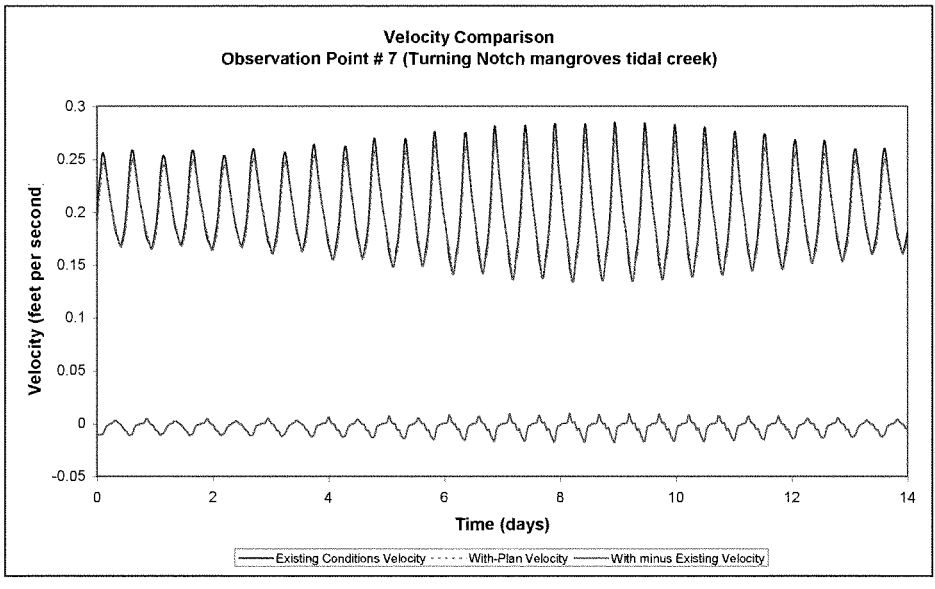

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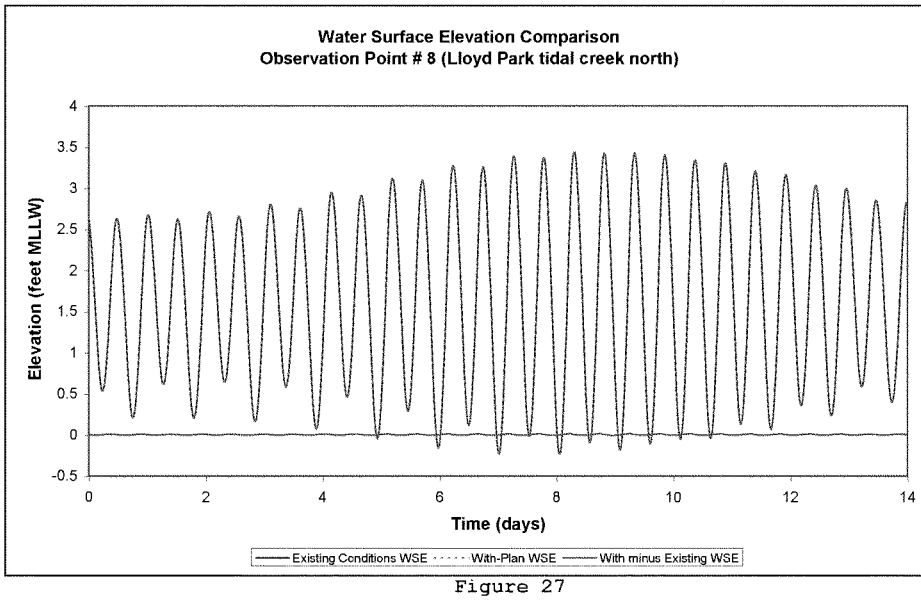

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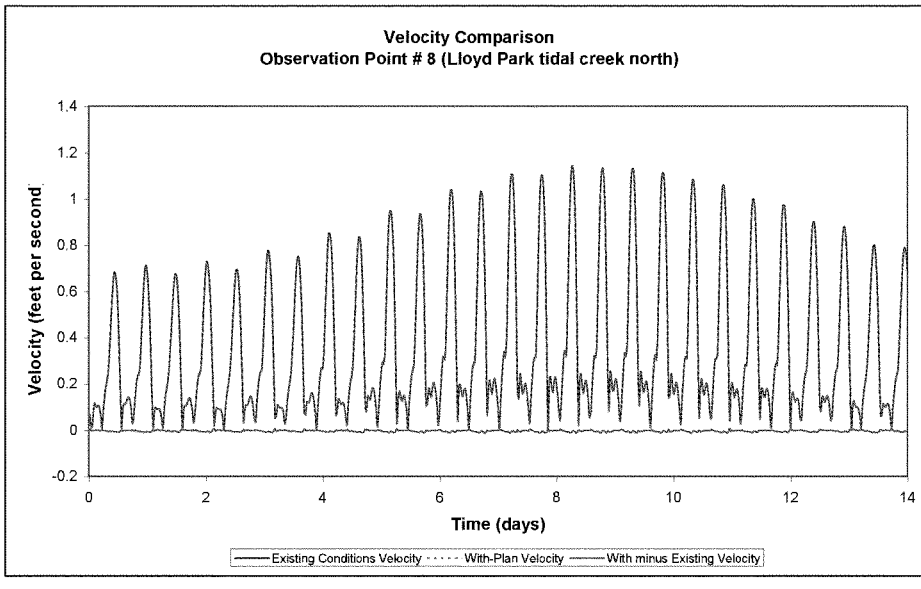

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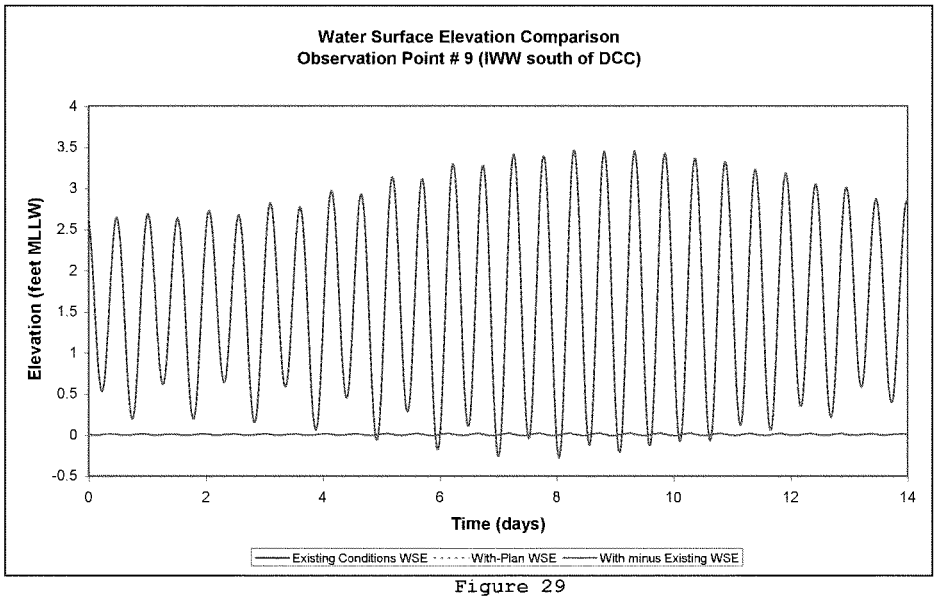

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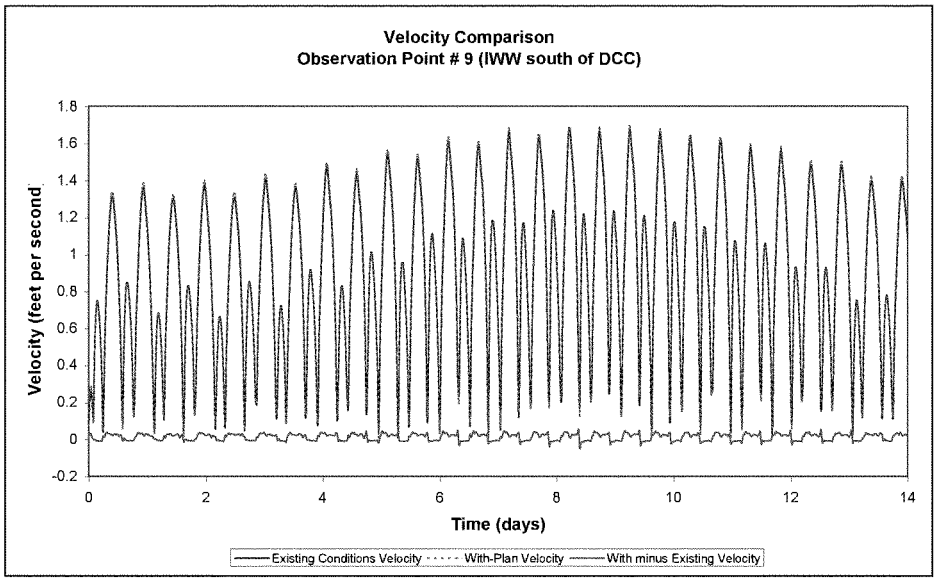

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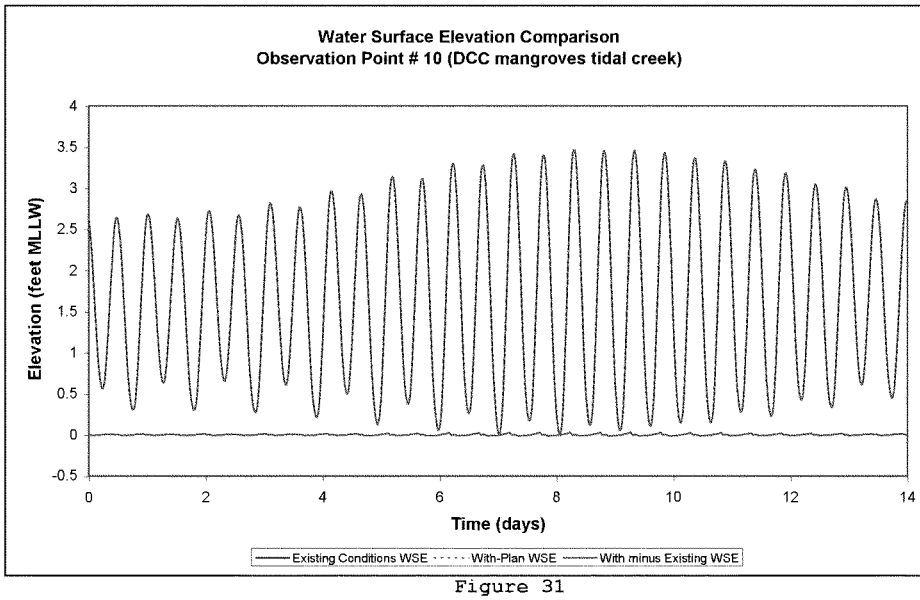

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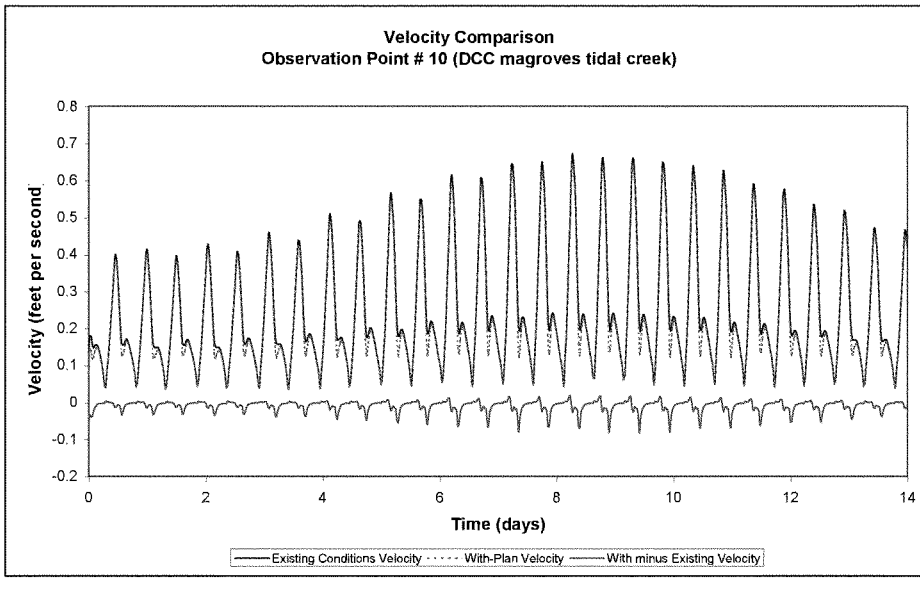

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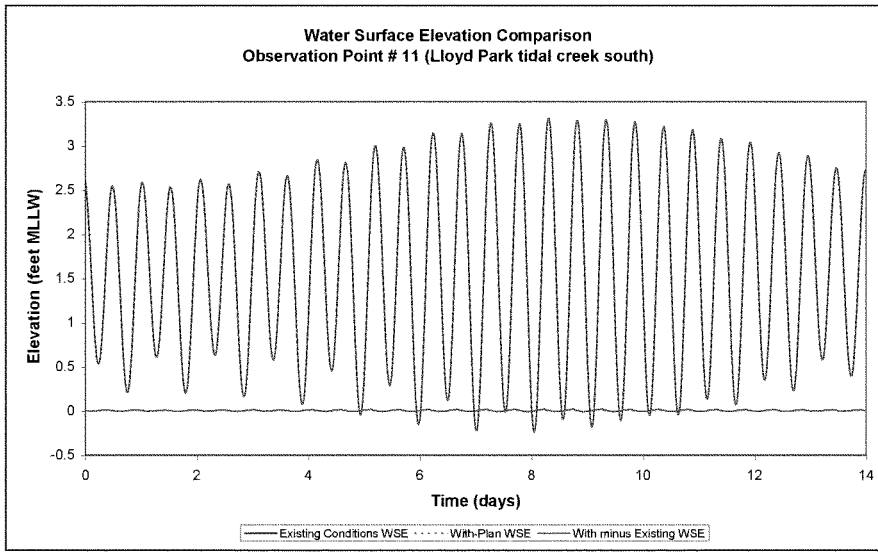

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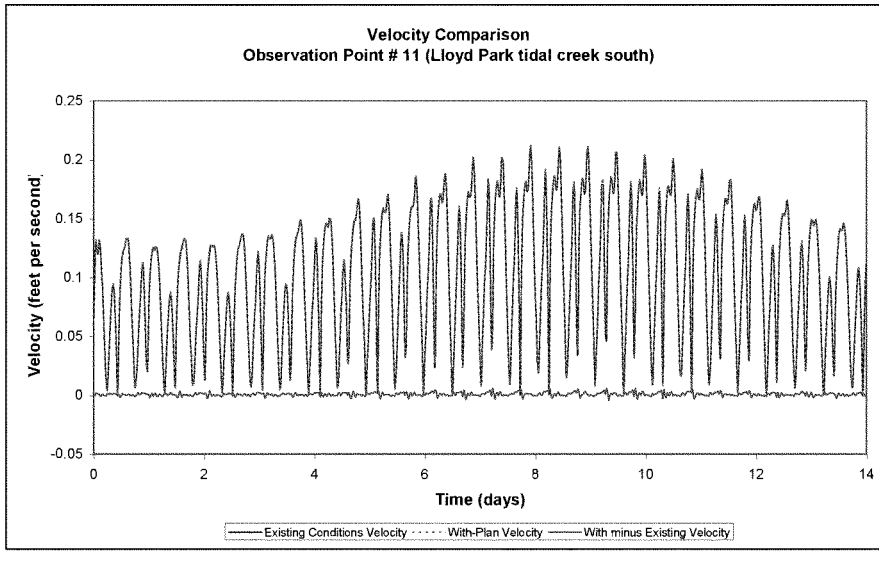

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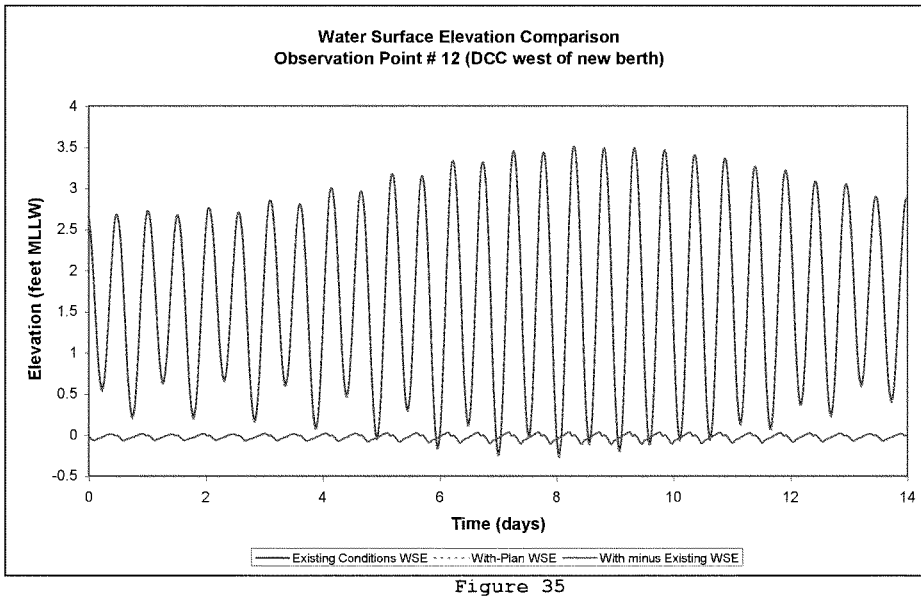

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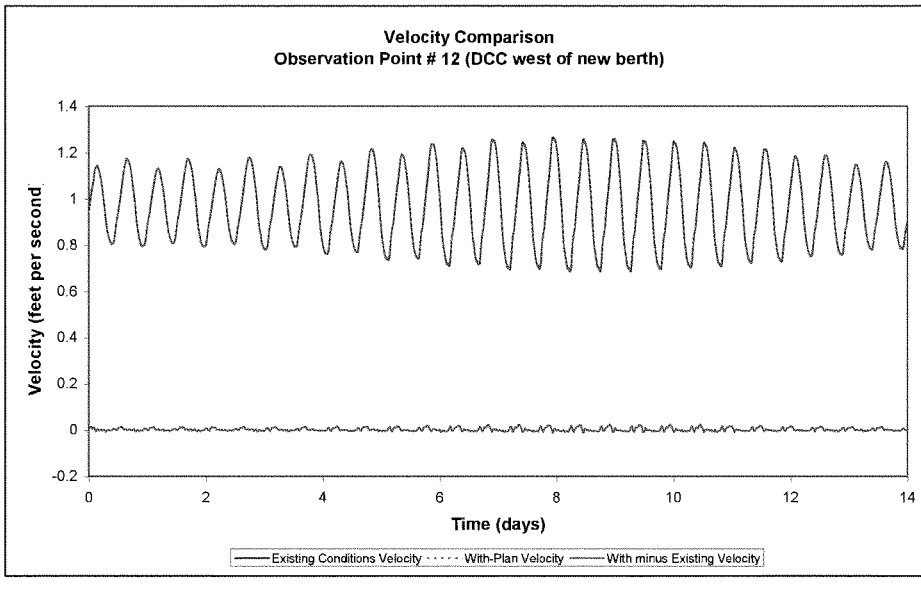

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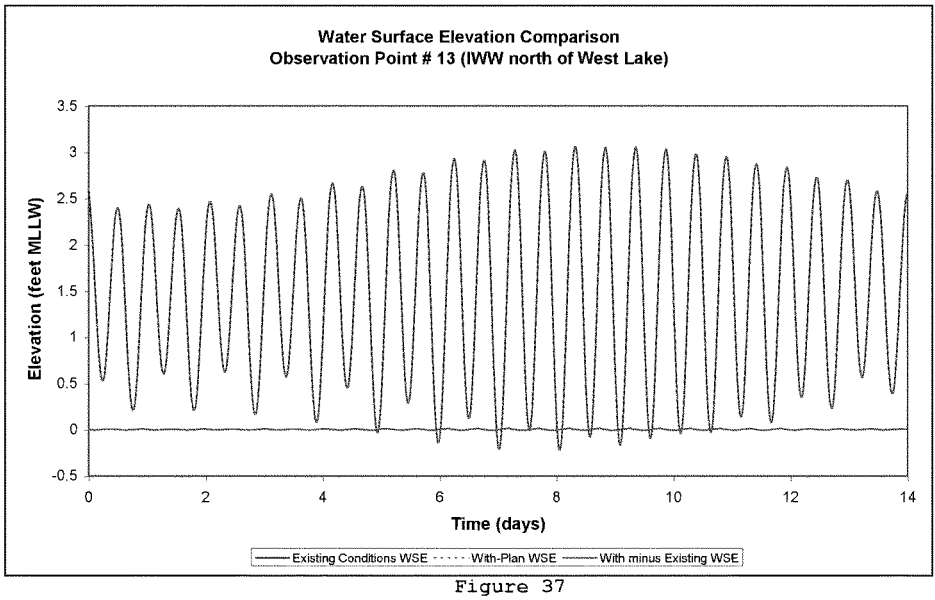

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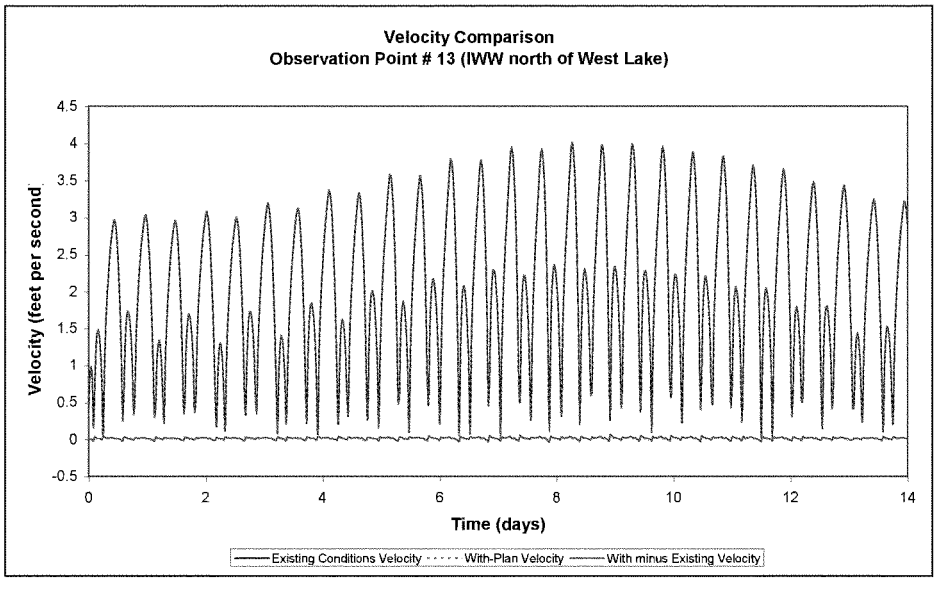

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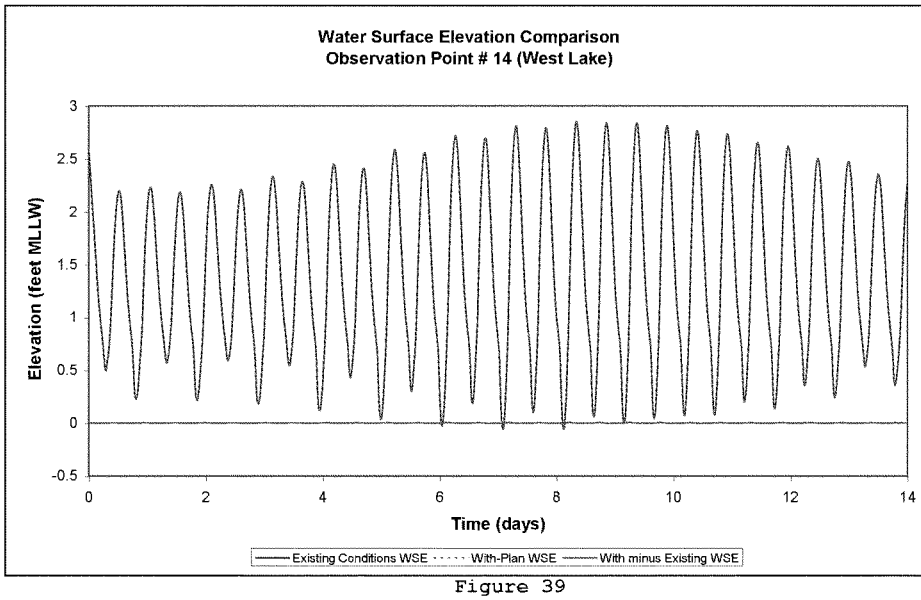

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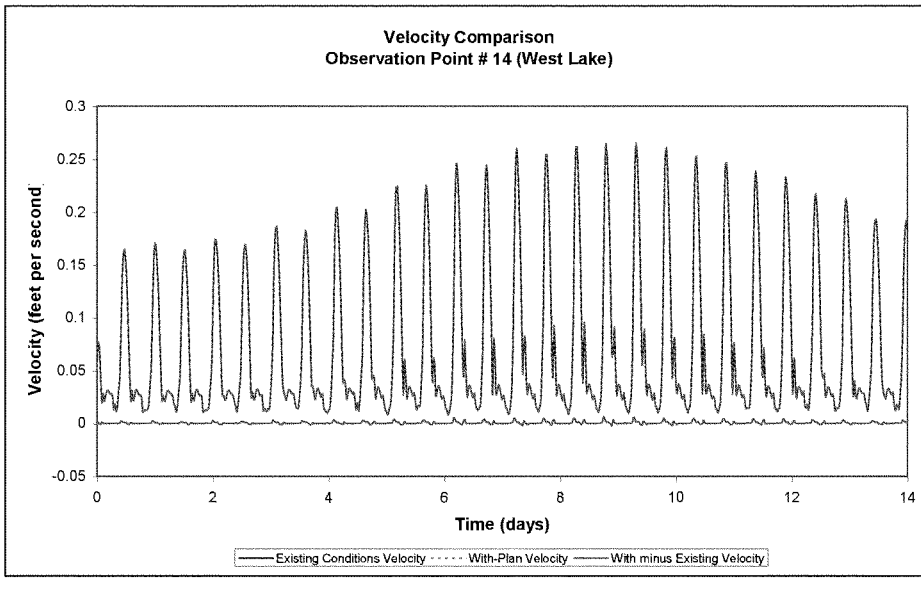

Figure 40

APPENDIX B

SOCIO-ECONOMICS

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

Executive Summary

Port Everglades is a port of national significance, located in heavily-populated southeast Florida. It is the 3rd busiest cruise port in the world, and 2nd in Florida for total tonnage. Port Everglades supplies southeast Florida with nearly all of its liquid petroleum products, such as gasoline, diesel, and jet fuel.

Currently there are navigational constraints, which cause vessel delays and loading inefficiencies. Particularly, there is a blockage of access to the Southport Access Channel for large containerships while large cruise ships occupy adjacent berth spaces. These problems will be exacerbated in the future as volume of cargo throughput and number of vessel calls increase.

The objectives of the project are to improve navigational conditions in the harbor. These improvements are expected to reduce congestion, improve navigational safety, accommodate recent and anticipated future growth in cargo and cruise vessel traffic, improve the efficiency of operations for cargo vessels and cruise ships within the Port complex, and allow for larger cargo vessels to use Port Everglades more efficiently through increased vessel loading.

This economic analysis examined widening and deepening. The HarborSym model was used to determine total transportation costs attributable to the study port. Transportation cost savings were determined based on the difference in total transportation costs between the with- and without-project conditions.

Based on the results of the transportation cost savings analysis, the National Economic Development (NED) plan is to widen and deepen to a project depth of 47 feet. The 48-foot alternative did result in higher net benefits by approximately $400,000, however in accordance with USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c which states "when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan" a corporate decision determined that 47 feet was the NED plan. The non-federal sponsor, Broward County, requested and was approved for a locally preferred plan (LPP) of 48-feet. Therefore, the Recommended Plan is the LPP which includes deepening the Federal channel to 48 feet. It provides average annual net benefits of $31,400,000 and has a benefit-cost ratio (BCR) of 2.90:1 at 3.375%.

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1 Introduction

The U.S. Army Corps of Engineers (USACE) Deep Draft Navigation Planning Center of Expertise (DDNPCX) has conducted an economic analysis to determine the feasibility of improvements to the Federal navigation project at Port Everglades Harbor (Port Everglades). Port Everglades is one of the largest multi-purpose cargo and cruise ports on the South Atlantic coast. Port Everglades is Florida's second largest cargo port in terms of total tonnage (Table 1) and the 31st ranked cargo port nationally[1]. Port Everglades is also the third busiest cruise port in the world, as measured by total annual multi-day passengers, with only 2% fewer passengers than the world's largest cruise port (Miami). In addition to supporting international tourism to South Florida, the Port helps to support South Florida's large year-round resident population, and many seasonal residents through the imports of manufactured goods and petroleum products.

Table 1. Port Everglades Rankings for Cargo Tonnage and Cruise Passenger Throughput

Calendar Year 2011 Total Cargo Tonnage (short tons)		
National Ranking	**Florida Port**	**Total Tonnage**
22	Tampa, FL	31,407,913
31	**Port Everglades, FL**	**20,955,921**
38	Jacksonville, FL	16,827,591
61	Miami, FL	7,177,761

Fiscal Year 2012 Multi-day Cruise Passengers		
World Ranking	**Port**	**Multi-day Cruise Passengers**
1	Miami, FL	3,774,452
2	Port Canaveral, FL	3,761,056
3	**Port Everglades, FL**	**3,689,022**

Sources: Tonnage data: AAPA statistics;
Passenger data: Port statistics and bizjournals.com
Notes: Fiscal Year 2012 = 01 Oct 11 through 30 Sep 12;
Passengers counted at embarkation and debarkation.

1.1 Background, Problems and Objectives

The last major improvements to the navigation channels at Port Everglades occurred in the 1980s[2]. Since that time, cargo and cruise traffic at the Port have increased substantially, resulting in increased

[1] More details are provided in Section 1.3 Port Everglades and the South Florida Economy.

[2] More details are provided in Section 3.1 Infrastructure.

congestion. Additionally the world fleet of cargo vessels has become larger than the existing channel dimensions[3] can accommodate, resulting in transportation cost inefficiencies. Potential channel improvements to increase efficiency of port operations include deepening and widening of navigational channels, and channel realignment at the port. The purpose of these potential improvements is to increase the efficiency of cargo vessel operations and to fully accommodate larger cruise ships and containerships, which are already calling at the port, and are projected to use the port increasingly in the future.

This economic analysis evaluated project alternatives that will:

1) reduce congestion,
2) improve navigational safety,
3) accommodate recent and anticipated future growth in cargo and cruise vessel traffic,
4) improve the efficiency of operations for cargo vessels and cruise ships within the Port complex, and
5) allow for larger cargo vessels to use Port Everglades more efficiently through increased vessel loading.

1.2 Location

Port Everglades is located on the southeast coast of Florida in Broward County in the cities of Hollywood, Dania Beach and Fort Lauderdale. The port is approximately 20 nautical miles north of Port Miami, 40 nautical miles south of the Port of Palm Beach, 144 nautical miles south of Port Canaveral, and 270 nautical miles south of Jacksonville Harbor (Figure 1).

Port Everglades lies on 2,190 acres within the urban, eastern section of Broward County (Figure 2). To the east of the Port is a barrier island that contains a U.S. Navy facility, the Nova Southeastern University (NSU) Oceanographic campus, U.S. Coast Guard (USCG) Station Ft. Lauderdale, and John U. Lloyd Beach State Park and adjacent beaches. The Atlantic Intracoastal Waterway runs in a generally north-south direction to the immediate east of the Port and west of the barrier island. The Port's southern boundary is the Dania Cutoff Canal, which is adjacent to an undeveloped coastal ecosystem known as West Lake Park. Immediately west of the Port is the Fort Lauderdale/Hollywood International Airport. North of the Port is a mixture of small craft waterways and commercial and residential development.

[3] More details on existing channel dimensions are provided in Section 3.1, Table 10.

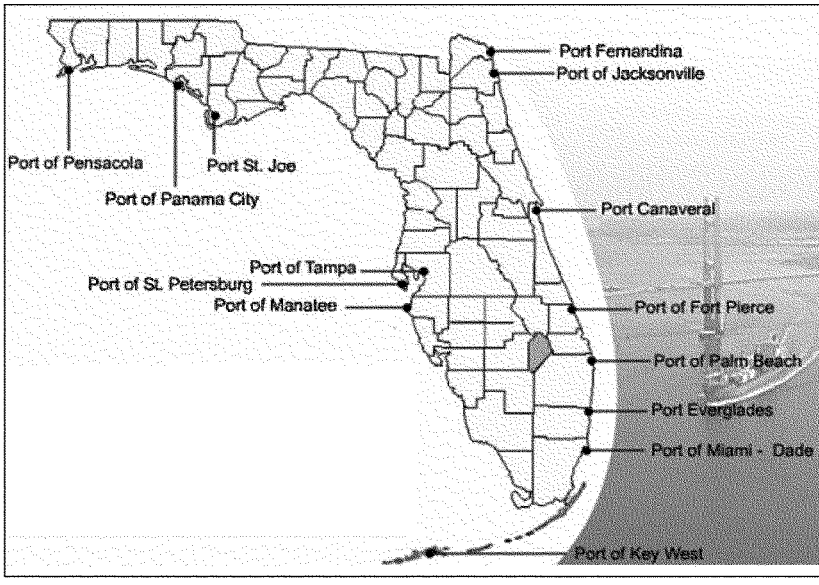

Figure 1. Florida Seaports

Source: *Florida Ports Council (http://www.flaports.org).* Notes: Not to scale. Locations are approximate.

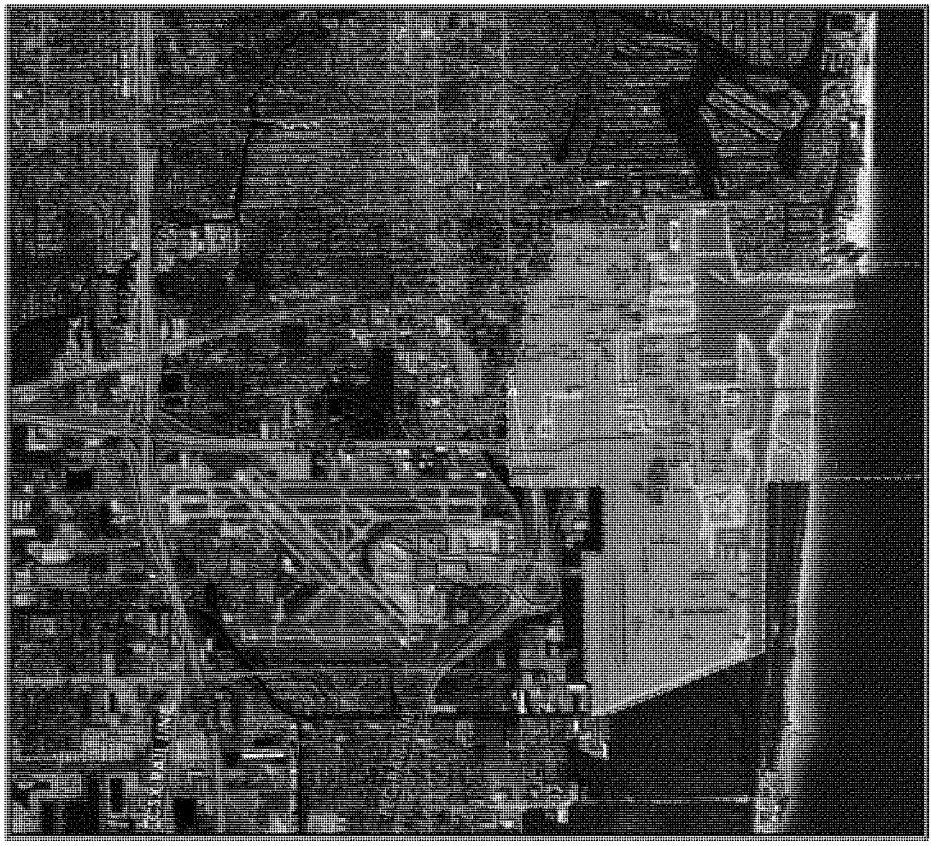

Figure 2. Port Everglades Boundary and Vicinity Map
Source: 2009 Port Everglades Master/Vision Plan

1.3 Port Everglades and the South Florida Economy

Port Everglades is a port of world, national, and regional significance. Port Everglades is the third largest cruise port in the world with only 2% fewer multi-day passengers (Table 1) than the world's largest cruise port (Miami). Port Everglades is the homeport for the world's largest cruise ships, Royal Caribbean International's Oasis Class (*Oasis of the Seas* and *Allure of the Seas*), with lengths of nearly 1,200 feet, passenger capacities of up to 6,300 and a crew of more than 2,000. In Fiscal Year (FY) 2012,

Port Everglades had 838 cruise ship calls (including ferry calls), including 199 calls by cruise ships longer than 1,000 feet, and 344 calls by Post-Panamax beam[4] cruise ships.

As a cargo port, Port Everglades is the second largest Florida port in terms of foreign trade tonnage and domestic trade tonnage (Table 2) and is the largest Florida Atlantic coast port in terms of total tonnage. Port Everglades supplies South Florida with nearly all of its liquid petroleum products (including gasoline, diesel, and jet fuel). In FY 2012, two-thirds of the Port's total cargo tonnage throughput was liquid petroleum (Figure 3).

Table 2. Florida Ports Cargo Tonnage Ranking in 2011

Total Trade		
National Ranking	**Port**	**Short Tons**
22	Tampa, FL	31,407,913
31	**Port Everglades, FL**	**20,955,921**
38	Jacksonville, FL	16,827,591
61	Miami, FL	7,177,761
Foreign Trade		
National Ranking	**Port**	**Short Tons**
32	Tampa, FL	10,451,809
33	**Port Everglades, FL**	**10,375,243**
34	Jacksonville, FL	10,002,705
39	Miami, FL	7,007,219
Domestic Trade		
National Ranking	**Port**	**Short Tons**
15	Tampa, FL	20,956,104
27	**Port Everglades, FL**	**10,580,678**
42	Jacksonville, FL	6,824,886
138	Miami, FL	170,542

Source: Waterborne Commerce Statistics Center

[4] Post-Panamax beam is defined as a beam greater than 106 ft; it is the limiting width of the existing Panama Canal locks.

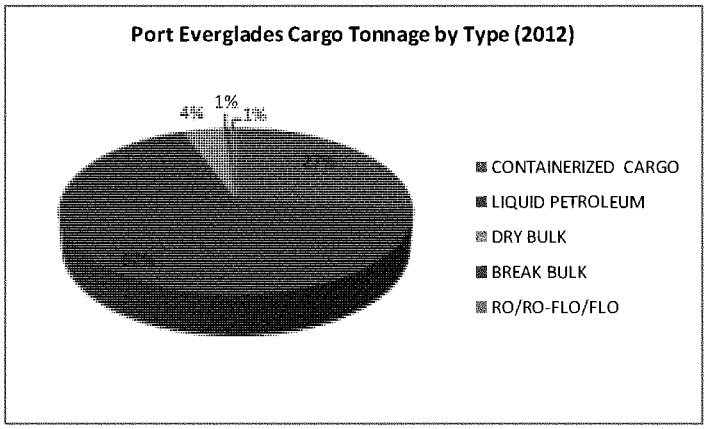

Figure 3. Port Everglades Cargo Tonnage by Type in 2012
Source: Port Everglades Waterborne Commerce Chart 2012

The value of foreign trade exports through Port Everglades in 2012 (nearly $14 billion) was greater than the foreign trade export value of any other Florida port (Table 3). Port Everglades also had the second highest total foreign trade value ($24.3 billion) of all Florida ports in calendar year 2012.

Table 3. Florida Ports Foreign Trade Value in 2012

	Imports	Exports	Total
Port Canaveral	$1,360,901,150	$180,096,311	$1,540,997,461
Port Everglades	**$10,366,436,078**	**$13,981,854,199**	**$24,348,290,277**
Fernandina	$10,987,347	$248,378,801	$259,366,148
Fort Pierce	$13,798,472	$89,244,282	$103,042,754
Jacksonville	$11,379,732,227	$11,713,827,070	$23,093,559,297
Manatee	$370,891,475	$181,823,787	$552,715,262
Miami	$13,456,899,892	$11,861,466,312	$25,318,366,204
Palm Beach	$552,526,002	$1,425,564,468	$1,978,090,470
Panama City	$2,689,495,868	$648,293,768	$3,337,789,636
Pensacola	$1,039,264	$208,732,670	$209,771,934
Tampa	$2,136,164,100	$2,660,699,978	$4,796,864,078

Note: Values are for calendar year 2012;
Source: The Five-Year Florida Seaport Mission Plan (2013 – 2017)

In addition, related port users throughout Florida generate substantial economic activity (Table 4). These include manufacturers and wholesale and retail distribution firms, which use Port Everglades but may also use other ports and therefore are not totally dependent on Port Everglades. These related port users generate:

- 173,300 related user jobs,
- $6.1 billion in personal income,

- $22.8 billion in business activity, and
- $0.57 billion state and local taxes.

Table 4. Port Everglades Regional Economic Impact

Jobs	Cargo	Cruise	Total
Direct	6,211	5,476	11,687
Induced	5,114	3,052	8,166
Indirect	4,392	3,855	8,247
Sub-total	**15,717**	**12,383**	**28,100**
Related Users	173,272	N/A	173,272
Total	**188,989**	**12,383**	**201,372**
Personal Income ($000's)	**Cargo**	**Cruise**	**Total**
Direct	$281,664	$164,173	$445,837
Induced	$632,673	$312,588	$945,261
Indirect	$205,505	$122,369	$327,874
Sub-total	**$1,119,842**	**$599,130**	**$1,718,972**
Related Users	$6,122,998	N/A	$6,122,998
Total	**$7,242,840**	**$599,130**	**$7,841,970**
Business Activity ($000's)	**Cargo**	**Cruise**	**Total**
Business Services	$1,022,151	$1,846,552	$2,868,703
Related User Output	$22,802,366	N/A	$22,802,366
Total	**$23,824,517**	**$1,846,552**	**$25,671,069**
Local Purchases ($000's)	Cargo	Cruise	Total
Local Purchases	$415,990	$170,480	$586,469
State & Local Taxes ($000's)	**Cargo**	**Cruise**	**Total**
Direct, Indirect & Induced	$104,145	$55,719	$159,864
Related User Taxes	$569,439	N/A	$569,439
Total	**$673,584**	**$55,719**	**$729,303**

Source: The Local and Regional Economic Impacts of Port Everglades – FY 2012 Final Report

1.4 Appendix Overview

The remaining sections of this appendix will guide the reader through the economic analysis of the project. By the end of Section 3, a complete picture of all existing conditions will be evident. Section 2 explores the study area and hinterland in more detail. In Section 3, the existing conditions and Port's infrastructure are described. Section 3 also provides more details on existing and historical commodity movements, vessel calls, and growth trends.

Once all of the existing conditions have been described, the appendix moves on to describe the details of future conditions in Section 4 though Section 9. First, in Section 4, Port infrastructure improvements that will be constructed with- or without the project are identified. Section 5 then focuses on the future commodity movements that are forecasted to transit through the Port in the with- and without-project conditions. Section 6 discusses the future without-project conditions, including vessel movements. Then, to address the problems described in the existing conditions and future without-project conditions, Section 7 depicts the project alternatives that were evaluated for their ability to meet the project objectives and provide quantifiable economic benefits from transportation cost savings. The general assumptions used throughout the with-project analysis are identified in Section 8. The results of

applying the commodity forecast to the fleet forecast are described in Section 9. By the end of Section 9, all future with- and without-project conditions have been explained.

The method for evaluation of alternatives and results of the analysis are detailed in Section 11 and Section 12, respectively. The final appendix sections discuss regional economic benefits, sensitivity and scenario analyses and summarize the report findings.

2 Study Area

In this section, the study area and hinterland are explored in more detail. While the footprint of the project is contained within Port Everglades Harbor, the surrounding area that will be most directly affected economically by the project includes a majority of South Florida, particularly Broward, Miami-Dade, and Palm Beach Counties. All Florida counties are shown labeled in Figure 4.

Figure 4. Florida Counties Map
Source: U.S. Census Bureau

2.1 Demographics

Population growth in the area has been rapid since 1950 (Table 5). This growth can be attributed to Florida's ideal climate and historically low property costs, warm climate, and abundant recreation opportunities. Over the last 60 years Broward County population increased from 83,933 in 1950 to 1,748,066 in 2010, an increase of over 2,000%. Due to a more established community, Miami-Dade County achieved less growth than Broward County, or the State as a whole. As seen in Table 5, Florida population grew over 500% in the 60-year span.

Population statistics for the past sixty years for the nine-county South Florida region are presented in Table 5. As a subset of Florida population, the summed total of these nine counties comprises a slowly increasing percentage share of the Florida state population over most of the period. Although the populations of the counties were increasing in absolute numbers from 1970-2000, their share of Florida's population did not change substantially over this period. However, from 2000 to 2010, the South Florida regional share of Florida state population increased to its highest percentage share ever at 40.6%.

Additionally, the proportional share of the population within the nine-county area has changed over the fifty-year period. Miami-Dade County's share of the nine-county population total population has declined from nearly 65% in 1950 to 43.5% in 2010. In contrast, Broward County's share of the regional total has nearly tripled over the sixty-year period (from 10.9% in 1950 to 30.5% in 2010). Palm Beach County's share of the nine-county population has increased by 50% over the last fifty years (from 15% in 1950 to 23% in 2010). While each county has seen an increase in its total population, the most rapid growth in population has been concentrated in Broward, Palm Beach, Martin, and Lee counties. These growth trends clearly illustrate that while Miami-Dade County still has the largest population, its share is declining as Broward and Palm Beach Counties to the north increase their regional share of population. The South Florida region continues to increase its share of State population by outpacing the State population growth rate.

South Florida is also home to the most ethnically diverse populations of the entire state. For the total population of Florida, approximately 17% classify themselves as African Americans while 22.5% classify their heritage as Hispanic or Latino (Table 6). In the nine-county South Florida region, the populations of Miami-Dade and Broward counties contained 49% of the Florida Latino population and 31% of the Florida African American population.

A pattern of median household income increasing with median age is exhibited across the three most populous counties in coastal South Florida (Miami-Dade, Broward, and Palm Beach). When median age is viewed at the county level (Figure 5), median age increases from Miami-Dade County to Broward County to Palm Beach County. Median household income also increases from Miami-Dade County northward (Figure 6). Palm Beach County has the highest median age and household income of the three counties. Miami-Dade County has the lowest median age and household income. Broward County has median ages and household incomes most similar to the national average.

Table 5. Historical Population Growth Statistics for Select South Florida Counties

Area	2010		2000		1990		1980		1970		1960		1950	
Florida	18,801,310		15,982,378		12,937,926		9,746,324		6,789,443		4,951,560		2,771,305	
	Population	%	Population	%	Population	%	Population	%	Population	%	Population	%	Population	%
Glades	12,884	0.2%	10,576	0.2%	7,591	0.2%	5,992	0.2%	3,669	0.1%	2,950	0.2%	2,199	0.3%
Hendry	39,140	0.7%	36,210	0.6%	25,773	0.6%	18,599	0.5%	11,859	0.5%	8,119	0.5%	6,051	0.8%
Lee	618,754	10.8%	440,888	7.7%	335,113	7.2%	205,266	5.7%	105,216	4.3%	54,539	3.3%	23,404	3.1%
Martin	146,318	2.6%	126,731	2.2%	100,900	2.2%	64,014	1.8%	28,035	1.1%	16,932	1.0%	7,807	1.0%
Miami-Dade	2,496,435	43.5%	2,253,362	39.3%	1,937,094	41.8%	1,625,781	45.2%	1,267,792	51.8%	935,047	57.2%	495,084	64.6%
Monroe	73,090	1.3%	79,589	1.4%	78,024	1.7%	63,188	1.8%	52,586	2.1%	47,921	2.9%	29,957	3.9%
Broward	1,748,066	30.5%	1,623,018	28.3%	1,255,488	27.1%	1,018,200	28.3%	620,100	25.3%	333,946	20.4%	83,933	10.9%
Okeechobee	39,996	0.7%	35,910	0.6%	29,627	0.6%	20,264	0.6%	11,233	0.5%	6,424	0.4%	3,454	0.5%
Palm Beach	1,320,134	23.0%	1,131,184	19.7%	863,518	18.6%	576,863	16.0%	348,753	14.2%	228,106	14.0%	114,688	15.0%
County SubTotal	6,494,817	40.6%	5,737,468	35.9%	4,633,128	35.8%	3,598,167	36.9%	2,449,243	36.1%	1,633,984	33.0%	766,577	27.7%

Source: U.S. Census Bureau

Table 6. Population Breakdown by Race and Ethnicity for Select South Florida Counties

County	White	African-American	Other	Total	Hispanic or Latino (of any race)
Florida	77.1%	17.0%	5.9%	100%	22.5%
Glades	72.4%	12.7%	14.9%	100%	21.1%
Hendry	62.1%	14.0%	23.9%	100%	49.2%
Lee	84.8%	9.1%	6.1%	100%	18.3%
Martin	88.6%	5.9%	5.5%	100%	12.2%
Miami-Dade	75.6%	19.9%	4.5%	100%	65.0%
Monroe	91.1%	6.3%	2.6%	100%	20.6%
Okeechobee	79.2%	8.6%	12.2%	100%	23.9%
Palm Beach	75.2%	18.3%	6.5%	100%	19.0%
Broward	65.1%	28.2%	6.7%	100%	25.1%

Source: U.S. Census Bureau, 2010

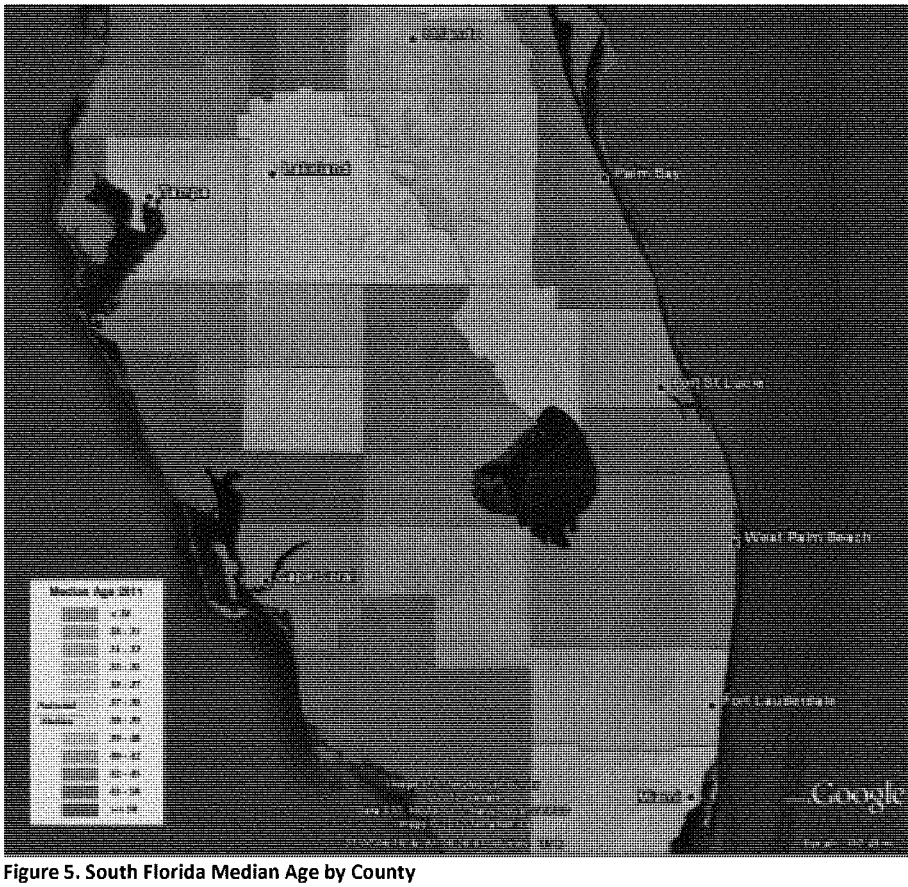

Figure 5. South Florida Median Age by County
Source: The Nielsen Company, 2011

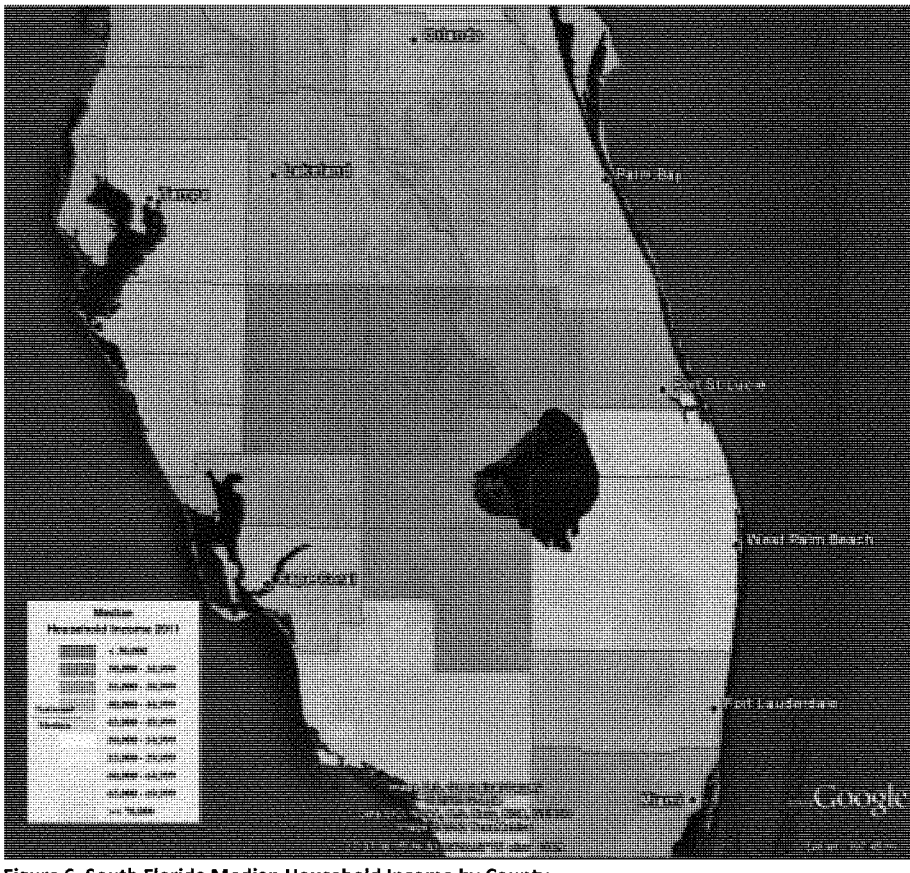

Figure 6. South Florida Median Household Income by County
Source: The Nielsen Company, 2011

In the future, Florida population is projected to grow a slower rate than historical. Population projections (Table 7) for Port Everglades' primary hinterland indicate a slow, but steady growth through 2040 exhibiting a thirty-year compound annual growth rate (CAGR) of 0.88%.

Table 7. Port Everglades Primary Hinterland Population Projections (2010-2040)

	Census 2010	Projections 2015	2020	2025	2030	2035	2040
Florida	18,801,310	19,664,972	21,021,643	22,329,543	23,567,010	24,730,724	25,846,980
Broward	1,748,066	1,775,264	1,816,224	1,853,626	1,886,564	1,915,231	1,946,355
Charlotte	159,978	164,784	173,129	181,028	188,302	194,940	201,123
Collier	321,520	341,959	375,585	408,254	439,367	468,770	497,011
Desoto	34,862	35,460	36,709	37,924	39,094	40,214	41,300
Glades	12,884	13,286	14,135	14,953	15,723	16,442	17,127
Hendry	39,140	38,488	39,615	40,665	41,620	42,484	43,279
Indian River	138,028	145,613	158,501	170,931	182,584	193,592	204,134
Lee	618,754	674,992	763,232	847,963	928,484	1,004,503	1,077,279
Martin	146,318	151,590	160,897	169,792	178,093	185,773	193,017
Miami-Dade	2,496,435	2,591,790	2,717,631	2,840,533	2,959,348	3,071,498	3,179,748
Monroe	73,090	72,074	70,863	69,702	68,624	67,633	66,700
Okeechobee	39,996	40,887	42,548	44,133	45,577	46,879	48,157
Palm Beach	1,320,134	1,372,682	1,461,234	1,546,129	1,625,651	1,699,536	1,769,470
Sarasota	379,448	394,783	420,152	444,483	467,286	488,487	508,564
Hinterland Sub-total	7,528,653	7,813,652	8,250,455	8,670,116	9,066,317	9,435,982	9,793,264
5-year CAGR		0.75%	1.09%	1.00%	0.90%	0.80%	0.75%

Source: University of Florida, Bureau of Economic and Business Research, 2013

2.2 Hinterland

The hinterland for the Port is defined by the land transportation costs relative to other ports with similar facilities and services. For refined liquid petroleum products, such as gasoline, diesel, fuel oil and jet fuel, Port Everglades is the primary port of entry for nearly all (over 95%) of these products consumed in south Florida counties (Miami-Dade, Broward, Palm Beach, and Martin) that move via water.

Port Everglades' primary hinterland for containerized cargo includes all of south Florida, where the Port competes with other Florida ports in terms of over-the-road freight costs (Figure 7). As shown (in yellow) Port Everglades offers the least cost truck routing to serve the counties surrounding Lake Okeechobee, and overlaps with Port Miami for both Broward and Miami-Dade Counties (shown in orange). Port Everglades' least-cost truck routing also overlaps with the Port of Tampa in Lee County (shown in orange). The Port of Tampa has the pure truck cost advantage to serve the Tampa and Orlando markets (shown in purple), which is due to the amount of distribution centers along the I-4 Corridor. Additionally, for some cargo destined for or originating from the west and east coasts of South America, Central America, and the Caribbean, for which Port Everglades is the only Southeastern U.S. port on the service, the Port's hinterland can include farther reaching areas of the Southeastern U.S. than shown in Figure 7.

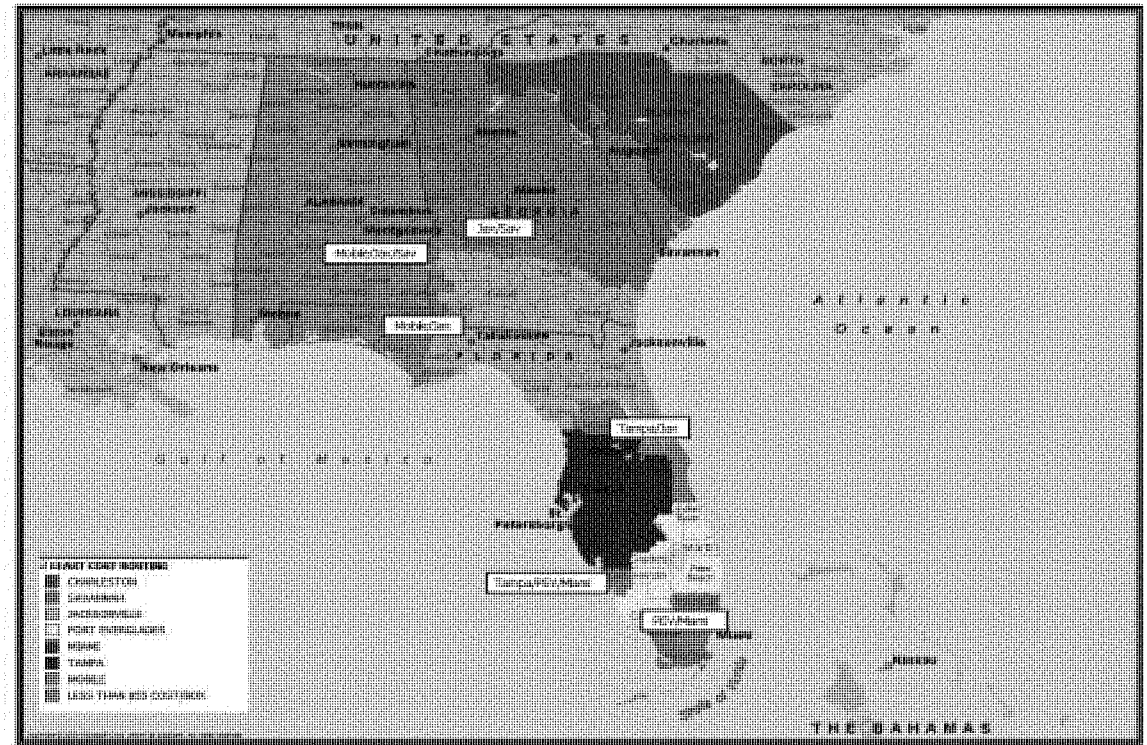

Figure 7. Truck Cost-Effective Hinterland Excluding Rail Competition

Source: Port Everglades Master Plan – Element 2: Market Assessment, 2009

2.2.1 Multi-port Analysis

The closest major ports to Port Everglades are Port of Palm Beach to the north and Port Miami to the south (Figure 1). Further to the north, the next major ports after Palm Beach are Port Canaveral and Jacksonville. Figure 8, below, shows that the Port Everglades is in close proximity to large, deep-draft ports, but Port Everglades has much greater cargo throughput than Miami to the south, and Port of Palm Beach and Port Canaveral to the north. Port Canaveral and Jacksonville generally move similar cargo types as Port Everglades but their hinterlands do not overlap substantially enough to compete for traffic. Port of Palm Beach is more of a niche port with regard to its cargo and vessel types, which means that its cargo does not normally compete directly with other nearby ports. Therefore, growth at the Port of Palm Beach will not affect growth in Port Everglades, which shares the same hinterland. The Port of Miami has significant overlap in hinterland with Port Everglades but its cargo throughput is much less than Port Everglades. This is mainly due to the fact that Port Everglades has facilities for movements of substantial quantities dry bulk and liquid bulk, while Miami does not. Therefore, Port Miami does not compete with Port Everglades for its dry bulk (cement and aggregate) and liquid bulk (refined petroleum products) cargo throughput (due to lack of facilities for these cargo types at this time).

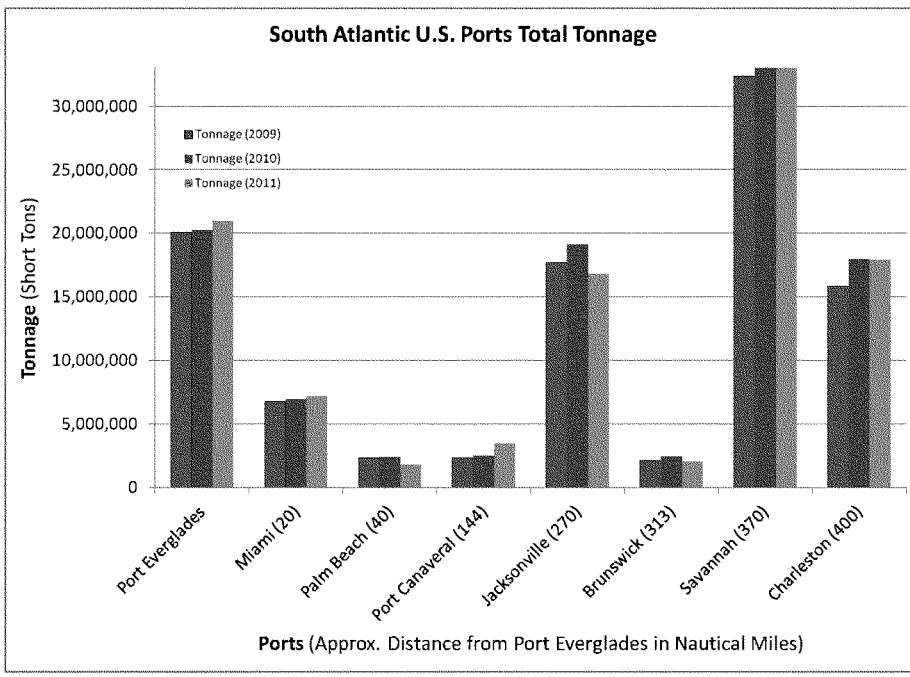

Figure 8. Comparison of South Atlantic U.S. Ports Total Tonnage
Source: USACE, Waterborne Commerce Statistics Center

2.3 Support of Local, State, and National Economy

Generally, tourism, strong wholesale and retail trade, government and service sectors characterize Florida's economy. Florida's warm weather and extensive coastline attracts vacationers and other visitors and helps make the state a significant retirement destination for people all over the country. Agricultural production is also an important sector of the state's economy. Compared to the national economy, the manufacturing sector has played less of a role in Florida, but high technology manufacturing has begun to emerge as a significant sector in the State over the last decade.

Of the nine counties shown in Table 8, the three largest, Broward, Miami-Dade and Palm Beach employ approximately 35% of Florida's work force and account for approximately 33% of state income. Table 9 indicates the importance of relatively low paying employment in the three counties of greatest economic impact. The results coincide with state averages across employment sectors and reflect the relative importance of industries related to tourism (retail, food service), the aged populations of South Florida (health care) and the growth experienced in Florida (construction).

Table 8. Employment as a Percentage of State Employment for Select South Florida Counties

County	Number of Wage & Salary Employees	Annual Wage & Salary Disbursements ($1,000)	Employee Percentage	Annual Salary Percentage
Florida	7,632,084	323,659,342	100%	100%
Glades	1,938	66,153	0.03%	0.02%
Hendry	14,224	418,654	0.19%	0.13%
Lee	208,538	8,238,828	2.73%	2.55%
Martin	59,631	2,378,068	0.78%	0.73%
Miami-Dade	1,038,010	48,445,712	13.60%	14.97%
Monroe	37,959	1,513,204	0.50%	0.47%
Okeechobee	11,016	364,625	0.14%	0.11%
Palm Beach	542,388	25,182,540	7.11%	7.78%
Broward	745,587	33,403,592	9.77%	10.32%
Select Counties Subtotal	2,659,291	120,011,376	35%	37%

Source: U.S. Bureau of Economic Analysis, 2010

Table 9. Employment by Industry for Three Major South Florida Counties

Industry	Broward County	Miami-Dade County	Palm Beach County	Three-County Total	Percentage of Employment by Industry
Health Care & Education	171,463	217,787	123,750	513,000	21%
Retail Trade	112,360	130,845	81,326	324,531	13%
Professional & Administration	108,344	134,619	81,209	324,172	13%
Food Service & Hospitality	86,607	112,057	63,721	262,385	11%
Construction	49,957	74,255	39,760	163,972	7%
Manufacturing	40,905	54,937	22,709	118,551	5%
Major Industry Sub-Total	398,173	506,713	288,725	1,193,611	48%
Total	826,452	1,075,625	577,572	2,479,649	100%

Source: U.S. Bureau of Economic Analysis, 2010

In 2010, the Miami-Fort Lauderdale-Pompano Beach Metropolitan Statistical Area (MSA) accounted for nearly 36% of Florida state real GSP (gross state product). The contributions to Gross Metropolitan Product (GMP) by industry are shown in Figure 9. The real estate industry is the largest contributor, followed by government expenditures and wholesale trade. Other large contributors include finance and insurance industry, retail trade, professional and technical services, and health care and social assistance.

The cruise industry and associated tourism supported by Port Everglades also contributes heavily to the local economy. Broward County accommodates visitors to the region by offering quality tourism infrastructure, comprised of airports, hotels, retail venues, and other entertainment facilities, all within close proximity to Port Everglades via major roadways.

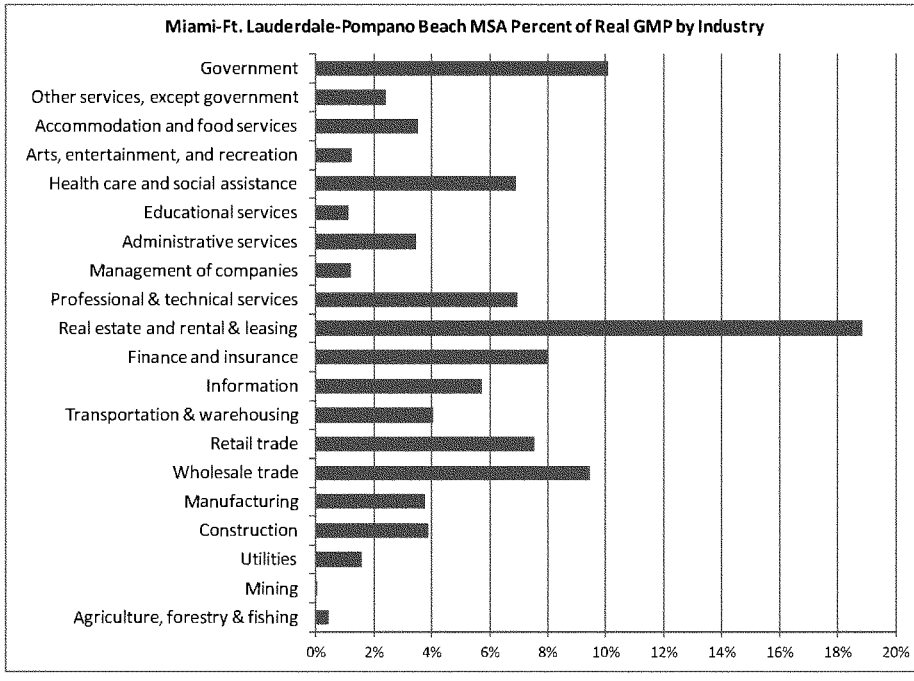

Figure 9. Miami-Ft. Lauderdale-Pompano Beach MSA Percent of Real GMP by Industry, 2010
Notes: MSA = Metropolitan Statistical Area; GMP = Gross Metropolitan Product
Source: U.S. Bureau of Economic Analysis, 2010.

3 Existing Conditions at Port

The purpose of this section is to define how the Port currently functions in serving its hinterland. Particularly, Section 3 conveys how the Port operates to serve demand for freight transport. The section will cover specifics on the Port's infrastructure, transportation networks, cargo types and volumes, and vessels types and number of calls.

3.1 Infrastructure

The current Federal Navigation Project dimensions listed in Table 10 incorporate the most recent Federal and non-Federal improvements. The Federal improvements of the 1970s include modifications to the Outer Entrance Channel (OEC), Inner Entrance Channel (IEC), Main Turning Basin (MTB), and South Turning Basin (STB). The non-federal improvements of the 1980s and 1990s include modifications to the Southport Access Channel (SAC) and the Turning Notch (TN). WRDA 1992 (PL 102-580) Title I, Section 101(9) authorized Federal maintenance of the locally constructed SAC and TN. WRDA 2000 (PL 106-541) Section 515 authorized Federal reimbursement of $15,003,000 to Broward County for the local construction of the SAC and the TN (Figure 10).

Table 10. Existing Federal and Non-Federal Project Dimensions

Existing Port Components	Authorized and Maintained Nominal Depth in feet MLLW[1]	Authorized and Maintained Nominal Width in feet
Outer Entrance Channel (OEC)	45	500
Inner Entrance Channel (IEC)	42	450
Main Turning Basin (MTB)	42	Varies[2]
North Turning Basin (NTB)	31	Varies[3]
South Turning Basin (STB)	31, 36, 37[4]	1,000 X 1,100
Southport Access Channel (SAC)	42	400
Turning Notch (TN)	42	750 X 1,000
Non-Federal Project Features	**Constructed and Maintained Nominal Depth in feet MLLW**	**Constructed and Maintained Nominal Width in feet**
Dania Cut-off Canal (DCC) from SAC to Port Dania	15	Varies (about 100 feet)

[1] *MLLW: Mean Lower Low Water: A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. (NOAA).*

[2] *Basin is irregular shaped that varies in width 800 to 1,100 feet, see* Figure 10.

[3] *Basin is irregular shaped. North to South length is 1,200 feet, north side is 500 feet and extends 800 feet on south side. See* Figure 10.

[4] *Variable depths by location. See* Figure 10.

Figure 10. Existing Channel Components

Port Everglades is divided into three port terminal areas: Northport, Midport, and Southport (Figure 11). General land use of the port is shown in Figure 12. The Northport terminal area serves multiple cargoes and vessel types, including cruise operations, liquid bulk unloading (and occasionally loading), small container vessels, general cargo, roll-on/roll-off ("RO/RO") cargo, float-on/ float-off cargo (yachts and other vessels), military berthing, and lay-berth areas. The Northport terminal area includes 22 acres, which are available for container handling operations.

The Midport terminal area serves cruise ships, containerships up to Panamax size, bulk vessels, lift-on/lift-off ("LO/LO") cargo, RO/RO cargo, naval ships, harbor tugboats, and smaller lay-in vessels. One Panamax size gantry crane and a mobile harbor crane are available at berth 16. The Midport terminal area includes 28 acres, which are available for container handling operations. The world's largest cruise ships currently use the Midport terminal area. Large vessels berthed at berths 24 – 29 cause congestion at the port due to "no by-passing" rules observed by the port pilots. Large cruise ships and Post-Panamax container ships may not bypass cruise ships moored at berths 24 – 29. Under both existing and without-project future conditions, the existing scheduling rule of "last-in, first-out" is in effect meaning that a cruise ship scheduled to arrive at berth 29 must arrive before other cruise ships arrive at berths 24 – 27. Also a cruise ship scheduled to depart from berth 29 cannot depart until after the cruise ships moored at berths 24 – 27 have departed.

The Southport terminal area is dedicated to cargo traffic and maintains both lo/lo and ro/ro operations. The Southport terminal area has 235 acres of open yard facilities for container-port operations and includes seven ship-to-shore gantry cranes capable of servicing Panamax-size containerships. These cranes are mounted on a rail which extends from Berth 30 at the Turning Notch to Berth 33 just north of the Dania Cutoff Canal.

The Port has an excellent intermodal transportation network that is undergoing major improvements. The Port Everglades Expressway (Interstate 595) runs directly to the Port (Figure 13), linking the port with Interstate 95 (2.9 miles away), the Florida Turnpike (6 miles away) and Interstate 75 (12 miles away). US Route 1 runs along the western border of the port. The port is also served by the Florida East Coast Railway, which connects directly with the national freight networks of CSX and Norfolk Southern in Jacksonville. The Port's new (completed in 2014) 42.5-acre near-dock intermodal container transfer facility (ICTF) includes 21,000 linear feet of track with the capability of marshalling multiple double stack trains simultaneously. The near-dock ICTF has the capability of processing foreign and domestic cargo. The Florida East Coast Railway projects that the ICTF will transport 110,000 international TEUs (twenty-foot equivalent units) and 55,000 domestic TEUs per year by 2021[5].

[5] See Section 4.1 Intermodal Container Transfer Facility for more information on the ICTF.

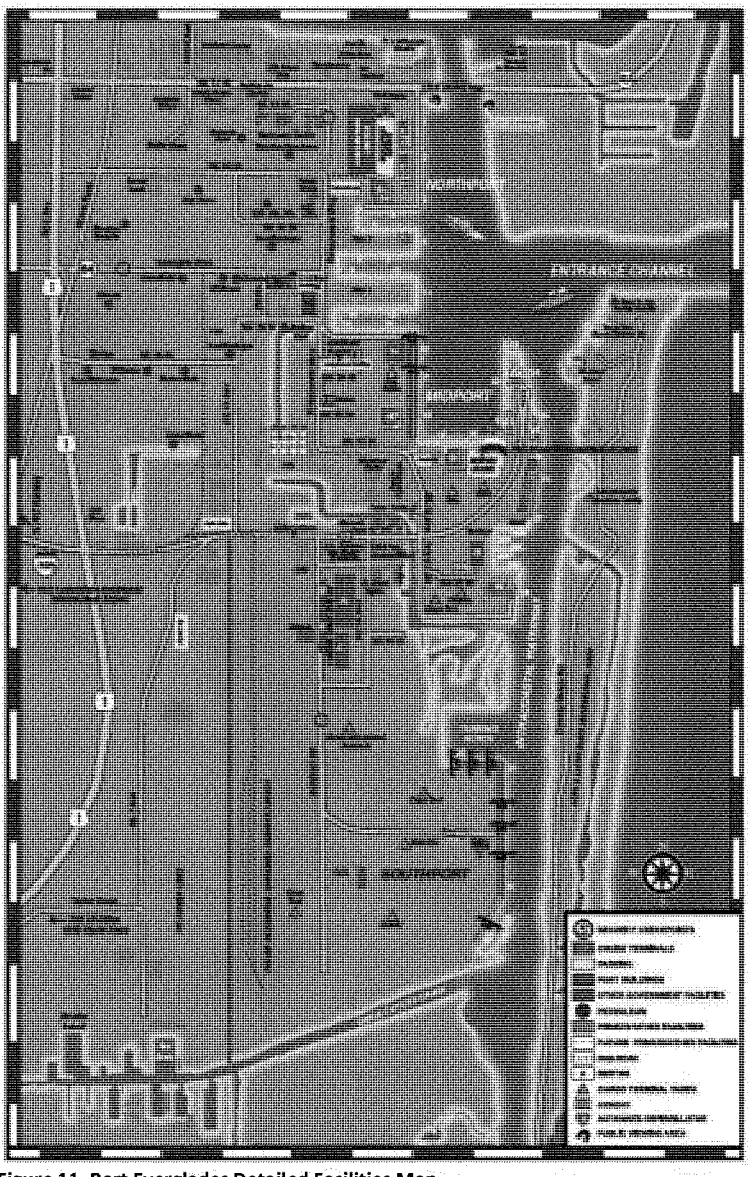

Figure 11. Port Everglades Detailed Facilities Map
Source: Port Everglades' Website: http://www.porteverglades.net/includes/media/docs/Port-Map-2009.pdf

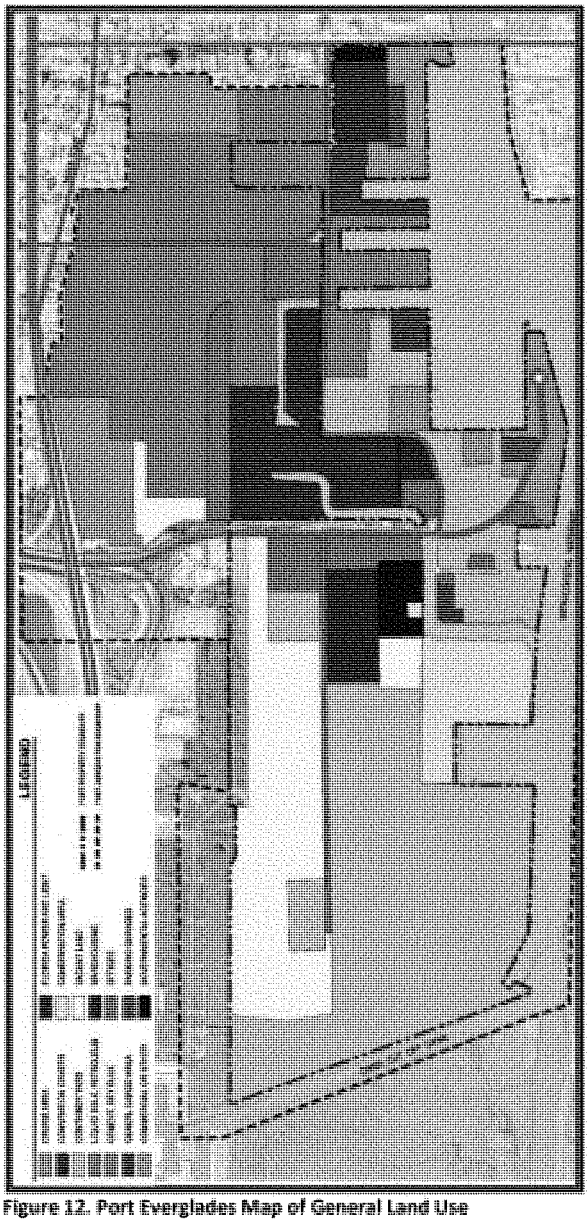

Figure 12. Port Everglades Map of General Land Use
Source: 2009 Port Master Plan

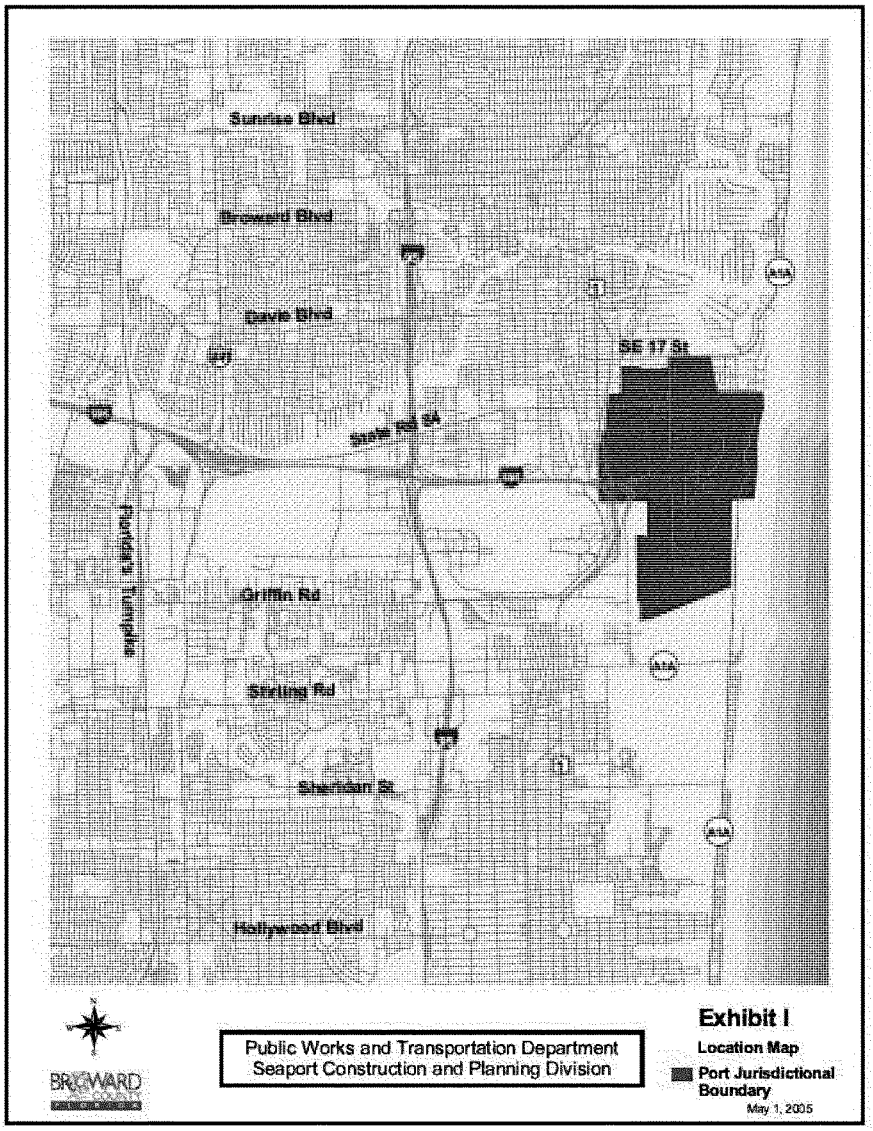

Figure 13. Port Jurisdictional Boundary and Road Connections
Source: Broward County Public Works and Transportation Department

3.2 Commodities and Cargo

Port Everglades handles a wide variety of cargo and vessel types. Port Everglades is one of the world's largest cruise ports and is one of the southeastern US's major cargo ports. The Port's total cruise passengers and waterborne commerce by type are shown in Table 11.

Table 11. Port Everglades Cruise Passengers and Total Tonnage by Type (FY2012)

Total Cruise Passengers	**3,757,320**
Single-day	68,298
Multi-day	3,689,022
Total Containerized Cargo Tonnage	**5,944,513**
TEUs Loaded	655,046
TEUs Total	923,600
Total Petroleum Tonnage	**14,830,384**
Total Bulk Tonnage	**973,191**
Bulk Cement	613,051
Other Dry Bulk	346,976
Liquid Bulk (non-petroleum)	13,164
Total Break Bulk Tonnage	**120,812**
Steel/Coil/Rebar	53,055
Other Break Bulk	67,757
Total Vehicles and Yachts	**166,237**
Total Waterborne Commerce Tonnage	**22,116,275**

Source: Port Everglades Commerce Report FY2012
Notes: Short tons. Cruise Passengers are counted at embarkation and debarkation.

For containerized cargo, Port Everglades handles the largest share (28%) of South and Central American-Caribbean regional[6] cargo (558,032 loaded TEUs in FY2012) as compared to all other southeastern US ports, including Jacksonville, Palm Beach, Miami, Savannah, and Charleston (**Table 12**). However, the Port's total containerized cargo throughput is similar to that of both Jacksonville and Miami (**Table 13**).

For containerized cargo, the top five imports transported through the port were miscellaneous fruits, bananas, vegetables, apparel, and menswear. These imports are driven by consumption by the population or the demand for a product within the hinterland that Port Everglades serves. The top five exports include grocery products, general cargo, paper and paper board, automobiles, and auto parts.

[6] South and Central American-Caribbean regional cargo refers to international trade with nation in the Caribbean, Central America, east coast of South America, north coast of South America, and the west coast of South America

Table 12. South and Central American and Caribbean Regional TEUs

Port	Regional TEUs	% Regional TEUs
Charleston	130,030	7%
Jacksonville	518,069	26%
Miami	426,213	22%
Port Everglades	**558,032**	**28%**
Savannah	175,282	9%
Palm Beach	162,328	8%
Total	1,969,954	100%

Source: Port Everglades Commerce Report 2012
Note: Loaded Import and Export (FY2012)

Table 13. Port Everglades' Share of South Atlantic US Port Containerized Cargo

	Charleston	Jacksonville	Miami	Port Everglades	Savannah	Palm Beach	Total	% Port Everglades
Caribbean	4,114	424,642	154,494	160,295	23,022	160,024	926,591	17.3%
Central America	17,286	4,368	186,029	**251,443**	39,333	50	498,509	50.4%
East Coast of South America	51,321	51,690	16,902	34,607	60,026	43	214,589	16.1%
Mediterranean	35,080	929	957	46,330	194,429	47	277,772	16.7%
Middle East	162,329	5,084	7,059	10,845	242,926	-	428,243	2.5%
North Coast of South America	17,410	30,701	41,212	**62,935**	18,427	2,195	172,880	36.4%
North Europe	435,916	16,080	60,622	17,423	210,341	55	740,437	2.4%
North Far East	301,940	94,689	182,599	22,569	1,037,190	32	1,639,019	1.4%
Other	42,498	5,599	4,812	8,800	142,542	10,181	214,432	4.1%
Southeast Asia	63,473	27,638	29,263	5,444	216,994	-	342,812	1.6%
West Coast of South America	39,898	6,668	27,577	**48,753**	34,473	16	157,385	31.0%
Total	1,171,265	668,088	711,526	669,444	2,219,703	172,643	5,612,669	11.9%
% of Total	21%	12%	13%	12%	40%	3%		

Source: Port Everglades Commerce Report 2012
Note: Loaded Import and Export TEUs (FY2012)

3.3 Vessel Traffic

Port Everglades has a large volume of vessel traffic each year. The Port is homeport to the largest cruise ships in the world and Post Panamax container vessels call on the harbor while servicing the U.S. east coast. The Port also receives Panamax petroleum product tankers and Panamax dry bulk carriers. Each of these operations, including: cruise, containerized cargo, petroleum, and dry bulk operates in a constrained manner at the Port due to the existing dimensions of the Federal navigation channel. The port operates according to a complex set of rules that attempt to minimize the effects of congestion on

the efficient arrival and departure of vessels. Table 14 shows the vessel calls in Fiscal Year 2012 by vessel type. Table 15 shows the percent of vessel movements in each draft range. Due to underkeel clearance requirements, all vessels sailing at 39 ft are the deepest permissible without using tide (in CY2012, 62 transits were greater than 39 feet including two transits at a 42 foot depth). Vessels sailing at greater than 39 ft draft are required to sail at high tide. Vessel movements in the 36 ft to 38 ft sailing draft range may be light-loaded to prevent them from having to wait for tide.

Table 14. Port Everglades Vessel Calls (FY2012)

Total Ship Calls	4,000
Cruise ships	838
Containerships	1,867
Cargo Ships	194
Petroleum Tankers/Barges	618
Navy/USCG	16
Other (Bunkers/Tugs)	467

Source: Port Everglades Commerce Report FY2012

Table 15. Port Everglades Movements by Draft (2011)

Draft Range (ft)	Percent of Movements
0-14	32.6%
15-29	49.0%
30-35	13.6%
36-38	3.5%
>=39	1.3%

Source: Waterborne Commerce Statistics Center

Note: Movements are counted inbound, outbound, and intra-port. Typically, a vessel call will consist of two movements, one inbound, and one outbound.

3.4 Existing Condition Operations and Navigational Constraints

This chapter describes the existing and projected future navigational problems at Port Everglades. The identification of problems is part of the first step in the six-step planning process described in the Principles and Guidelines[7]. Channel dimension-related problems at Port Everglades occur under existing conditions and are projected to continue to occur and intensify in the future under without-project

[7] The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, Water Resources Council (February 3, 1983)

conditions as cargo throughput and passenger transfers increase, creating more vessel traffic. The problems identified in this section stem from the fact that the existing Federal navigation channel at Port Everglades was designed in the 1970's for use by sub-Panamax vessels. Under existing conditions, Panamax and Post-Panamax vessels use Port Everglades daily and weekly. Under future conditions, the number and size of Post-Panamax vessels at Port Everglades are projected to increase.

The primary problems at Port Everglades affect container ship and bulk vessel operations in the Federal navigation channel leading to the Southport container terminal (Southport Access Channel), and cruise ship operations in Southport Access Channel (SAC) leading to three of the Port's cruise terminals (berths 24/25, 26/27, and 29). Also, the entrance channel and main turning basin would require improvements to facilitate access to the SAC, and petroleum terminals at berths 7-10. In addressing existing problems and to maintain safe conditions in the harbor, the Port Everglades Pilots have developed operational rules and restrictions, which increase transportation costs for the cargo (compared to an unrestricted condition).

The primary problems identified in this analysis relate to the inefficient operation of containerships, tankers, and cruise ships in the Federal channel at Port Everglades, which affect the Nation's international trade transportation costs and cruise industry operating costs. The following problem statements describe these inefficiencies:

1. Existing cargo shippers are experiencing increased operation costs due to light loading, congestion delays, and tidal delays;
2. Existing ships are experiencing maneuverability problems in the Federal navigation channel associated with restricted access to portions of the Federal navigation channel during typical port operations;
3. Light loading, congestion delays, and tidal delays will increase as present harbor users increase their annual tonnage throughput and as larger ships that require deeper and wider channels replace older, smaller ones;

The inefficient operation of cargo vessels and cruise ships at Port Everglades directly results from insufficient depth and width of the Federal channel at the Port. The existing channel depth constraint causes some carriers to light-load vessels and restricts the efficient vessel size utilized by carriers. Examples of light loading are exhibited in containership operations. Restrictions on efficient vessel size are exhibited by liquid bulk and dry bulk operations, which have the landside capacity to use larger vessels, but the existing channel depth restricts the efficient use of these larger vessels. Containership size is also restricted by the existing Federal navigation channel depth (and width). Light-loading and restricted vessel size both increase cargo transportation costs.

The Port Everglades Pilots have developed restrictive operational rules in response to the difficulties associated with navigating a modern fleet in outdated narrow channel conditions. There are by-passing restrictions on vessels transiting the SAC while certain vessels are berthed immediately alongside the channel. The restrictions prevent all Panamax and Post-Panamax beam vessel traffic in the SAC, when Panamax-beam (or greater) vessels are moored alongside berths 24/25, 26/27, or 29. Additional tugs are required for Panamax and Post-Panamax vessels transiting the SAC if sub-Panamax vessels are moored alongside these same berths. Additional tugs are required for all Post-Panamax containerships

with a beam greater than 140 feet. These operational rules increase cargo and cruise ship transportation costs by causing delays, increasing fuel consumption to avoid delays or while waiting at sea or at berth, and by requiring additional tugs. These existing problems are projected to increase as future cargo tonnage, vessel calls, and vessels sizes increase at the Port.

3.4.1 Cruise Ship Operations and Navigational Constraints

In 2012, there were 628 multi-day cruise ship calls at Port Everglades, of which 344 were Post-Panamax vessel calls, 226 Panamax, and 58 sub-Panamax vessel calls. Post-Panamax and Panamax size cruise ships use berths 2/3, 4, 17/18, 19/20, 21/22, 24/25, 26/27, and 29. A selection of the largest cruise ships, which regularly use each berth, is presented in Table 16.

Table 16. Largest Cruise Ships by Berth

Berth	Vessel Name	GRT	LOA (ft)	Beam (ft)
2/3	*Crown Princess*	113,561	947	118
4	*Emerald Princess*	113,561	947	118
17/18	*Allure/Oasis of the Seas*	225,282	1,184	154
19/20	*Carnival Freedom*	110,320	952	116
21/22	*Grand Princess*	108,806	950	118
24/25	*Liberty of the Seas*	154,407	1,112	127
26/27	*Eurodam*	86,273	936	106
29	*Navigator of the Seas*	138,279	1,021	127

Notes: GRT = Gross Registered Tons; LOA = Length Overall.

Cruise ship operations at berths 2/3, and 4, in the Northport area of the Port, and at berths 17/18, 19/20, and 21/22, in the Midport area of the Port, typically do not experience constraints due to the Federal navigation channel, or impact other vessel operations at the Port. Alternatively, cruise ship operations at berths 24/25, 26/27, and 29 have a substantial impact on cruise ship and container ship operations at the Port. A standard operating rule of the Port is that a Panamax or Post-Panamax vessel cannot by-pass a Post-Panamax vessel moored at berths 24/25, 26/27, or 29[8]. This restriction is based on the 400-foot width of the Southport Access Channel (SAC), which does not provide sufficient safety clearance for a Panamax or Post-Panamax vessel to bypass the large cruise vessels typically berthed at berths 24/25, 26/27 and 29.

The navigation restriction at the SAC results in a "last-in, first-out" & "first-in, last-out" set of rules for cruise ships, which requires the cruise ship at berths 24/25 to be the last vessel in and the first vessel out, otherwise cruise ships cannot get to berths 26/27 and 29. Conversely, it also requires the cruise ship at berth 29 to be the first vessel in and the last vessel out. The constraint imposed by the narrow SAC causes congestion delays and imposes additional costs on cruise ship operators. Additional costs include the cost of increased fuel consumption when the vessel increases speed to make up for delays at Port

[8] Pilots Association interview notes 31 Jan 13

Everglades, and the cost of overtime labor when the vessel must arrive early or leave late in order to be the first vessel in or the last out[9].

Panamax and Post-Panamax containerships are also impacted by the Southport Access Channel cruise berth by-pass constraint. Large containerships must arrive before cruise ships arrive at berths 25 – 29 in order to access the Southport container terminal. MSC (Mediterranean Shipping Company) has indicated that their vessels must arrive by 0330 on the days when the cruise ships are scheduled to be in port. If the containership misses this window, then it cannot access the Southport container terminal until 1800 (after all the cruise ships have departed). The operational constraint at the SAC causes increased costs, due to increased fuel consumption, overtime labor costs, and potential rerouting of the vessel to Freeport, BS.[10]

3.4.2 Containership Operations and Navigational Constraints

Containerships calling at Port Everglades in 2012 ranged in size from very small feeder vessels, which service Caribbean islands, to Post-Panamax vessels on trans-Atlantic liner services. As is the case for all major container ports, most of the containerships calling at Port Everglades are sub-Panamax in size. These small vessels, some of which have ship's gear, use many of the Port's berths. Sub-Panamax vessels are not constrained in their operations by channel dimensions at the Port and are therefore not primary contributors to economic benefits of the channel improvement study, except only as they affect overall port congestion.

The larger Panamax and Post-Panamax containerships exclusively use berths 30, 31, and 32 at the Southport container terminal. Containership operations at the Southport container terminal are constrained by the 42-foot controlling depth of the Federal navigation channel and by the narrow width of the Federal navigation channel at the Southport Access Channel (SAC). Two containership lines, MSC and Hamburg-Sud, have indicated that their current and projected future operations are impacted by existing channel conditions.

MSC, the second largest container shipping line in the world, had vessels call Port Everglades in 2012 on three services: 1) North Europe to the U.S. East Coast and Gulf of Mexico (EU-ECUS-GMEX), 2) Mediterranean to the U.S. East Coast and Gulf of Mexico (MED-ECUS-GMEX), and 3) a feeder service to the Bahamas. This discussion focuses on the EU-ECUS-GMEX, and the MED-ECUS-GMEX services, which employ Panamax and Post-Panamax vessels. The feeder service to the Bahamas uses a sub-Panamax vessel.

MSC's Panamax and Post-Panamax vessels operated at maximum allowable drafts (39.0 feet and greater) on 32% of calls (Figure 14). The EU-ECUS-GMEX service consisted of mostly Post-Panamax

[9] Interview notes with Royal Caribbean International 01 Feb 13

[10] Interview with MSC 01Feb13 and interview with Pilots Association 31 Jan 13

vessels, ranging from 5,500 TEUs to 6,700 TEUs capacity with 44 to 47-foot design drafts. The vessels on the EU-ECUS-GMEX service were operating light loaded at Port Everglades due to constraints of the Federal navigation channel. In March 2013, MSC pulled Port Everglades from this service due to operational constraints at the Port. Cargo on this route, which had been serviced by MSC through Port Everglades, is now being routed through other ports. MSC is replacing the North Europe service calls at Port Everglades by adding Port Everglades to the service from Europe to Ecuador and Panama, which uses smaller and less efficient Panamax vessels. This will result in higher transportation costs for TEUs transported to and from Port Everglades under both existing and future without project conditions.

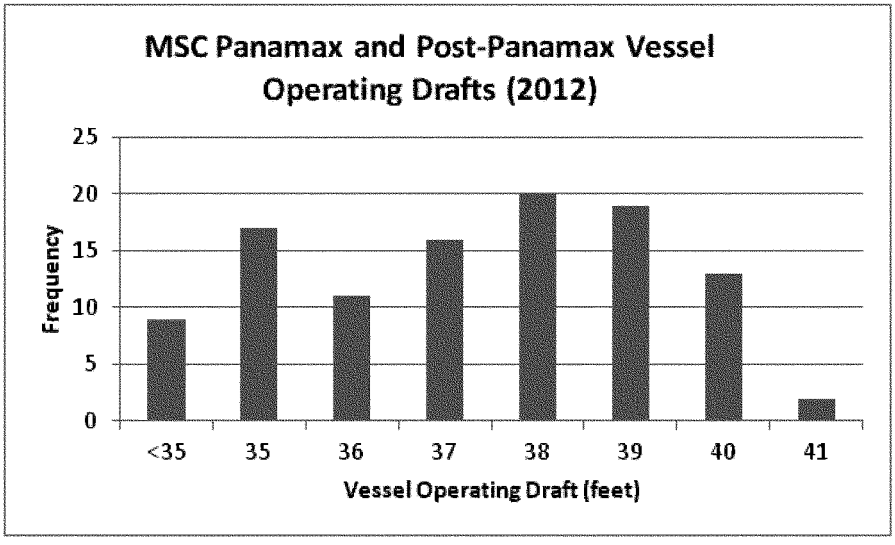

Figure 14. MSC Vessel Operating Drafts at Port Everglades

MSC's MED-ECUS-GMEX service consists of mostly Panamax vessels, but includes some calls by Post-Panamax vessels (5,500 TEUs). The vessels on the MED-ECUS-GMEX service face the same channel constraints as the vessels on the EU-ECUS-GMEX service, but because the MED-ECUS-GMEX service consists mostly of Panamax vessels, this service is not as severely impacted as the EU-ECUS-GMEX service.

The existing channel depth and width constraints limit MSC's ability to bring the new industry-standard Post-Panamax containerships to Port Everglades. MSC has stated that Port Everglades is already too shallow and that it is difficult to maintain existing services at Port Everglades with their rapidly expanding fleet of larger Post-Panamax containerships. MSC is looking to enter the US East Coast to East Coast of South America North-South trade, but would only do so if they could gain a competitive advantage by using their larger Post-Panamax vessels, which cannot cost-effectively call at Port Everglades under existing constrained channel depths. MSC projects that after the Panama Canal

expansion, their vessels will arrive through the Canal with sailing drafts of 47 and 48 feet. These vessels will have to by-pass Port Everglades and go on to transship cargo via Freeport, BS if channel depth constraints at the Port are not alleviated.[11]

Hamburg-Sud operates an east coast of South America to U.S. east coast (ECSA-ECUS) service using five Hamburg-Sud Panamax vessels (4,255 TEUs to 4,616 TEUs capacity) and two CSAV Panamax vessels (3,500 TEUs capacity). These vessels have design drafts of 41 to 44 feet. Hamburg-Sud considers its operations at Port Everglades very constrained by the existing depth of the Federal navigation channel. Hamburg-Sud indicated during an interview that they generally operate with an out-bound (typically deeper than inbound) depth constraint of 11.5 meters (37.7 feet)[12]. The operating data for Hamburg-Sud's ECSA - USEC service indicates that the vessels seldom operate at greater drafts than 37 feet (Figure 15).

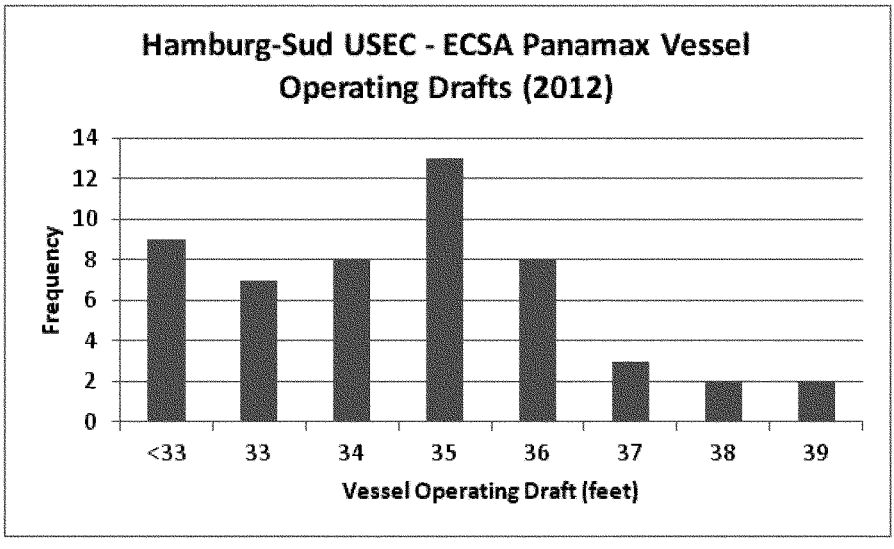

Figure 15. Hamburg-Sud Panamax Vessel Operating Drafts at Port Everglades

Hamburg-Sud's stated strategy is to operate with very high vessel utilization rates, which they consider necessary for survival in a competitive industry[13]. Another component of this competition is being able

[11] MSC interview notes 02 Feb 13

[12] Hamburg-Sud interview notes 02 Feb 13

[13] Ibid.

to operate with larger vessels, which increases productivity and lowers per-unit operating costs[14]. Hamburg-Sud has identified the next generation of vessels for the ECSA-ECUS service as the "Monte Class" of Post-Panamax vessels, which have a TEU capacity of approximately 5,500 TEUs and an operating draft capacity of 43 feet. These vessels would likely not call at Port Everglades unless the Federal navigation channel is deepened. In this case, cargo on the ECSA-ECUS service would be forced to use a different port or continue to use Panamax class vessels, which would likely increase the total transportation costs (landside plus waterside) of this cargo.

3.4.3 Petroleum and Liquid Bulk Vessel Operations and Constraints

Liquid bulk petroleum commodities are delivered to Port Everglades by large tankers and ocean-going barges. The major commodities are categorized as gasoline, jet fuel, diesel, ethanol, and fuel oil. Other liquid bulk commodities such as bio-diesel and crude oil are exclusively transported by barge and not anticipated to benefit from the proposed deepening. Asphalt and tallow are transported by small specialized tankers. Gasoline, jet fuel, and diesel typically use berths 7, 9, and 13. Fuel oil uses berths 5 and 7. Port Everglades has a unique manifold and pipeline system which allows multiple petroleum firms with facilities at Port Everglades to share the contents of a single vessel without the vessel moving to a different berth. Petroleum firms at Port Everglades will "swap" the contents of an arriving vessel based on agreements made while vessels are in transit. They can also transfer inventory from one firm to another's storage tanks at the adjacent landside facilities. The practice of swapping inventory and sharing loads provides cost savings to Port Everglades' petroleum firms because single deliveries can be larger and therefore transported more efficiently. There are no additional tug, pilot, and line-handler costs, which would be associated with moving the vessel from one berth to another in order to split the load, or the additional at-sea transportation costs of bringing separate shipments for each firm.[15]

Tankers often arrive at Port Everglades efficiently loaded, which because of the existing berth depth of 37 ft limits the size of tankers calling at Port Everglades. The larger tankers currently calling at Port Everglades frequently transport gasoline and jet fuel, and arrive at drafts generally ranging from 35 to 38 feet. These tankers are typically Panamax vessels of approximately 45,000 to 60,000 DWT (deadweight tonnes) with lengths from 600 to 620 feet. Less frequently, Panamax tankers of approximately 60,000 to 80,000 DWT with lengths up to 750 feet also call at the port. Smaller tankers and barges, carrying ethanol, fuel oil, asphalt, and tallow typically arrive at Port Everglades with drafts of less than 33 feet. Figure 16 presents tanker arrival drafts at Port Everglades.

[14] Interview with Florida International Terminals 02Feb13

[15] Interview with TransMontaigne 15Feb13

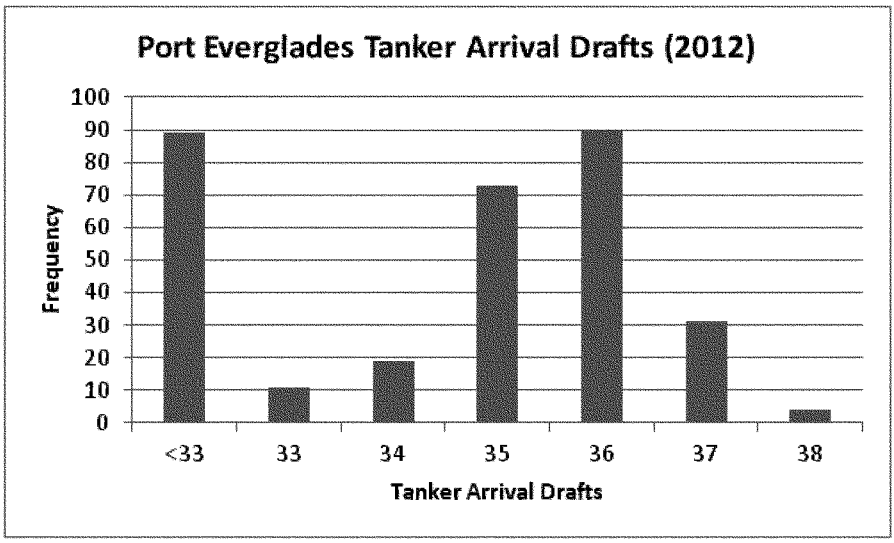

Figure 16. Tanker Arrival Drafts at Port Everglades

Berths 7-10 have not been deepened to date because of the combination of depth restrictions at other U.S. east coast ports and the nature of the market for petroleum products. Interviews with shippers of petroleum products revealed that the petroleum products market is a "spot market," where delivery is taken immediately, and ownership of the cargo can often change hands several times while the vessel is en route. If a foreign shipper knows that a cargo load is headed for the U.S. east coast, but that the specific delivery port may change en route, then they will typically load the vessel to be able to call the Port of New York & New Jersey, since it is such a large market. Many of the petroleum terminals in New York & New Jersey Harbor are located along the Arthur Kill channel, which has a controlling depth of 35 ft, and 6 ft of usable tide. Assuming 3 ft of underkeel clearance, the maximum sailing draft in the Arthur Kill is 38 ft. Therefore, Port Everglades has never deepened its primary petroleum berths past 38 ft because of external market factors, namely the depth restriction at Arthur Kill. However, there is currently part of an authorized project for New York and New Jersey Harbor that is set to begin construction in FY14, which will deepen Arthur Kill to 40 ft MLLW. Given the same tide and underkeel clearances, petroleum vessels will soon be able to call New York and New Jersey Harbor at sailing drafts of up to 43 ft (using high tide). This will cause a shift in the vessel operations for petroleum products tankers calling the U.S. East Coast, which will provide reason for Port Everglades to pursue deepening their petroleum berths[16]. The 2009 Port Everglades Master/Vision Plan details the planned expansion of

[16] In the with project condition, the sailing draft distribution for petroleum tankers takes into account the depth of the terminals located along the Arthur Kill channel. Approximately 90% of all petroleum tankers sail at 43 feet or less. The remaining 10% sails up to a 47 foot depth.

the three slips at Northport in Element 3, Section 3.6.7. In Figure 3.6-27 of that report, the proposed slip dimensions indicate a dredge depth of 42 ft for Slip 1 and Slip 3 (berths 7-10 and 12-15, respectively).

The use of larger, more efficient tankers would reduce transportation costs for the petroleum firms operating at Port Everglades. The load sharing/swapping among petroleum firms at Port Everglades facilitates the efficient loading of tankers, regardless of their size. Larger vessels are not currently used due to the depth constraint of the berths at the port, but those constraints will be removed before the proposed Federal improvement project is constructed (see Section 4), which will leave only the Federal navigation channel as the remaining depth constraint. If greater channel depth were available, Port Everglades petroleum firms would use larger vessels to take advantage of the economies of scale.[17]

3.4.4 Dry Bulk Vessel Operations and Constraints

Historically, Port Everglades had been a major import destination for cement and related dry bulk products, such as gypsum and bauxite, which are cement-production input materials (Table 17). Prior to 2007, when demand was high, cement would often arrive on vessels loaded to or near the Port's un-tide-restricted operating depth of 39 feet[18]. Currently, only vessels carrying bauxite or gypsum arrive at these operating drafts and there are now only a few of these calls per year (3 in 2012).

Table 17. Historical Port Everglades Cement and Dry Bulk Tonnage

	Cement	Dry Bulk	Total
2003	2,164,610	354,444	2,519,054
2004	2,333,142	509,891	2,843,033
2005	2,222,492	607,063	2,829,555
2006	2,465,753	475,084	2,940,837
2007	1,432,837	307,825	1,740,662
2008	494,054	387,383	881,437
2009	306,727	246,988	553,715
2010	264,211	234,068	498,279
2011	375,050	141,189	516,239
2012	613,051	346,976	960,027

Source: Port Everglades Commerce Report FY 2012
Note: Short tons

Operators of the CEMEX and Continental Cement facilities at Port Everglades both indicated that, when demand picks up again, vessels would operate at the Port in a manner similar to vessel operations prior to the economic downturn. Both operators also indicated that, historically and under future conditions of higher demand, vessel size and loading is constrained by depth conditions in the federal navigation channel. CEMEX has a silo capacity of 60,000 tons, but historically has used vessels in the 40,000 to

[17] Interview with TransMontaigne 15 Feb 13

[18] Interview with CEMEX 14 Mar 13

45,000 DWT (deadweight tons) range. If additional depth were available at Port Everglades, CEMEX would use larger vessels. Continental Cement has indicated that under conditions of higher demand and a deeper Federal navigation channel, they would use larger vessels and split shipments between Port Everglades, which they would call first, and Port Canaveral, which also has a Continental Cement facility. Both operators indicated transportation cost savings as the reason for using larger, more deeply loaded vessels if product demand and channel conditions allowed[19].

3.4.5 Tug Operations

Most large cargo vessel arrivals and departures at Port Everglades require tug assistance. Cruise ships require tug assistance far less frequently and are designed specifically to provide the maneuverability required to avoid tug assistance. The narrow conditions of the existing Federal navigation channel and the 105-degree turn required to enter the Southport Access Channel cause additional tugs to be required for large vessels. Additional tugs (a third tug) are required for Panamax and Post-Panamax containerships if they by-pass a vessel moored at berths 24 – 29. Note that no vessels are allowed to by-pass berths 24 – 29 if a Post-Panamax vessel is moored there.[20] Sub-Panamax containerships and other small vessels were moored at berths 24 – 29 on 139 separate occasions. Regardless of vessel operating draft, all containerships with beams greater than 140 feet (Post-Panamax Generation 2 vessels) require a third tug when transiting the Southport Access Channel due to the narrow conditions of the Federal navigation channel.

Cruise ships, which typically do not require tug assistance, sometimes will use tugs to overcome scheduling delays resulting from the last-in, first-out rule. The first-in, last-out rule was developed as a way to accommodate large vessels, which are constrained by the narrow width of the Federal navigation channel. If a vessel at berth 24 or 25 is delayed, cruise ships at berths 26, 27 and 29 may use tugs to carefully by-pass the delayed vessel. Table 18 presents tug use by cruise ships, Panamax container ships, and Post-Panamax containerships at Port Everglades in calendar year 2012.

[19] Interview with CEMEX 14 Mar 13 and interview with Lehigh-Hanson 14Mar13

[20] Interview with Port Everglades Pilots Association 03 Feb 13

Table 18. Tug Use by Vessel Type

Vessel Type	Number of Tugs	Frequency
Cruise Ship	1	91
	2	13
	3	2
Panamax Container Ship	1	1
	2	477
	3	12
Post-Panamax Container Ship	1	0
	2	118
	3	33

Note: Data from 2012 Port Everglades' Harbormaster Records

The use of additional tugs increases existing vessel operating costs for cargo carriers and cruise ships operating at the Port. Under future conditions, with larger vessels operating at the Port, the costs associated with additional tug use are projected to increase. Although not all of the tug use identified in Table 18 would be affected by navigation improvements at the port, the Pilots Association indicates that third tugs would not be required and that cruise ship use of tugs when by-passing vessels at berths 24 – 29 would also not be required under conditions of a wider Federal navigation channel.

4 Planned Infrastructure Improvements

This section describes the planned infrastructure improvements and anticipated changes (compared to Section 3) that are scheduled to be completed by base project year in both the with- and without-project conditions. First, the improvements will be identified and then the expected effects on the Port's capacity for vessel accommodations and cargo throughput will be qualified or quantified. These changes are assumed to be in place throughout analysis. Note that some changes will be necessary to realize full benefits in the with-project condition (even though those improvements will also help in the without-project condition).

The port has a long history of planning and executing infrastructure improvements, which increase the capacity and efficiency of port operations. Port infrastructure planning is conducted over a twenty-year planning period in two five and one ten-year increments. The near-term five-year plan guides the implementation of annual capital plans. The most recently adopted[21] 5-Year Master Plan covers Fiscal Years (FY) 2011 to 2015; the 10-Year Vision Plan covers FY 2016 to 2019, and the 20-Year Vision Plan covers FY 2020 to 2029. Recent improvements constructed by the port, which are identified in the 5-Year Master Plan, include upgrades to Cruise Terminal (CT) 2, CT 19, CT 21, and CT 26 to facilitate use by the world's largest cruise ships and reconfiguration of Berth 28 as a lay berth and tug berth with a

[21] 2009 Port Everglades Master/Vision Plan

mooring dolphin. The port has also conducted a bulkhead study[22], which provides a 20-year schedule of future bulkhead reconstruction based on existing bulkhead conditions and operational requirements. Construction of the Intermodal Container Transfer Facility (ICTF), the Eller Drive overpass, and the reconstruction of interior roadways were all completed in 2014. Table 19 presents the schedule of improvements, excluding those already implemented, identified in the 2009 Master/Vision Plan and 2010 Bulkhead Study.

Planned improvements will affect all aspects of port operations including:

- Cruise ships and terminals;
- Dry bulk cargo;
- Liquid bulk cargo; and
- Containerized cargo.

Planned cruise-related improvements include construction of additional parking and enhanced passenger facilities at CT 4 and CT 18, and a centralized cruise passenger processing facility in the Midport terminal area. Cruise terminals 4, 25, and 29 will be upgraded to accommodate the large size cruise ships currently using the recently improved cruise terminals at the Port, and berth 4 will be extended from 900 to 1150 feet to accommodate larger cruise ships. Dry bulk cargo operation will be improved by bulkhead replacement at the cement ship berths and by construction of a crushed rock aggregate facility. The new crushed rock aggregate facility will be located in the Turning Notch Extension and will be linked to the ICTF through a conveyor system. Rail cars will be able to be loaded with aggregate from storage facilities filled by a conveyor system from the berth. Liquid bulk operations will be improved by the widening of liquid bulk slips to accommodate Aframax-size vessels (80,000 to 120,000 deadweight tons), by bulkhead reconstruction, deepening to existing project depth, and by manifold replacements, which will be concurrent with bulkhead reconstruction. While initially the liquid bulk berths will be deepened from 37 ft to the existing project depth of 42 ft, bulkhead reconstruction will allow for berth depths as deep as 50 feet, to accommodate additional deepening in the future with-project condition.

Containerized cargo handling operations at the port will be greatly improved through a series of planned terminal expansions and equipment upgrades. Berth 30 will be extended from 900 feet to 2,400 linear feet as a part of the Turning Notch Extension[23]. The relocation of the Foreign Trade Zone will provide an additional 23 acres to the Southport container terminals, bringing the total container terminal area to 258 acres. The Southport container terminals are adjacent to the ICTF, which is currently under construction. The ICTF will be able to service double stack trains up to 9,000 feet in length[24]. The

[22] 2010 Bulkhead Study

[23] Environmental mitigation for the Turning Notch Expansion is currently being implemented by the Port.

[24] Additional information on the ICTF is in Section 4.1.

Midport (28 acres) and Northport (22 acres) container handling facilities combined provide an additional 50 container terminal acres.

There are currently 7 ship-to-shore cranes at the Southport container terminal, which are capable of servicing Panamax-size containerships. Five Post-Panamax size cranes (capable of reaching across 22 rows of containers) will be added at Southport for a total of 12 cranes. The first two Post-Panamax cranes are scheduled for delivery in 2015 (Table 19). Throughput capacity at Southport will be enhanced by increased storage density at the terminals. The Port's densification strategy includes a transition from the existing top-pick container handling operations at Southport to a rubber-tire-gantry (RTG) operation, which increases the number of containers that can be stored per acre. Southport throughput capacity will be approximately 2 million TEUs per year, once the densification improvements are in place.

The existing bulkheads at the Southport container terminal (berths 31 and 32) and the new bulkhead along the Turning Notch Extension (berth 30) will all be able to accommodate depths as deep as 50 feet. However, due to existing FAA flight surface restrictions that affect air draft and crane height on the western end of the Extension, the current USACE project would only deepen the eastern 1,300 feet of the Turning Notch to the new project depth, with the remaining 1,100 feet to the west, staying at the existing depth of 42 feet.

Table 19. Port Everglades Existing and Planned Future Port Configuration

Berth	Cargo	Existing Length	Planned Improvements
1a 1b	Yachts, lay Yachts, lay	180 220	
1 2 3	Ro-Ro cruise cruise	1,601	2019/20 – new bulkheads
4	Multi cargo & cruise	900	2014/5 – berth extend to 1150 ft; improvements to CT 4 for large cruise ships 2019/20 – CT 4 parking garage (multi-level)
5 6	Multi cargo & asphalt Multi cargo & diesel load	900 380	2027 – new bulkheads 2029 – reduced to 330 feet
7 8	Petroleum products Petroleum products & asphalt	1,200	2017 – new tank farm 2021 – Slip 1 (berths 7&8) widened to the north from 425 to 475 feet; new bulkheads
9 10	Petroleum products Petroleum products & FPL	1,200	2016 – Slip 1 (berths 9&10) widened to the south from 300 to 425 feet to allow Aframax-size vessels; new bulkheads; deepened to project depth
11	Propane, lay	500	2015 – reduced to 375 feet; 2029 – no longer a berth
12 13	Petroleum products & FPL Petroleum products	1,226	2034 – new bulkheads;
14 15	Multi cargo & cement Multi cargo & cement	1,226	2023 – new bulkheads;
16 17	Small container ships cruise	1,648	2019 –CT 18 parking garage 2019 – new bulkheads

Berth	Cargo	Existing Length	Planned Improvements
18	cruise		
19 20	Multi cargo & cruise Multi cargo & cruise	1,300	Ship's gear only – no cranes 2022/25 – centralized cruise processing center/intermodal facility 2024 – new bulkheads
21 22	Cruise & lay Cruise & lay	1,475	2019 – new bnlkheads
23	Lay, USCG	240	2025 – new bulkheads
24 25	Cruise & lay Cruise & lay	1,369	2017 – improvements to CT 25 for large cruise ships 2025 – new bulkheads
26 27	Cruise & lay Cruise & lay	1,337	
28a 28b/e 28f	Tugs & lay Tugs & lay Tugs & lay	480 550 400	
29	Cruise & multi cargo	800	Ship's gear only – no cranes 2017 – improvements to CT 29 for large cruise slips 2036 – new bnlkheads
30	Containers	900	2016 – additional 23 acres added to container yard (former FTZ) 2017 – lengthen berth to 2400 ft; 2017/18 – third 22-wide crane (10 cranes total) 2020/21 - fifth 22-wide crane (12 cranes total)
31 32	Containers Containers	2,000	2015 - first & second 22-wide crane (9 cranes total) 2018/19 – fourth 22-wide crane (11 cranes total) 2039 – new bulkheads
33a 33b 33c	Containers & RO/RO Containers & RO/RO Containers & RO/RO	800 400 400	2020 – lengthen to 1100 ft 2020 – no longer functional 2020 – no longer functional
ICTF	Double stack containers	21,000 LF	2014 - Service trains up to 9,000 LF; double track spur to mainline
New New New	Crushed rock aggregate Containers & RO/RO Ferry	1,000 1,000 600	2017 – north side turning basin first year of operation 2017 – north side turning basin first year of operation 2017 – west side turning basin first year of operation

Source: 2009 Port Everglades Master/Vision Plan, Element 5: Final Plan; and 2010 Bulkhead Study.

The Port's current Capital Improvement Plan includes a number of projects, currently under construction or in the design phase, which will substantially improve cargo operations at the Port. Each of these improvements will be completed and operational between 2014 and 2017 (Table 20). Three projects: the ICTF, the McIntosh Road Realignment, and the Eller Drive Over-pass are a part of the Port's integrated intermodal transportation network improvements. The McIntosh Road Realignment and the Eller Drive Overpass will enhance operation of the ICTF by removing on-grade railroad crossings outside of the Port, separating truck and rail traffic at the Port. Container cargo operations will be enhanced by the Turning Notch Expansion, which will allow the largest Panamax and Post-Post Panamax vessels that currently call the Port to use berth 30, which will be extended from 900 feet to 2,400 feet. The first two Super Post-Panamax cranes, each with a reach of 22 containers across, will resolve the weight and reach restrictions currently associated with the Ports existing cranes (16 containers across reach).

Table 20. Selected Ongoing Port Infrastructure Improvement Projects

Project	Year Operational	Cost (millions)
ICTF	2014	$72
Eller Drive Overpass	2014	$42
McIntosh Road	2014	$8
Turning Notch Expansion	2017	$122
22-Wide Cranes (2)	2015	$24
Total		$268

Source: Port Everglades

4.1 Intermodal Container Transfer Facility

Construction of the new Intermodal Container Transfer Facility (ICTF) was completed in 2014. The ICTF is a rail terminal for Florida East Coast (FEC) railway that is located adjacent to the Southport Container Terminal (see planned location in Figure 11). It is expected to further expand Port Everglades' rail-accessed hinterland to include cost-effective access to markets as far as Jacksonville, Atlanta, Charlotte, and Nashville[25]. For example, an analysis conducted by the Port Everglades Department[26] indicates that cargo using rail from Port Everglades to Atlanta will be cost and time competitive with cargo that spends additional time on a container vessel, unloaded in Savannah, and is then trucked from Savannah to Atlanta.

5 Commodity Forecast

The purpose of this section is to show how future commodity growth was forecasted. The details of the assumptions and methods used to determine the forecast are described. The primary benefitting commodities in this study are those moving on the largest cargo vessels that call the Port: containerized cargo, liquid petroleum products, and dry bulk. The containerized cargo that will benefit the most from channel deepening and widening is cargo moving on trans-Atlantic and North America-South America trade. The liquid petroleum products that will benefit the most from deepening are gasoline, diesel, and jet fuel moving on foreign-flagged tankers. The dry bulk commodities that will benefit the most from channel expansion are cement, cement-production input materials, and aggregate. An increase in domestic production could impact the benefits associated with dry bulk commodities, therefore, a sensitivity analysis will be conducted to evaluate the significance of the dry bulk good benefits to the proposed project. Other cargo types (such as break-bulk and non-containerized general cargo) moving on smaller vessels will receive incidental benefits through reduced congestion and delays in the harbor. The forecast for primary benefitting commodities was given the most consideration in the following sub-sections. A breakdown of benefits by commodity type is included in section 11.5.

[25] FEC interview notes 1 February, 2013

[26] Port Everglades Master Plan – Element 2: Market Assessment, 2009

5.1 Commodity Forecast Methods and Assumptions

For the purposes of this analysis, commodities were grouped into "trade concepts." A trade concept is a grouping of commodities by the manner in which freight is unitized, loaded and unloaded from a vessel so that it can be traded. Commodity growth rates over the period of analysis were specified by trade concept. Applying growth rates at this lower level of detail allowed the forecast to be simplified. The trade concepts identified for this are:

- Liquid bulk[27]
- Dry bulk, non-containerized general cargo, and break-bulk
- Containerized Cargo

The primary foreign commodity forecast used in this analysis for near-term growth (2015-2029) was based on a growth forecast for the south Atlantic U.S., obtained from IHS Global Insight (now renamed IHS Economics & Country Risk), a data and consulting firm. The Port Everglades' share of southeast U.S. cargo was determined based on historical averages. The Port Everglades cargo share percent was then applied to the regional IHS forecast to calculate future tonnages. The following is a description of how IHS Global Insight forecasts are produced:

The primary input used to derive the Port's commodity forecasts is IHS Global Insight's World Trade Service (WTS). The WTS relies on several key sources of information within the development of its forecast, including IHS Global Insight's economic forecasting model of the U.S. economy and IHS Global Insight's International Models. IHS Global Insight's Regional state economic models provided additional information that factored into the forecast.

The IHS Global Insight world trade forecasting system provides detailed forecasts of international commodity trade to assist decision makers involved with international commodity transportation. The world trade forecasts include all commodities that have physical volume; they exclude trade in services or commodities without physical volume, such as electricity. The trade forecasts are produced with a system of linked world trade commodity models collectively called the World Trade Model (WTM). The commodity forecasts are grouped into IHS Global Insight's own categories derived from the International Standard Industrial Classification (ISIC) and cover 88 ISIC categories. For all trade partners in the world, the WTM has 66 major countries individually and groups the rest of the world into 12 regions according to their geographic location. Therefore, IHS Global Insight forecast 88 commodities traded among 78 country/regions. This is a framework of 77 by 78 by (78-1), or 528,528 potential trade flows.

Because not every country trades every commodity with every other country, they include about 365,000 trade flows in their forecasts. The forecasts of world trade, in both nominal and real commodity value, are converted to physical volume by transportation mode using standard formulas. Primary modes of transportation include air, overland, and maritime transport, all measured in metric

[27] Foreign liquid bulk and domestic liquid bulk were forecasted separately.

tons as well as in value. Container trade is measured in twenty-foot equivalent units (TEUs) as well as metric tons.

IHS Global Insight's flagship model of the U.S. economy integrates modern economic theory and behavior in an analytical tool that is widely used in forecasting, assessing derivative risks, and evaluating policy alternatives. The model embodies major properties of the Neoclassical growth models developed by Robert Solow; thus ensuring that short-run cyclical developments will converge to robust long-run equilibrium.

In growth models, the expansion rate of technological change (or adoption of technology), the labor force, and the capital stock determine the productive potential of an economy. As a result, monetary and fiscal policies will influence both the short- and the long-term characteristics of such an economy through their impacts on national saving and investment. A modern model of output, prices, and financial conditions is melded with the growth model to present the detailed, short-run dynamics of the economy.

The IHS Global Insight Model captures the full simultaneity of the U.S. economy, forecasting over 1,400 concepts spanning final demands, aggregate supply, prices, incomes, international trade, industrial detail, interest rates, and financial flows.

In the IHS Global Insight regional forecasting approach, each area is modeled individually and then linked into the national system. Thus, the models do not forecast regional growth as simple proportions of U.S. totals, but focus on internal growth dynamics and state-specific business cycle response. This approach is referred to as "top-down bottom-up." Unlike pure share (top-down) models and models that are not linked to a national macroeconomic model (bottom-up), the IHS Global Insight model includes both approaches.

A primary objective is to project how regional activity varies, given an economic environment as defined by macroeconomic and industry forecasts. Important regional issues are addressed using information about detailed industrial mix, inter-industry and interregional relationships, productivity and relative costs, and migration trends. IHS Global Insight maintains separate models for 50 states and for Washington, DC, as well as for 318 metropolitan areas. The state models have two fundamental characteristics: (1) Each state is modeled individually, with different model structures specified according to the characteristics of the state; and (2) national policy is explicitly captured from the output of the U.S. macro model.

For long-term growth (2029-2060), and domestic petroleum shipments (non-benefitting), several related forecasts were used as proxy rates for the long-term growth rate forecast of cargo at Port Everglades. These sources and the rates used are detailed throughout this section and the estimated tonnages are displayed in Table 26. Due to the uncertainty of forecasting over 40 years into the future, and to keep the assumptions as conservative as possible, no additional cargo growth was assumed after 2060. Cargo throughput in 2060 was held constant through the end of the period of analysis.

Near-term Liquid Bulk, Dry Bulk, Break Bulk, and Non-containerized General Cargo: The forecast for foreign bulk and general cargo movements over the near-term period from 2015-2029 was based on the IHS Global Insight south Atlantic U.S. regional forecast. The method used to apply the regional forecast to Port Everglades was to first determine the historic share of Port Everglades' import and export tonnages for each commodity group from the total regional forecast of South Atlantic ports. Then the average historic Port Everglades' cargo share percentages (by commodity category) were applied to the future regional tonnage forecast from IHS Global Insight.

Below is an overview of the steps taken to determine the Port Everglades forecast for foreign liquid bulk, dry bulk, break bulk, and non-containerized general cargo:

1. Waterborne Commerce Statistics Center commodity movement tonnage data was assembled for all South Atlantic region ports[28] for years 2003-2010
    a. Level of detail included 4-digit commodity code as well as category totals
    b. Domestic and foreign trade were separated
    c. Inbound and outbound cargo were separated
2. For foreign trade only, commodity tonnages were totaled at the general category level separately for imports and exports for all South Atlantic ports over the historical period
3. For each commodity category, the annual share of commodities transiting through Port Everglades was derived as a percent of the total South Atlantic tonnage
4. The average share of Port Everglades' import and export tonnage for each commodity category was derived from the historical record over the period 2003-2010 (Table 21 and Table 22)
5. These percent shares, broken down by commodity category and import/export, were then applied to the IHS Global Insight commodity forecast for bulk commodities and non-containerized cargo (for forecast period through 2029)[29]
    a. This assumes that the average historical share of bulk and non-containerized cargo commodities would remain the same throughout the forecast period

[28] The south Atlantic U.S. ports included were: Wilmington, NC, Charleston, SC, Savannah, GA, Brunswick, GA, Fernandina, FL, Jacksonville, FL, Canaveral, FL, Palm Beach, FL, Port Everglades, FL, and Miami, FL.

[29] After reviewing the results of applying the Port Everglades proportion to the IHS forecast, crude petroleum movements and petroleum product exports were both reduced to be more in line with low historic levels.

Table 21. Port Everglades Historical Percent Share of South Atlantic Imports by Commodity Type

Port Everglades Imports Percent Share of South Atlantic Imports by Commodity Category	2003	2004	2005	2006	2007	2008	2009	2010	Import Share Average
All Commodities	14.76%	16.66%	16.10%	15.80%	15.65%	13.66%	13.41%	12.94%	14.87%
Total Chemicals and Related Products	2.00%	2.41%	3.50%	2.43%	5.90%	8.28%	7.92%	2.16%	4.32%
Total Coal,Lignite and Coal Coke	2.83%	4.21%	0.22%	0.01%	0.01%	0.01%	0.18%	0.01%	0.93%
Total Crude Materials, Inedible Except Fuels	4.02%	5.37%	4.57%	4.08%	4.67%	5.54%	4.27%	3.46%	4.50%
Total Food and Farm Products	15.99%	20.09%	21.50%	23.48%	26.71%	27.61%	25.32%	23.91%	23.08%
Total All Manufactured Equipment, Machinery	6.10%	6.30%	7.64%	7.04%	6.91%	5.87%	4.87%	4.78%	6.19%
Total Petroleum and Petroleum Products	25.85%	30.63%	29.84%	28.21%	28.28%	27.58%	24.13%	26.42%	27.62%
Total Primary Manufactured Goods	22.92%	23.14%	20.07%	21.72%	19.49%	12.00%	10.23%	10.01%	17.45%
Total Unknown or Not Elsewhere Classified	3.05%	5.32%	5.21%	3.54%	4.45%	6.16%	5.31%	9.93%	5.37%

Source: Waterborne Commerce Statistics Center, New Orleans, LA

Table 22. Port Everglades Historical Percent Share of South Atlantic Exports by Commodity Type

Port Everglades Exports Percent Share of South Atlantic Exports by Commodity Category	2003	2004	2005	2006	2007	2008	2009	2010	Export Share Average
All Commodities	8.62%	8.92%	9.95%	10.63%	10.44%	10.26%	9.26%	9.33%	9.67%
Total Chemicals and Related Products	4.99%	3.73%	4.16%	4.72%	4.19%	4.91%	5.19%	4.42%	4.54%
Total Coal,Lignite and Coal Coke	2.55%	3.96%	1.82%	3.67%	3.72%	6.32%	17.25%	9.54%	6.10%
Total Crude Materials, Inedible Except Fuels	1.59%	1.31%	2.23%	2.67%	3.00%	3.51%	3.97%	4.50%	2.85%
Total Food and Farm Products	7.93%	7.85%	9.59%	9.79%	9.22%	10.03%	8.43%	8.15%	8.87%
Total All Manufactured Equipment, Machinery	15.64%	17.42%	18.67%	18.84%	18.56%	17.79%	16.53%	14.73%	17.27%
Total Petroleum and Petroleum Products	43.32%	40.72%	41.82%	38.48%	59.06%	20.18%	23.42%	21.57%	36.07%
Total Primary Manufactured Goods	9.39%	9.87%	9.67%	10.51%	8.43%	9.57%	8.57%	9.32%	9.42%
Total Unknown or Not Elsewhere Classified	23.68%	31.09%	36.73%	39.90%	38.47%	23.75%	24.48%	22.31%	30.05%

Source: Waterborne Commerce Statistics Center, New Orleans, LA

The following figure provides the historical and forecasted tonnage through 2029 for Dry Bulk and General Cargo. After 2029, an annual 0.8% growth rate was applied.

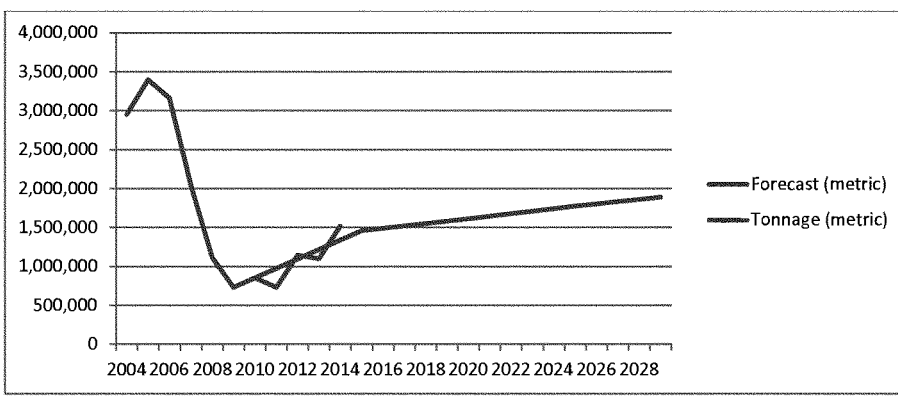

Figure 17. Dry Bulk/General Cargo Historical/Forecasted Commodity Growth

Figure 18. Historical and Forecasted Tonnage (through 2029) for Liquid Bulk transported through Port Everglades

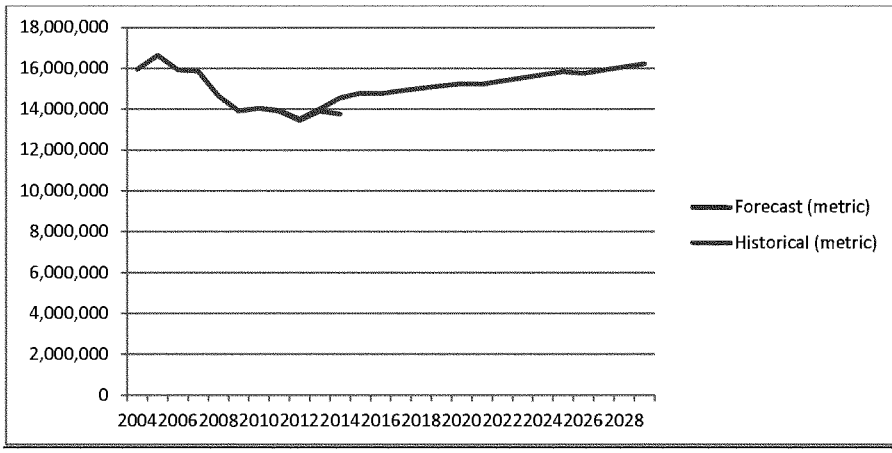

Figure 18. Historical and Forecasted Tonnage (through 2029) for Liquid Bulk transported through Port Everglades

Near-term Containerized Cargo: The containerized cargo forecast over the near-term period (2015-2029) applied the Port Everglades historical share of south Atlantic containerized cargo throughput to the south Atlantic regional IHS forecast. PIERS (Port Import Export Reporting Service) data was used to derive the port's share and incorporate the correct share of regional trade partners with Port Everglades into the containerized cargo forecast. Port Everglades' share of south Atlantic containerized cargo by foreign trade region was then applied to the IHS Global Insight forecast of containerized cargo for the region.

Below is an overview of the steps that were taken to determine the Port Everglades forecast for foreign containerized cargo:

1. PIERS containerized cargo tonnage data was assembled for south Atlantic region major container ports[30] for years 2008-2011
    a. Level of detail included the world region's trade with each port
    b. All tonnages were based on foreign traffic only

[30] The south Atlantic U.S. major container ports included were:

   c. Imports and Exports were combined
2. Containerized cargo tonnages were totaled at the trade-region level for all South Atlantic ports over the historical period
3. For each trade region, the annual share of containerized cargo tonnage transiting through Port Everglades was derived as a percent of the total South Atlantic tonnage
4. The average share of Port Everglades' containerized cargo tonnage for each trade region was derived from the historical record
5. These percent shares, broken down by trade region, were then applied to the Global Insight commodity forecast for containerized cargo (forecast period through 2029)
   a. This assumes that the average historical share of containerized cargo commodities by trade region would remain the same throughout the forecast period

Table 23. Port Everglades Historical Percent Share of South Atlantic Containerized Cargo by Region[31]

Region	2008	2009	2010	2011	Average
ASIA	2.65%	2.31%	1.62%	2.24%	**2.20%**
CARIBBEAN	18.56%	16.74%	15.10%	15.45%	**16.46%**
CENTRAL AMERICA	51.58%	49.68%	49.39%	50.56%	**50.30%**
EUROPE	1.66%	2.16%	3.20%	2.78%	**2.45%**
MEDITERANEAN	11.32%	10.18%	10.55%	13.07%	**11.28%**
MIDEAST	1.98%	4.62%	5.45%	5.18%	**4.31%**
EAST COAST SOUTH AMERICA	33.31%	27.24%	14.78%	13.27%	**22.15%**
WEST COAST SOUTH AMERICA	18.08%	19.60%	23.84%	24.01%	**21.38%**
NORTH COAST SOUTH AMERICA	36.36%	36.03%	33.63%	34.92%	**35.24%**
AFRICA/OCEANIA/NORTH AMERICA/OTHER	2.63%	2.63%	2.37%	2.67%	**2.58%**
Overall Share	**12.02%**	**11.56%**	**10.54%**	**10.99%**	**11.28%**

[31] The East Coast United States – East Coast South America trade land for containerized tonnage consists of approximately 14 percent of total projected containerized tonnage

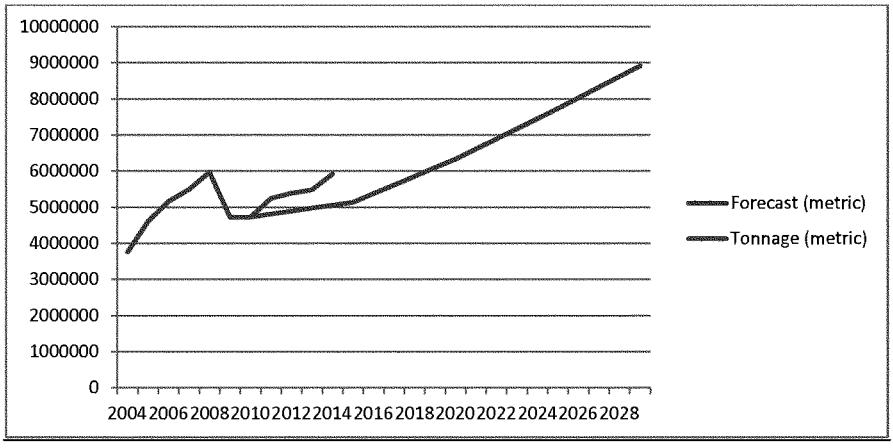

Figure 19. Historical and forecasted tonnage for Containerized Cargo (through 2029)

Long-term dry bulk and general cargo[32]: For the long-term forecast period from 2029 to 2060, dry bulk and general cargo imports and exports were associated with the long term population growth estimates (2030-2040) for South Florida counties[33] at 0.8% annually. This growth rate was based on the results from the Florida Demographic Estimating Conference, February 2013 and UF, BEBR, Florida Population Studies, Volume 46, Bulletin 165, March 2013 medium-growth county projections. The projected long-term growth in population was used as a proxy for long-term foreign dry bulk and general cargo throughput at the Port.

The following figure displays the projected long term commodity growth for Dry Bulk/General Cargo. As shown, Dry Bulk/General Cargo is anticipated to reach approximately 2.4 million tonnes by 2060.

[32] General cargo includes break-bulk. Over the entire forecast period, general cargo was estimated as a fixed percentage (10.8%) of the total dry bulk and general cargo forecast. This percent was based on historical averages.

[33] South Florida Counties included Broward, Indian River, Martin, Miami-Dade, Orange, Osceola, Palm Beach, and St. Lucie.

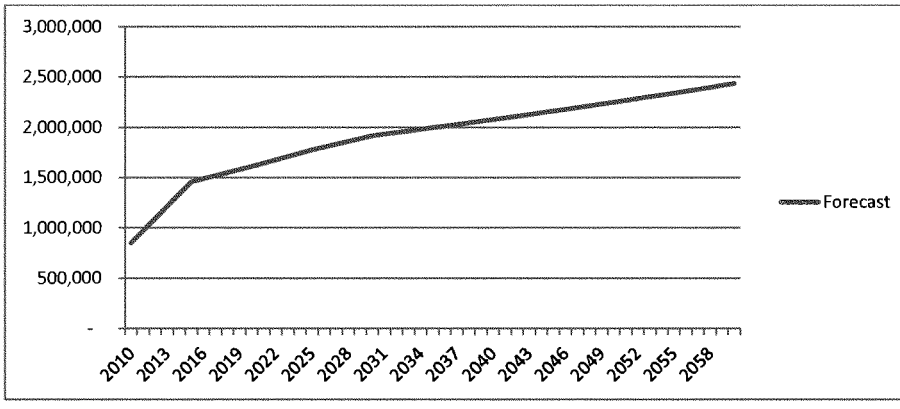

Figure 20. Projected Long-Term Commodity Growth for Dry Bulk/General Cargo

Long-term Liquid Bulk: For the long-term forecast period from 2029 to 2060 liquid bulk imports were associated with the U.S. Energy Information Administration Annual Energy Outlook 2012 forecast for demand for liquid petroleum products for the transportation sector at 0.2% annually. The projected growth in demand for liquid petroleum products in the transportation sector was used as a proxy for long-term foreign liquid bulk cargo throughput growth at the Port. No growth was assumed after 2060 for any commodities.

Displayed in **figure 21** below is the total tonnage projected for Liquid Bulk for the period of analysis. As shown, the forecast is anticipated to reach about 17.3 million tonnes in 2060.

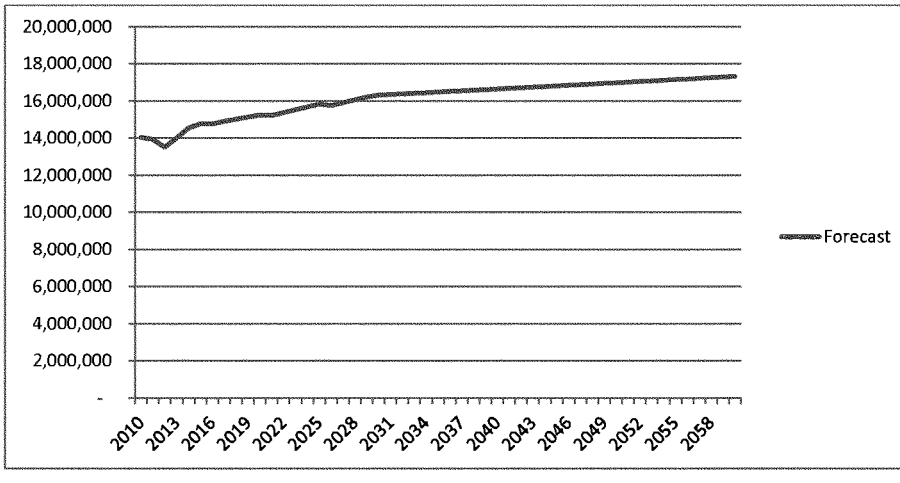

Figure 21. Total Tonnage Projected for Liquid Bulk

The forecast for Domestic liquid bulk was forecast using the transportation sector of the U.S. Energy Information Administration Annual Energy Outlook 2012. It is forecasted to grow at 0.2% annually throughout the period of analysis and reach just over 9 million tonnes in 2060.

Medium-term Containerized Cargo: For the medium-term forecast period from 2029 to 2040 containerized cargo imports and exports were associated with IHS Global Insight & U.S. Energy Information Administration Annual Energy Outlook 2012 economic activity growth rates at 2.5% annually. This rate was applied to all trade routes over this period except for Caribbean basin traffic, which was forecasted to remain constant after 2030. The projected growth of economic activity was used as a proxy for medium-term containerized cargo throughput growth at the Port.

Long-term Containerized Cargo: For the long-term forecast period from 2040 to 2060 containerized cargo imports and exports were associated with long-term South Florida counties population growth estimates (2030-2040) at 0.8% annually. The projected long-term growth in population was used as a proxy for long-term containerized cargo throughput growth at the Port. No growth was assumed after 2060. The results of the foreign containerized cargo forecast are shown in Section 5.2.Domestic Liquid Bulk: For the entire forecast period from 2015 to 2060 domestic coast-wise liquid bulk receipts were forecasted with a growth rate based on the U.S. Energy Information Administration Annual Energy Outlook 2012 forecast for demand for liquid petroleum products for the transportation sector at 0.2% annually. The projected growth in demand for liquid petroleum products in the transportation sector was used as a proxy for domestic liquid bulk cargo throughput at the Port. No growth was assumed after 2060. The results of the domestic liquid bulk forecast are shown in Section 5.2. The following **Figure 22** displays the containerized tonnage forecast for the period of analysis. Containerized tonnage is anticipated to increase to 11.6 million tonnes in 2060.

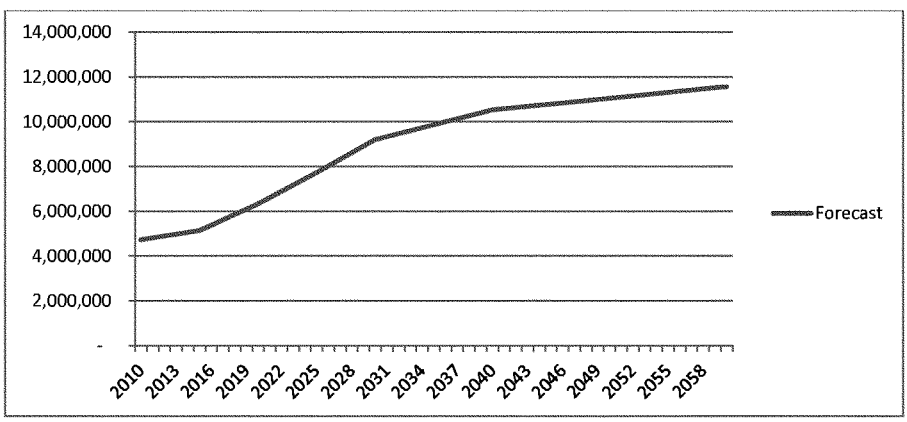

Figure 22. Containerized Tonnage Forecast

The results of the foreign liquid bulk, dry bulk, and general cargo forecast are shown in Section 5.2.

5.2 Commodity Forecast Results

The resulting growth rates for the short-term total foreign cargo forecast are shown in Table 24, below. The results of the total domestic and foreign cargo forecasts, over the entire forecast period from 2015 to 2060, using the growth rates and sources detailed above, is summarized in Table 26, and shown graphically in Figure 23. Finally, historical containerized cargo tonnages are compared to the forecasted tonnages in Figure 24. The annual growth rates (forecasted and historical where available) are provided as well.

Table 24. Growth Rates for Near-term Foreign Trade Forecast by Trade Concept

Growth Rates for Total Foreign Trade Forecast by Trade Concept				
	2015-2020	2020-2025	2025-2029	2015-2029
Dry Bulk / General Cargo	2.00%	1.95%	1.75%	1.91%
Liquid Bulk	1.13%	1.45%	1.27%	1.28%
Container	4.27%	4.07%	3.81%	4.07%
Total	**2.50%**	**2.65%**	**2.50%**	**2.56%**

Note: Based on IHS Global Insight projections. Percentages represent compound annual growth.

Table 25. Trade Concept Growth Rates

	Petroleum		Containerized		Dry Bulk/General Cargo	
	Historical	Forecasted	Historical	Forecasted	Historical	Forecasted
2010	0.96%		0.24%		16.47%	
2011	-1.02%	-0.79%	10.95%	1.72%	-14.05%	14.27%
2012	-3.23%	-2.98%	2.70%	1.69%	56.07%	12.49%
2013	3.37%	3.60%	1.70%	1.66%	-3.89%	11.10%
2014	3.65%	3.87%	5.86%	1.63%		9.99%
2015		1.64%		1.61%		9.08%
2016		-0.13%		4.65%		2.08%
2017		0.92%		4.45%		2.04%
2018		0.83%		4.26%		2.00%
2019		0.75%		4.08%		1.96%
2020		0.70%		3.92%		1.92%
2021		-0.14%		4.42%		2.03%
2022		1.04%		4.23%		1.99%
2023		1.01%		4.06%		1.95%
2024		0.98%		3.90%		1.92%
2025		0.97%		3.75%		1.88%
2026		-0.50%		3.81%		1.61%
2027		0.99%		3.67%		1.58%
2028		0.96%		3.54%		1.56%
2029		0.94%		3.42%		1.53%
2030		0.61%		3.31%		1.51%
2031		0.20%		1.43%		0.80%
2032		0.20%		1.41%		0.80%
2033		0.20%		1.39%		0.80%
2034		0.20%		1.37%		0.80%
2035		0.20%		1.36%		0.80%
2036		0.20%		1.34%		0.80%
2037		0.20%		1.32%		0.80%
2038		0.20%		1.30%		0.80%
2039		0.20%		1.29%		0.80%
2040		0.20%		1.27%		0.80%
2041		0.20%		0.49%		0.80%
2042		0.20%		0.49%		0.80%
2043		0.20%		0.49%		0.80%
2044		0.20%		0.49%		0.80%
2045		0.20%		0.49%		0.80%
2046		0.20%		0.48%		0.80%
2047		0.20%		0.48%		0.80%
2048		0.20%		0.48%		0.80%
2049		0.20%		0.48%		0.80%
2050		0.20%		0.47%		0.80%
2051		0.20%		0.47%		0.80%
2052		0.20%		0.47%		0.80%
2053		0.20%		0.47%		0.80%
2054		0.20%		0.46%		0.80%
2055		0.20%		0.46%		0.80%
2056		0.20%		0.46%		0.80%
2057		0.20%		0.46%		0.80%
2058		0.20%		0.46%		0.80%
2059		0.20%		0.45%		0.80%
2060		0.20%		0.45%		0.80%

Table 26. Total Port Everglades Foreign and Domestic Cargo Throughput Forecast

Trade Concept (metric tons)	2005	2010	2015	2020	2023	2025	2030	2040	2060
Dry Bulk / General Cargo	3,396,909	852,270	1,460,315	1,612,202	1,710,471	1,775,983	1,918,548	2,077,678	2,436,625
Foreign Liquid Bulk	7,357,786	5,009,209	6,506,815	6,883,369	7,124,892	7,395,750	7,792,705	7,949,969	8,274,083
Container	4,605,283	4,732,678	5,139,336	6,335,324	7,175,075	7,734,909	9,208,759	10,528,196	11,570,013
Total Foreign Cargo	**15,359,977**	**10,594,157**	**13,106,466**	**14,830,895**	**16,010,438**	**16,906,642**	**18,920,013**	**20,555,842**	**22,280,721**
Domestic Liquid Bulk	9,278,682	9,037,653	8,281,138	8,364,281	8,414,668	8,448,259	8,533,080	8,705,286	9,060,193
Total Cargo	**24,638,659**	**19,631,810**	**21,387,603**	**23,195,176**	**24,425,106**	**25,354,901**	**27,453,093**	**29,261,129**	**31,340,915**

Note: Metric Tons

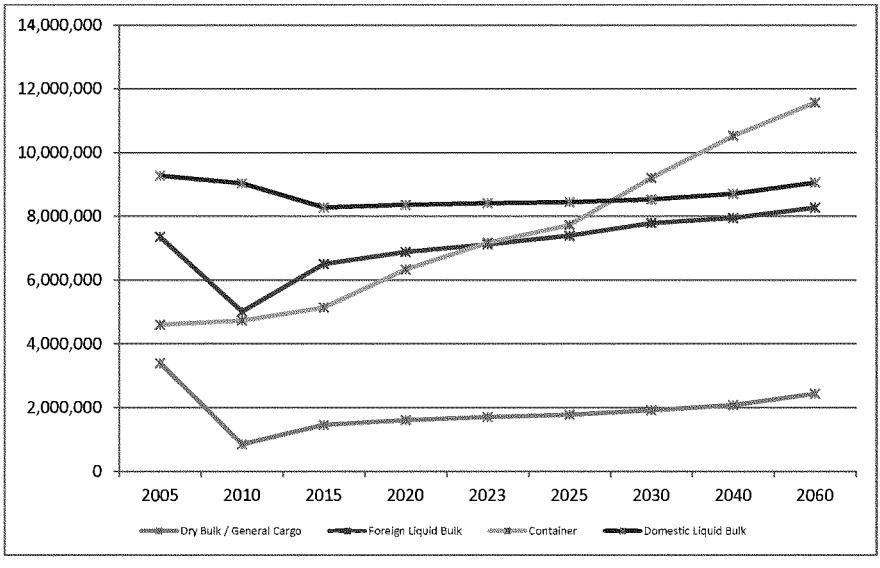

Figure 23. Graph of Total Port Everglades Cargo Throughput Forecast

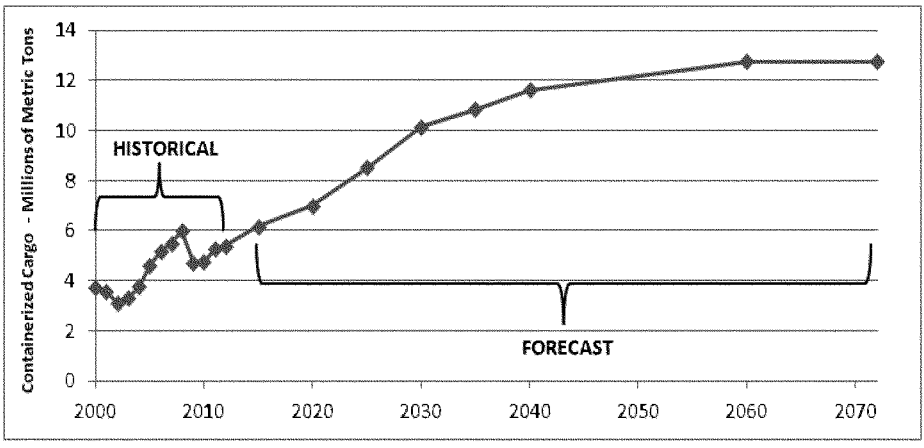

Figure 24. Graph of Historical and Forecasted Port Everglades Containerized Cargo Tonnage

6 Future Without-Project Conditions

The purpose of this section is to show how future cargo movements will affect existing identified problems (see Section 3) with no changes to the channel configuration. The section will discuss how commodity growth results were applied to the anticipated without-project vessel fleet. It will also identify assumptions behind the future without-project fleet, and provide details on the effect of the future fleet on pre-existing problems.

6.1 Future Without-Project Vessel Fleet

In the without-project condition the overall vessel fleet will remain much the same as it is today, burdened by the same set of problems and navigational constraints. The fleet for bulkers and foreign-flagged liquid petroleum tankers will not experience any shift in vessel sizes. The domestic fleet of petroleum tankers and barges will not experience any shift in the without-project condition. The cruise vessel fleet is assumed to remain unchanged as well. This is a conservative assumption because the cruise fleet may increase in size in the future. However, since cruise vessels are not primary drivers of transportation cost savings, the assumption of no change in fleet was considered sufficient for this analysis.

The containership fleet is expected to shift towards larger vessels. Over time, more new builds of Post-Panamax container vessels are expected to come into service. These vessels will be deployed on strings that call Port Everglades, as they do now, in a draft-constrained condition, without being able to fully utilize vessel capacity. Additionally, container liners would not be able to fully utilize the vessel fleets

that will be available to them. The liners are not anticipated to deploy as many Generation 2 Post-Panamax vessels[34] onto strings that service Port Everglades in the future without-project condition.

6.2 Future Without-Project Vessel Movements

Table 27 shows the forecasted number of vessel calls in the future without-project condition, projected for the years 2023, 2030, and 2060.

Table 27. Future Without-Project Vessel Calls

Vessel Class	2023	2030	2060
Sub-Panamax Containership 1 (SPX1)	1,433	1,773	1,773
Sub-Panamax Containership 2 (SPX2)	194	240	240
Panamax Containership 1 (PX1)	308	386	520
Panamax Containership 2 (PX2)	172	206	304
Post-Panamax Containership 1 (PPX1)	194	294	475
Post-Panamax Containership 2 (PPX2)	5	7	10
Tank Barge	152	154	164
Tanker 20k DWT	37	40	42
Tanker 25k-45k DWT	38	41	43
Tanker 45k-60k DWT	300	316	336
Tanker 60k-80k DWT	15	16	17
Tanker 110k DWT	0	0	0
Bulker 15k DWT	11	12	16
Bulker 25k DWT	11	12	16
Bulker 40k DWT	27	30	39
Bulker 60k DWT	5	6	7
Bulker 80k DWT	0	0	0
General Cargo Ship-15k DWT	32	36	46
General Cargo Ship-15k-25k DWT	40	45	57
General Cargo Ship-25-35k DWT	18	21	26
General Cargo Ship-35-40k	15	17	22
Ferry Ship	221	221	221
Cruise Ship-Luxury - 400 passengers	53	59	59
Cruise Ship-Small - 1200 passengers	58	64	64
Cruise Ship-Contemporary - 2600 passengers	498	552	552
Cruise Ship-Large - 4000 passengers	50	56	56
Cruise Ship-Oasis Class - 5400 passengers	132	147	147
Total	4,019	4,751	5,252

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

6.3 Future Without-Project Condition Summary

In conclusion, vessel calls will continue to increase into the future, while still being affected by the navigational constraints described earlier in Section 3.4.

[34] Generation 2 Post-Panamax vessels are characterized by having a beam greater than 140 ft, and being able to load approximately 8,000 to 10,000 TEUs.

7 Project Alternatives

The intent of this section is to introduce the options available that were studied and considered to alleviate problems, and meet project objectives. It also details the planning-level economic costs of proposed alternatives.

7.1 Description of Final Array of Alternatives

The structural project alternatives considered deepening and widening to address the problems present in the harbor. Widening the channel in strategic locations would alleviate the existing navigational constraints in the channel due to the rules against passing at the knuckle (berths 24-27). Widening would also allow for larger vessels transit more safely when fully laden. Once the widening features had been identified, deepening the channel at 1 ft incremental depths from 43' to 51' was evaluated in conjunction with widening in this analysis. The primary planning objectives were stated as:

1. Decrease costs associated with vessel delays (due to congestion, channel passing restrictions, and berth deficiencies) through the end of the period of analysis.
2. Decrease transportation costs by increasing economies of scale for cargo and petroleum vessels through the end of the period of analysis.
3. Increase channel safety and maneuverability for large vessels that are calling now and ones that are expected to call through the end of the period of analysis.

A summary of the management measures that were examined and combined to form alternative widening plans is shown in Table 28. Plan 2 was selected based on its ability to meet the most objectives while being anticipated to provide the most economic benefits. The features of Plan 2 are shown in relation to the existing project footprint in Figure 25.

Table 28. Table of Management Measures by Plan

Management 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/Deepen IEC	X	X			X	
Deepen MTB	X	X			X	
Deepen STB	X			X	X	
Widener – Shoaling Area Removal		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
Notes: Plan 6 does not have any deepening. Plans 1-5 examine the existing and greater depths incrementally.						

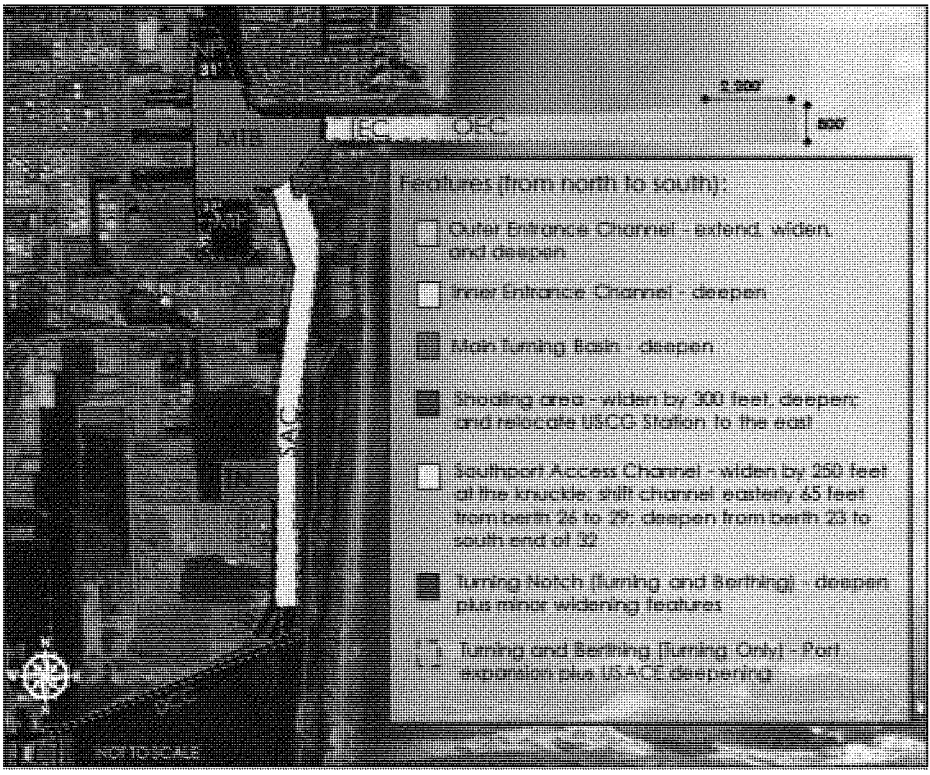

Figure 25. Features of Plan 2

7.2 Planning-level Costs

Once the final array was established as Plan 2 plus deepening at incremental depths, planning-level costs for these alternative plans were estimated. Table 29 shows the planning-level costs that were used in evaluation of the final array of alternatives.

Table 29. Planning-Level Cost Estimates Used in Economic Analysis

Project Depth (ft) +Widening	Project First Cost	Duration (days)	IDC Est. based on mid-month uniform payments	Total Investment Cost Including IDC	Average Annual Cost
42	$ 297,000,000	638	$ 8,805,585	$ 305,805,585	$ 13,037,627
43	$ 298,500,000	1,162	$ 16,745,834	$ 315,245,834	$ 13,440,099
44	$ 311,000,000	1,266	$ 19,122,309	$ 330,122,309	$ 14,074,339
45	$ 323,500,000	1,371	$ 21,646,324	$ 345,146,324	$ 14,714,868
46	$ 336,000,000	1,475	$ 24,316,928	$ 360,316,928	$ 15,361,647
47	$ 352,000,000	1,646	$ 28,639,271	$ 380,639,271	$ 16,228,064
48	$ 370,000,000	1,816	$ 33,468,003	$ 403,468,003	$ 17,201,338
49	$ 387,500,000	1,998	$ 38,843,182	$ 426,343,182	$ 18,176,591
50	$ 405,000,000	2,179	$ 44,607,715	$ 449,607,715	$ 19,168,445
51	$ 422,500,000	2,361	$ 50,768,319	$ 473,268,319	$ 20,177,184

Notes: IDC = Interest During Construction; IDC was calculated at 3.75% interest rate. Average Annual Costs were calculated at 3.5% discount rate. Costs for project alternatives at 43', 45', and 49' depths were linearly interpolated.

8 Future With-Project General Methods and Assumptions

This section describes the general methods of analyzing project alternatives versus the without-project condition. It then details the assumptions of the changes that are expected to take place in the future with-project condition.

8.1 Transportation Cost Savings

The Planning Guidance Notebook, Engineer Regulation 1105-2-100, gives specific details of what can be considered a NED benefit for deep-draft navigation improvement projects. The NED benefits for the Port Everglades Harbor feasibility study were determined using the transportation cost reduction method. Transportation cost reductions, in the most basic terms, are calculated by subtracting the total cost of moving all of the goods through the port over the period of analysis in the with-project condition from the total cost in the without-project condition.

Transportation cost savings benefits in the study were derived from increased efficiencies in the movement of cargo. For the purposes of this study, all benefits from reductions in transportation costs were assumed to have the same origin, destination, and harbor with and without the project. For the sake of simplification of the analysis, it was assumed that increased efficiencies would reduce transportation costs without affecting the demand for import and export of goods through the harbor. This means that the commodity tonnages forecast to be transited through Port Everglades are expected to move with or without the proposed improvements. There will be no expected shift in origin, destination, mode of transportation, or any induced movement of cargo due to the proposed navigation improvements. Transportation cost savings will result primarily from the use of larger, more efficient

vessels, more efficient use of large vessels that are currently transiting the harbor, and reduced congestion in the harbor.

8.2 Assumptions on Changes in With-Project Condition

Below are the general assumptions on changes in the with-project condition that will lead to transportation cost savings:

Fleet transition to larger vessels / more efficient use of existing fleet: The primary driver of transportation cost savings will be the transition to larger cargo vessels and more efficient use of existing fleet. A majority of the transportation costs accrue while the vessel is transiting at-sea. When larger vessels are utilized or the existing fleet can be utilized more efficiently by increasing loading, the cost per ton per mile of cargo drops significantly. Furthermore, the increases in efficiencies are often so great that the number of vessel calls per year can be reduced (compared to moving a similar amount of cargo in the without-project condition).

Reduced congestion and wait times: Widening features will eliminate the passing restrictions in the Southport Access Channel (SAC) while large cruise vessels are at Berths 24-27. With a greater availability for use of the SAC, congestion and wait times will be reduced, resulting in transportation cost savings. Also, the fleet transition and more efficient use of vessels will reduce the number of vessel calls required to move the forecasted cargo throughput. The reduction in number of vessel calls will also contribute to reducing congestion and wait times.

Reduced tidal delays: As the channel gets deeper, vessels that were previously tide-constrained (i.e. were so fully loaded that they could only transit at high tide) become less constrained by the need to wait for high tide. Alleviation of this constraint reduces tidal delays and transportation costs.

Finally, with a wider and deeper channel the following existing conditions will be addressed and channel users will experience improved safety[35]:

i. Outer Entrance Channel (OEC) existing dimensions and strong unpredictable cross currents combine to make entrance transit difficult under 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;
ii. The "Knuckle" area configuration restricts maneuverability and passing operations, especially when vessels are at Berths 24-25 and 26-27;
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;

[35] For more information on vessel safety problems and opportunities, see Section 4 of the Main Report.

9 Future With-Project Fleet Forecast

The fleet forecast in the future with-project condition was analyzed for each vessel type, and, in the case of containerships, by each trade route. The primary benefitting vessel types are foreign-flagged petroleum tankers and containerships. There is also expected to be some shift in the dry bulk fleet. For general cargo, domestic petroleum products, and cruise ships, no shift in vessel fleet was forecasted.

9.1 Containership Future With-Project Fleet Forecast

The total world containership fleet has been shifting towards larger Post-Panamax container vessels in recent years. Figure 26 shows that the TEU capacity of sub-Panamax and Panamax containerships has remained fairly constant over the past 15 years, while Post-Panamax containership capacity has increased dramatically from around 6,500 TEUs in 1998 to over 9,000 TEUs in 2010. This increase in capacity is also reflected in the overall dimensions of the vessels.

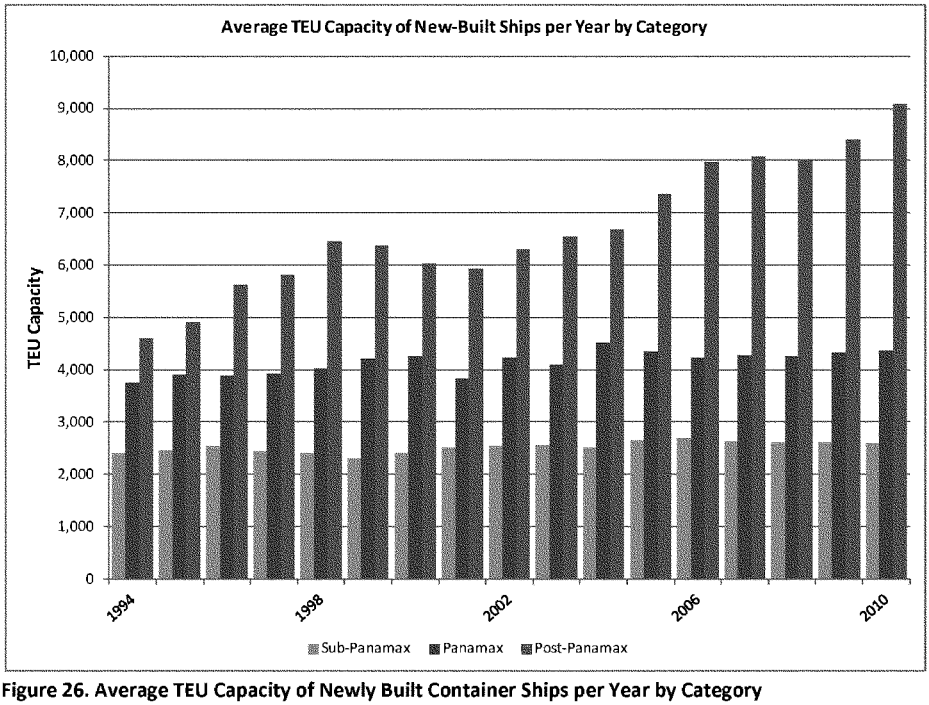

Figure 26. Average TEU Capacity of Newly Built Container Ships per Year by Category
Source: IHS Sea-web

In addition to the increasing capacity and size of Port-Panamax vessels, the number of new builds has also increased in recent years (Figure 27). With fewer than 30 new builds per year before 2000, the number of new builds reached 96 in 2010. At the same time the average design draft of all vessels built each year increased from 46.1 feet in 1998 to 47.6 feet in 2010. These increases reflect the shift from the "Generation 1" Post-Panamax containerships to the "Generation 2" Post-Panamax ships.

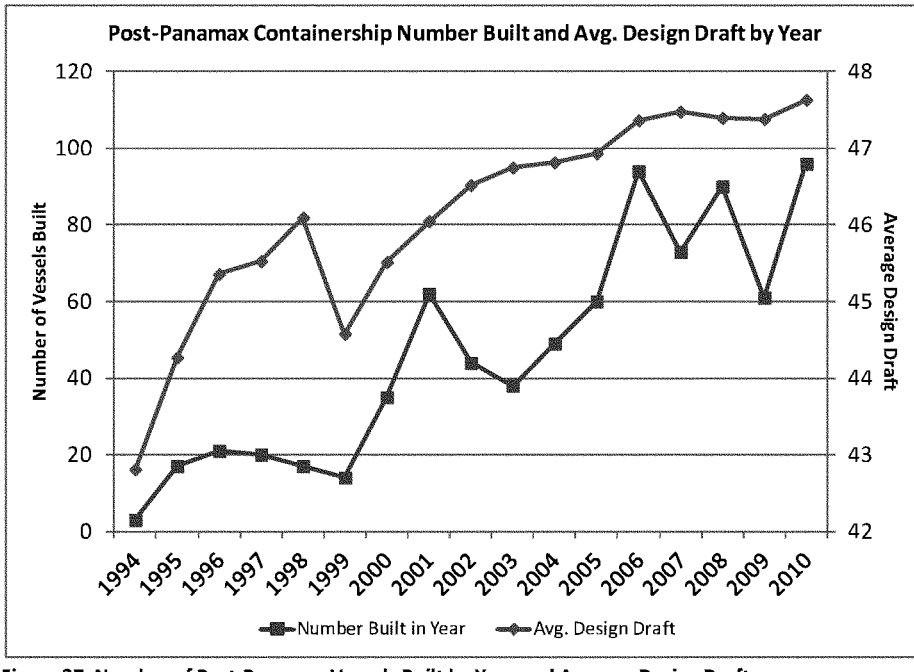

Figure 27. Number of Post-Panamax Vessels Built by Year and Average Design Draft
Source: IHS Sea-web

The addition of larger Post-Panamax containerships has contributed to changing the distribution of cargo capacity of the world containership fleet. Smaller "feeder" category ships still account for the greatest number of vessels in the world fleet (Figure 28), but Post-Panamax containerships now account for over 40% of total TEU capacity (Figure 29).

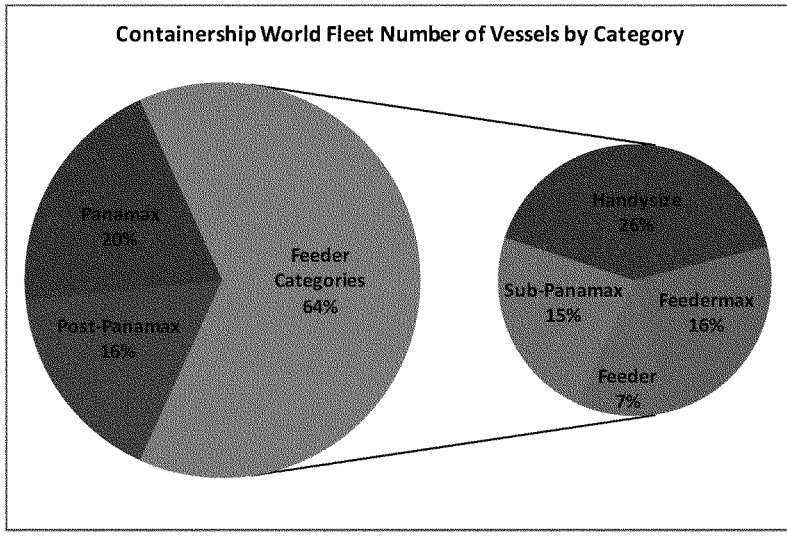

Figure 28. Percent of Number of Vessels in Containership World Fleet by Category
Source: IHS Sea-web, 2011

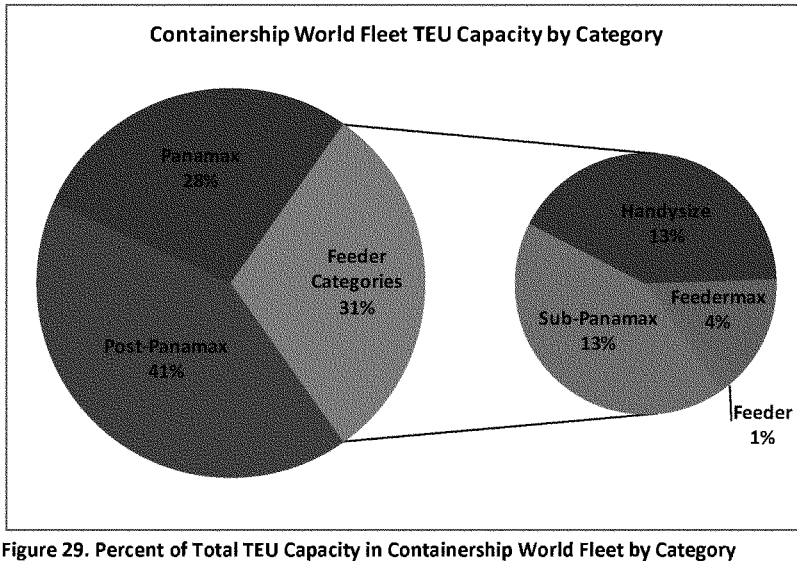

Figure 29. Percent of Total TEU Capacity in Containership World Fleet by Category
Source: IHS Sea-web, 2011

Post-Panamax containerships are already calling Port Everglades in significant numbers, and that trend is expected to increase into the future. The largest containerships that call the port are deployed on the longest trade routes, where the carriers are most able to take advantage of the economies of scale of a larger ship. The longest trade routes that currently service Port Everglades are the Europe and Mediterranean to East Coast U.S. and Gulf of Mexico pendulum route, East Coast South America to East Coast U.S. pendulum route, and West Coast South America to East Coast U.S. pendulum route. Separate fleet forecasts were used for each of these primary benefitting trade routes.

9.1.1 South America Trade Routes

East Coast South America to East Coast U.S. pendulum route (ECSA-ECUS) and West Coast South America to East Coast U.S. pendulum route (WCSA-ECUS) both used the same fleet forecast for the future with-project condition and the future without-project condition. The regional fleet forecast was derived from data provided by a consultant, and was adapted to coincide with existing fleet characteristics at Port Everglades. The existing fleet at Port Everglades does not employ any sub-Panamax vessels on the ECSA-ECUS trade route; the forecast does not include any sub-Panamax vessels on either the ECSA-ECUS or WCSA-ECUS routes.

The South America containership fleet calling Port Everglades is expected to transition to Generation 1 Post-Panamax (PPX1)[36] container vessels by the base-year (2023). This trend is expected to continue throughout period of analysis for with- and without-project conditions. There is no increase in PPX1 vessel deployment expected with increased channel depths for this trade route; efficiency is gained only from more efficient loading and increased cargo capacity as channel depths increase. A transition to larger Generation 2 Post-Panamax (PPX2) container vessels is not expected on this trade route. The amount of cargo expected to be carried by each container vessel class throughout the period of analysis is shown in Table 30.

Table 30. Forecast of South America Container Trade Routes Distribution of Cargo by Vessel Class

Vessel Class	TEU Capacity	2023 Cargo Percent	2030 Cargo Percent	2060 Cargo Percent
Panamax 1	3,500	39%	35%	30%
Panamax 2	4,800	32%	28%	27%
Post-Panamax Gen 1	6,500	29%	37%	43%

[36] See Table 45 in Section 11.3.1 for standard dimensions of vessel sizes used in the analysis.

9.1.2 Europe and Mediterranean Trade Routes

The Europe and Mediterranean to East Coast U.S. and Gulf of Mexico pendulum route (EU-MED-ECUS-GMEX) is made up of several services that each have different ports of call, but similarly sized ships, container weights, and load factors. This is the trade route with the largest vessels calling on the most frequent basis, and is the one most likely to transition to greater use of Post-Panamax Generation 2 (PPX2) vessels as the channel depth becomes deeper in the future with-project condition. The regional fleet forecast was derived from data provided by a consultant, and was adapted to coincide with existing fleet characteristics at Port Everglades. Europe and Mediterranean trade routes were combined because they both had similar vessel sizes, U.S. ports of call, and carried similar cargo. No Sub-Panamax vessels are on this trade route.

The fleet transition to Post-Panamax Generation 1 (PPX1) and Generation 2 (PPX2) container vessels is forecasted to occur by base-year (2023), and continue throughout period of analysis. Some transition to larger vessels is expected to occur in the without-project condition as the world fleet of containerships shifts towards larger vessels. However, a greater level of deployment is expected to occur in the future with-project condition, as Port Everglades channel depth is more able to accommodate larger and more fully-laden PPX2 ships. The amount of Port Everglades cargo expected to be carried by each container vessel class throughout the period of analysis by each project depth is shown in Table 31.

Table 31. Forecast of Europe and Mediterranean Trade Routes Distribution of Cargo by Vessel Class

Channel Depth	Vessel Class	TEU Capacity	2023 Cargo Percent	2030 Cargo Percent	2060 Cargo Percent
42 ft. WOP	Panamax 1	3,500	24%	24%	24%
	Panamax 2	4,800	15%	15%	15%
	Post-Panamax 1	6,500	58%	58%	58%
	Post-Panamax 2	8,700	3%	3%	3%
44 ft.	Panamax 1	3,500	17%	14%	14%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	58%	58%	58%
	Post-Panamax 2	8,700	12%	17%	17%
46 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	13%	18%	18%
47 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	14%	19%	19%
48 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	14%	19%	19%
50 ft.	Panamax 1	3,500	13%	10%	10%
	Panamax 2	4,800	13%	11%	11%
	Post-Panamax 1	6,500	61%	61%	61%
	Post-Panamax 2	8,700	14%	19%	19%

Note: Not all depths shown.

9.1.3 Caribbean Sea and Gulf of Mexico Regional Trade

Nearly half of all the containerized cargo that transits through Port Everglades is on shorter regional trade routes in the Gulf of Mexico and Caribbean Sea. Most of this trade is on smaller "feeder" class vessels which are sub-Panamax in size. There is no fleet shift expected over time, or in response to increased channel depths in the with-project condition. Therefore, the historical fleet mix was used throughout all alternatives over entire period of analysis. Approximately 83% of cargo on this trade route moves on sub-Panamax 1 class vessels that have an average capacity of about 600 TEUs, 16% of the cargo moves on sub-Panamax 2 vessels that have a 2,200 TEU capacity, and the remaining 1% of cargo on this route moves on Panamax 1 vessels with a 3,500 TEU capacity.

9.1.4 Containership Sailing Draft Distributions and Load Factors

Containership sailing drafts (particularly arrival and departure drafts at the study port) are critical to the economic analysis of channel deepening. Sailing drafts are dependent on the amount and weight of cargo on board the ship, as well as the vessel dimensions (design draft) and immersion rate (how many tons of cargo must be loaded for the vessel to sink 1 inch in the water).

The amount of cargo and weight of cargo on board the ship at arrival is not directly observable; therefore the arrival draft of the ship is not directly calculable using empirical data. So, arrival drafts for containerships by vessel class were applied based on best-available data. Departure drafts were calculated by the HarborSym model, based on cargo tonnage transferred and the vessel characteristics. The arrival drafts were applied as a distribution, based on empirical data. The sailing draft distribution for Sub-Panamax and Panamax 1 vessel classes was based on USACE Waterborne Commerce Statistics Center's "Entrances and Clearances" data from 2007-2010 for those vessel classes at all U.S. Ports. The sailing draft distribution for Panamax 2 and Post-Panamax vessel classes was based on arrival draft information provided by MSC (Mediterranean Shipping Company) for years 2010-2012 at the ports of Charleston, Norfolk, New York-New Jersey, and Long Beach. These data sets were used to determine the mean and standard deviation of the arrival draft distributions by vessel class. The arrival draft distributions were then based on a truncated normal distribution centered on a mean with upper and lower limits. The upper limit was the lower value of either the upper limit of the sailing drafts in the dataset or the channel depth. The mean, standard deviation, and upper and lower limits for each vessel class are shown in Table 32. Arrival draft distributions for containerships are shown in Figure 30 through Figure 33. Note that these figures show arrival draft distributions for the 2060 forecast year; not all project depths are included in the figures.

Table 32. Containership Sailing Draft Distribution Characteristics by Trade Route and Vessel Class

Trade Route	Vessel Class	Min. Arrival Draft (ft)	Mean Arrival Draft (ft)	Max. Arrival Draft (ft.)	Standard Deviation (ft)
ECUS-MED-EU-GMEX	Panamax 1	29.3	32.6	41.0	3.3
	Panamax 2	34.9	39.7	43.3	2.4
	Post-Panamax 1	34.1	40.2	45.0	1.9
	Post-Panamax 2	35.6	42.3	47.4	2.2
ECUS-WCSA & ECUS-ECSA	Panamax 1	28.6	31.9	41.0	3.3
	Panamax 2	34.9	39.7	43.3	2.4
	Post-Panamax 1	34.1	40.2	45.0	1.9

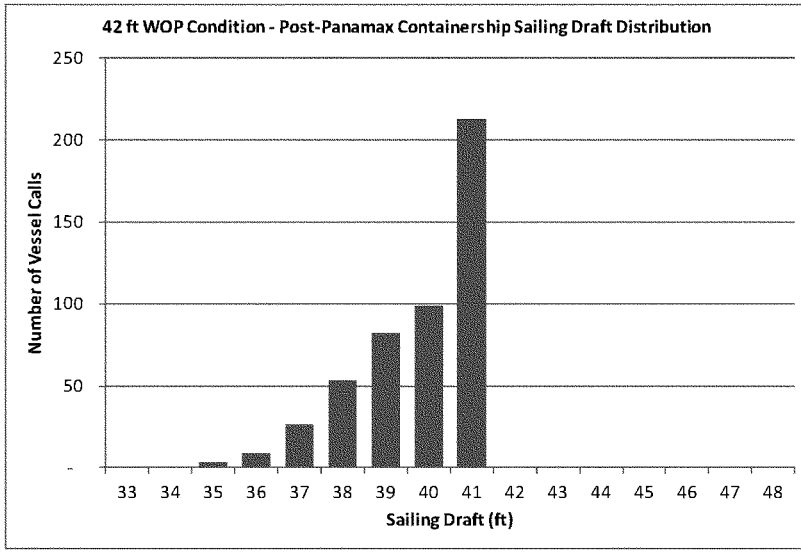

Figure 30. Post-Panamax Containership Arrival Drafts by Depth for 42 ft WOP Condition

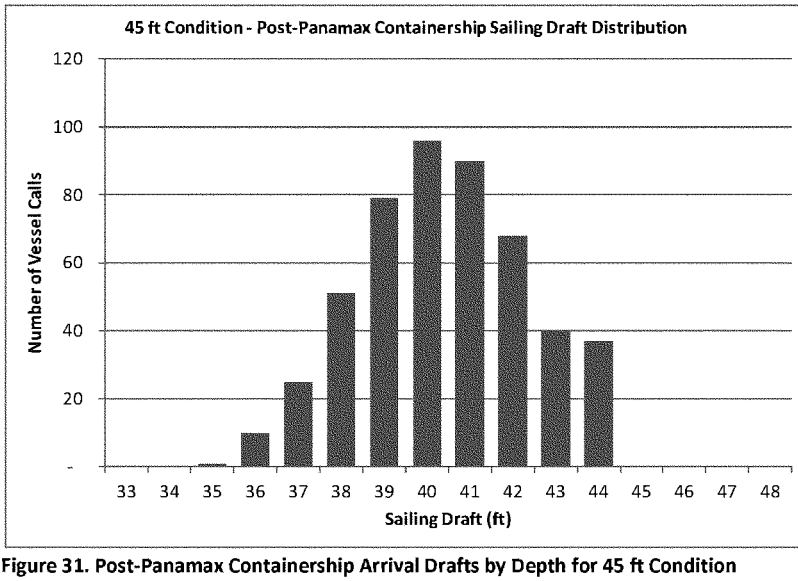

Figure 31. Post-Panamax Containership Arrival Drafts by Depth for 45 ft Condition

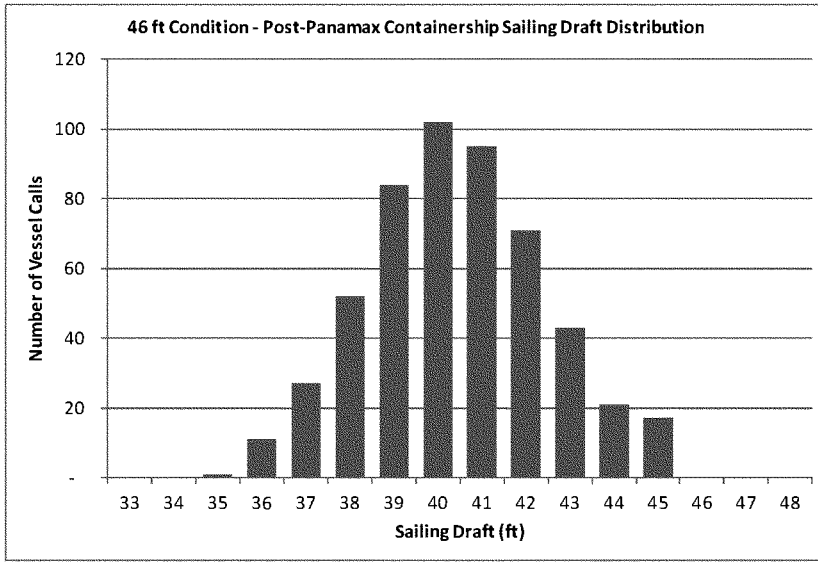

Figure 32. Post-Panamax Containership Arrival Drafts by Depth for 46 ft Condition

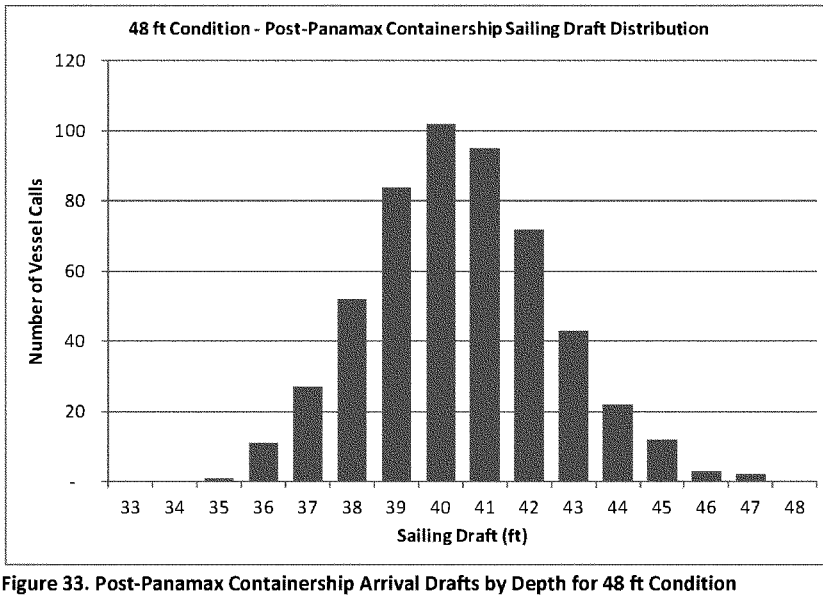

Figure 33. Post-Panamax Containership Arrival Drafts by Depth for 48 ft Condition

Containership load factors are another critical component of economic analysis of channel deepening. Load factors include: average weight per loaded TEU, percentage of loaded vs. empty TEUs, percentage of imports vs. exports, and percent vacant slots. These factors are used to determine the total tonnage of TEUs that are loaded and unloaded per call, as well as the associated change in sailing draft, and what percent of total trip cargo is actually unloaded at the port (to determine the transportation cost allocation). Load factors were determined using Port Everglades Harbormaster's data and regional data from other south Atlantic U.S. ports. A summary of the load factors used in the analysis for the primary benefitting container trade routes is shown in Table 33.

Table 33. Containership Load Factors by Trade Route

Trade Route	Laden TEU Weight (metric tons)	Percent Empties	Percent Vacant Slots	Import Percent	Export Percent
ECUS-MED-EU-GMEX	10.31	18.9%	4.65%	73%	27%
ECUS-ECSA	7.57	23.2%	6.15%	58%	42%
ECUS-WCSA	8.31	24.7%	6.15%	57%	43%

9.2 Liquid Bulk and Dry Bulk Fleet Forecast

Liquid bulk makes up the largest proportion of total cargo throughput at Port Everglades, approximately two-thirds annually. Foreign-flagged petroleum tankers are currently limited in size by channel depth, berth depth, and manifold height. The berth depth and manifold height will be addressed by improvements in the future without-project condition[37]. In the future with-project condition, as channel depth increases, larger tankers will be able to call Port Everglades, offering greater levels of efficiency.

Dry bulk vessels make up a relatively small proportion of total cargo throughput at Port Everglades, less than 5% annually. However, the largest of the dry bulk vessels that are currently calling are draft constrained in the future without-project condition, and a larger bulker could be utilized for greater efficiency in the future with-project condition.

Throughout this forecast, all bulkers and tankers are expected to load to either their full capacity or the limits of the channel depth in each with-project condition (accounting for underkeel clearance and tide-riding behavior).

9.2.1 Tanker World Fleet

The world fleet of petroleum tankers includes some of the largest ships in the world. However, the largest tankers are usually reserved for carrying crude petroleum only. Since there are no refineries in South Florida, all petroleum must be brought in already refined as "products." The fleet of vessels that

[37] See Section 4.

are suited to carry petroleum products is a subset of the world fleet of tankers. Some tankers are designed to carry both products and crude, depending on their route, and to minimize empty backhauls. For this analysis, both products tankers and products/crude tankers were included in the world fleet of tankers that could service Port Everglades in the future with-project condition. Both of these vessel types are referred to as "products tankers" throughout this section.

Tankers are grouped into sizes based on classes that were created to standardize oil contracts. The two main classification systems in use today are the Average Freight Rate Assessment (AFRA) scale and the Flexible Market scale (Table 34). The largest products tankers calling the port in the existing condition, and projected to call in the future without-project condition are 60,000 DWT to 80,000 DWT tankers, which fall in the Large Range 1 (LR-1) or Panamax class of ships. In the future with-project condition, it is expected that Large Range 2 (LR-2) or Aframax tankers would be utilized, particularly vessels in the 100,000 DWT to 120,000 DWT size range.

Table 34. Tanker Classification Scales

Fixed AFRA Scale		Flexible Market Scale	
General Purpose (GP)	10,000-24,999 dwt	Product Tanker	10,000-60,000 dwt
Medium Range (MR)	25,000 - 44,999 dwt	Panamax	60,000-80,000 dwt
Large Range 1 (LR-1)	45,000 - 79,999 dwt	Aframax	80,000-120,000 dwt
Large Range 2 (LR-2)	80,000 - 159,999 dwt	Suezmax	120,000-200,000 dwt
VLCC	160,000 - 319,999 dwt	VLCC	200,000-315,000 dwt
ULCC	320,000 - 549,999 dwt	ULCC	320,000-550,000 dwt

Source: "Scaling the Tanker Market". Surveyor (American Bureau of Shipping) (4): 5–11

In the world fleet of products tankers, there are nearly 1650 vessels in-service from 45,000 DWT to 120,000 DWT. LR-1 tankers outnumber Aframax tankers about 3.5:1, but they only represent a 1.8:1 ratio of capacity (Table 35). Within the Aframax fleet however, larger ships are more prevalent: 100,000 DWT to 120,000 DWT tankers outnumber 80,000 to 100,000 DWT tankers by a ratio of nearly 4.8:1. This large difference is the result of a shift towards larger vessels in recent years. While the total number of Aframax products tankers has not changed substantially from 2011 to 2013 (359 to 363 vessels), the number of 100,000-120,000 DWT tankers has increased by 41 ships, over a 15% increase, and the number of 80,000-100,000 DWT tankers has decreased by 37 ships, a 37% decrease (Table 36). Additionally, nearly all new builds (over 93% of vessels on-order or under construction) are in the 100,000 DWT to 120,000 DWT size range. The trend towards building more of the larger Aframax products tankers resulted in a sub-class of 100,000-120,000 DWT vessels that is 10-years newer than the 80,000-100,000 DWT vessels on average.

Table 35. Products Tankers World Fleet Composition

	45k-80k DWT Products Tanker Class (LR1)	80k-120k DWT Products Tanker Class (Aframax)	Total	Ratio of LR1 to Aframax
Number of Vessels	1,283	363	1,646	3.5
Total Capacity (DWT)	70,148,227	38,979,887	109,128,114	1.8
Percent of Total Vessels	78%	22%		
Percent of Total Capacity	64%	36%		

Source: IHS Sea-web.

Note: "Total vessels" refers to total LR1 and Aframax products tankers; "Total capacity" refers to total LR1 and Aframax products tankers capacity.

Table 36. Comparison of Aframax Products Tanker Fleet from 2011 to 2013

Aframax Products Fleet as of January 2011	Sub-Class		
	80,000 DWT to 100,000 DWT	100,000 DWT to 120,000 DWT	Total
Number of Vessels In-Service/ Launched	100	259	359
Number of Vessels On-Order/ Keel Laid / Under Construction	0	38	38
Number of Vessels Laid up/Rebuilding	0	5	5
Number of Vessels to be Broken up	0	0	0
Total	100	302	402
Average Build Year of Vessels In-Service / Launched	1994	2006	2002
Aframax Products Fleet as of June 2013	Sub-Class		
	80,000 DWT to 100,000 DWT	100,000 DWT to 120,000 DWT	Total
Number of Vessels In-Service/ Launched	63	300	363
Number of Vessels On-Order/ Keel Laid / Under Construction	3	41	44
Number of Vessels Laid up/Rebuilding	2	2	4
Number of Vessels to be Broken up	2	0	2
Total	70	343	413
Average Build Year of Vessels In-Service / Launched	1996	2006	2005

Source: IHS Sea-web.

9.2.2 Foreign-Flagged Tanker Fleet Forecast

Foreign petroleum imports make up approximately one-third of all petroleum receipts at Port Everglades. A majority of these petroleum products are gasoline, diesel fuel, and jet fuel. The historical fleet composition was used as a basis for the future without-project fleet forecast. About two-thirds of

the foreign-flagged petroleum tankers in the existing fleet of vessels calling Port Everglades are products tankers on the smaller side of the LR-1 class, approximately 45,000 to 60,000 DWT. These tankers have a near-Panamax beam, and design drafts of about 41 ft. They are very well represented in the world fleet of products tankers, and will continue to carry the largest proportion of cargo with the most vessel calls in the future without- and with-project conditions.

However, as the channel depth increases, larger and deeper-drafting vessels will become more cost-effective to transport liquid petroleum products. Considering the greater prevalence and average lower age of the 100,000-120,000 DWT Aframax products tanker vessels compared to the smaller 80,000-100,000 DWT sub-class, as well as the relative cost savings over the LR-1 class, the expected transition in the fleet of vessels calling Port Everglades will be from Medium Range (MR) tankers to LR-1 and from LR-1 to 100,000-120,000 DWT Aframax tankers. The expected transition of cargo carried by each vessel class for each project depth is shown in Table 37 and Figure 34.

Table 37. Distribution of Cargo for Foreign-Flagged Petroleum Tanker Fleet by Project Depth

Tanker Class	42 ft WOP	44 ft	45 ft	46 ft	47 ft	48 ft	49 ft	50 ft
20k DWT	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%
25-45k DWT	14.5%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
45-60k DWT	66.4%	43.9%	36.2%	35.8%	35.5%	35.3%	35.2%	35.2%
60-80k DWT	10.9%	18.8%	19.0%	19.1%	19.2%	19.2%	19.2%	19.2%
100k-120k DWT	0.0%	21.9%	29.4%	29.7%	29.9%	30.1%	30.2%	30.2%

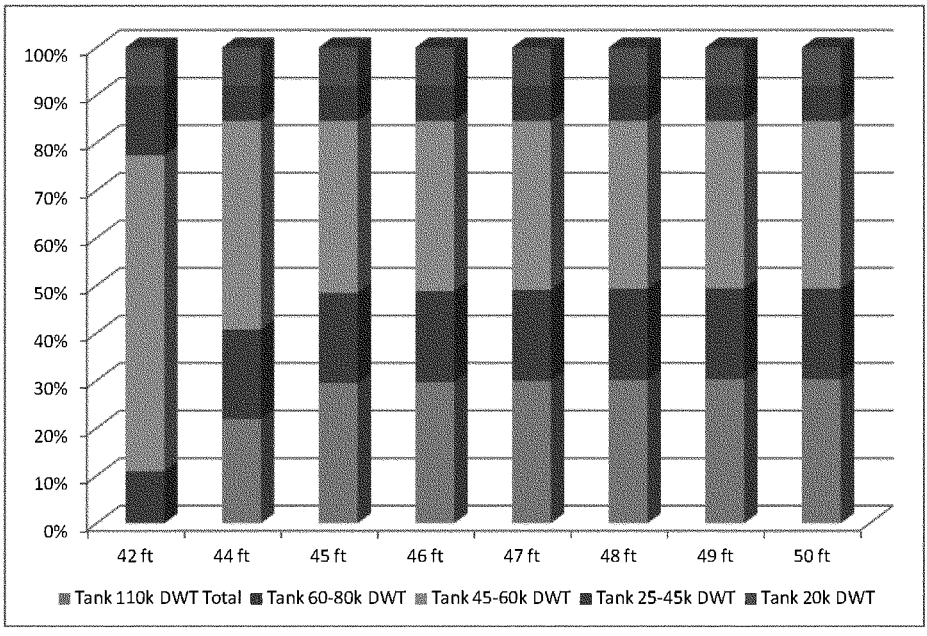

Figure 34. Distribution of Cargo for Foreign-Flagged Petroleum Tanker Fleet by Project Depth

The expected fleet transition for foreign-flagged products tankers shows that 100,000 – 120,000 DWT tankers can be employed efficiently at project depths as shallow as 44 feet, even though these large Aframax tankers have average design drafts of 49 feet. This is due to the relatively light weight of refined petroleum products being carried by these tankers. It was important to determine what specific petroleum products are moving through Port Everglades; their physical qualities and properties, including, cargo density or weight per unit of volume versus volumetric capacity of vessels as applied for the fleet forecasts. Correspondingly, the analysis needed to account for carrying capacity (limited either by weight or volume) of respective cargo type (in this case gasoline, diesel oils, and jet fuels) with immersed draft and calculate need for depth accordingly.

Refined liquid petroleum products vary considerably in density. Crude oil and residual fuels are the heaviest by volume, while "light distillates" such as gasoline and diesel are the lightest by volume (Table 38). As tankers increase in size, their hulls are designed to accommodate a large range of product densities. Since petroleum products are traded by volume and not weight, the vessels are designed to carry a specific volume of product, while accounting for the densest cargo possible. The vessels will only draw their maximum design draft when loaded with the densest products. Therefore, when loaded with any lighter products, the vessel will not draw full draft.

Table 38. Comparison of Liquid Densities

Water	Crude Oil (Mexican crude)	Marine Diesel	Jet Fuel (Jet A) / On-Highway Diesel (ULSD)	Gasoline
1,000 kg/m³	973 kg/m³	880 kg/m³	820 kg/m³	737 kg/m³

The 100,000 – 120,000 DWT vessel class is represented in the analysis by an average sized vessel of approximately 110,000 DWT. The 110,000 DWT sized representative vessel has a design draft of 49.1 ft. and liquid volume capacity of 120,315 cubic meters, which is the average volumetric capacity for the class. This volumetric capacity, when loaded with gasoline at 737 kg/ m^3, specifies that the vessel will be fully loaded (volumetrically) with only 88,672 metric tons of gasoline. Using the vessel's dimensions and immersion rates, and after accounting for underkeel clearance and tide-riding behavior, the vessel can load to nearly 97% of volumetric capacity with a 44 ft. channel depth. When loaded with diesel fuel or jet fuel, the vessel requires a 47 ft. deep channel to reach 96% loading.

9.2.3 Dry Bulk Fleet Forecast

The dry bulk forecast assumed that the next larger size bulker vessel would enter the fleet when it could be utilized at greater than 90% capacity. For dry bulk, an 80,000 DWT bulker enters the fleet at the 46 ft project depth (Table 39).

Table 39. Distribution of Cargo for Dry Bulk Vessel Fleet by Project Depth

Vessel Class	42 ft WOP	44 ft	45 ft	46 ft	47 ft	48 ft	49 ft	50 ft
Bulk 15k DWT	9%	9%	9%	8%	8%	8%	8%	8%
Bulk 25k DWT	15%	15%	15%	13%	13%	13%	13%	13%
Bulk 40k DWT	59%	58%	58%	52%	52%	51%	51%	51%
Bulk 60k DWT	17%	18%	18%	16%	16%	16%	16%	16%
Bulk 80k DWT	0%	0%	0%	11%	11%	12%	12%	12%

The annual forecasted vessel calls, based on the methods and assumptions described in the previous sections, was forecast for without- and with-project conditions. A sampling of the vessel fleet forecast at 42, 44, 46, 47, 48, and 50 ft for 2023, 2030, and 2060 is shown in Table 40,

Table 41, and Table 42. These tables also display the estimated fleet transition over the period of analysis for each channel depth.

Table 40. Without-Project (WOP) and With-Project Vessel Call Forecast for 2023

10 Class	42 ft WOP Calls	44 ft + widening Calls	46 ft + widening Calls	47 ft + widening Calls	48 ft + widening Calls	50 ft + widening Calls
Sub-Panamax Containership 1 (SPX1)	1,433	1,433	1,433	1,433	1,433	1,433
Sub-Panamax Containership 2 (SPX2)	194	194	194	194	194	194
Panamax Containership 1 (PX1)	308	270	256	254	254	254
Panamax Containership 2 (PX2)	172	159	159	159	159	159
Post-Panamax Containership 1 (PPX1)	194	188	193	193	193	193
Post-Panamax Containership 2 (PPX2)	5	18	20	21	21	21
Tank Barge	152	152	152	152	152	152
Tanker 20k DWT	37	37	37	37	37	37
Tanker 25k-45k DWT	38	20	20	20	20	20
Tanker 45k-60k DWT	300	248	230	229	228	228
Tanker 60k-80k DWT	15	25	25	25	25	25
Tanker 110k DWT	0	20	27	27	27	27
Bulker 15k DWT	11	11	10	10	10	10
Bulker 25k DWT	11	11	10	10	10	10
Bulker 40k DWT	27	27	24	24	23	23
Bulker 60k DWT	5	6	5	5	5	5
Bulker 80k DWT	0	0	3	3	3	3
General Cargo Ship-15k DWT	32	32	32	32	32	32
General Cargo Ship-15k-25k DWT	40	40	40	40	40	40
General Cargo Ship-25-35k DWT	18	18	18	18	18	18
General Cargo Ship-35-40k	15	15	15	15	15	15
Ferry Ship	221	221	221	221	221	221
Cruise Ship-Luxury - 400 passengers	53	53	53	53	53	53
Cruise Ship-Small - 1200 passengers	58	58	58	58	58	58
Cruise Ship-Contemporary - 2600 passengers	498	498	498	498	498	498
Cruise Ship-Large - 4000 passengers	50	50	50	50	50	50
Cruise Ship-Oasis Class - 5400 passengers	132	132	132	132	132	132
Total	4,019	3,936	3,915	3,913	3,911	3,911

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

Table 41. Without-Project (WOP) and With-Project Vessel Call Forecast for 2030

Class	42 ft WOP Calls	44 ft + widening Calls	46 ft + widening Calls	47 ft + widening Calls	48 ft + widening Calls	50 ft + widening Calls
Sub-Panamax Containership 1 (SPX1)	1,773	1,773	1,773	1,773	1,773	1,773
Sub-Panamax Containership 2 (SPX2)	240	240	240	240	240	240
Panamax Containership 1 (PX1)	386	320	300	297	297	297
Panamax Containership 2 (PX2)	206	184	182	181	181	181
Post-Panamax Containership 1 (PPX1)	294	283	290	290	290	290
Post-Panamax Containership 2 (PPX2)	7	35	38	39	39	39
Tank Barge	154	154	154	154	154	154
Tanker 20k DWT	40	40	40	40	40	40
Tanker 25k-45k DWT	41	21	21	21	21	21
Tanker 45k-60k DWT	316	259	239	238	237	237
Tanker 60k-80k DWT	16	27	27	27	27	27
Tanker 110k DWT	0	22	28	28	28	28
Bulker 15k DWT	12	12	11	11	11	11
Bulker 25k DWT	12	12	11	11	11	11
Bulker 40k DWT	30	30	27	26	26	26
Bulker 60k DWT	6	6	6	5	5	5
Bulker 80k DWT	0	0	3	3	3	3
General Cargo Ship-15k DWT	36	36	36	36	36	36
General Cargo Ship-15k-25k DWT	45	45	45	45	45	45
General Cargo Ship-25-35k DWT	21	21	21	21	21	21
General Cargo Ship-35-40k	17	17	17	17	17	17
Ferry Ship	221	221	221	221	221	221
Cruise Ship-Luxury - 400 passengers	59	59	59	59	59	59
Cruise Ship-Small - 1200 passengers	64	64	64	64	64	64
Cruise Ship-Contemporary - 2600 passengers	552	552	552	552	552	552
Cruise Ship-Large - 4000 passengers	56	56	56	56	56	56
Cruise Ship-Oasis Class - 5400 passengers	147	147	147	147	147	147
Total	4,751	4,636	4,608	4,602	4,601	4,601

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

Table 42. Without-Project (WOP) and With-Project Vessel Call Forecast for 2060

Class	42 ft WOP Calls	44 ft + widening Calls	46 ft + widening Calls	47 ft + widening Calls	48 ft + widening Calls	50 ft + widening Calls
Sub-Panamax Containership 1 (SPX1)	1,773	1,773	1,773	1,773	1,773	1,773
Sub-Panamax Containership 2 (SPX2)	240	240	240	240	240	240
Panamax Containership 1 (PX1)	520	423	393	389	389	389
Panamax Containership 2 (PX2)	304	272	269	268	268	268
Post-Panamax Containership 1 (PPX1)	475	456	467	467	467	467
Post-Panamax Containership 2 (PPX2)	10	53	57	59	59	59
Tank Barge	164	164	164	164	164	164
Tanker 20k DWT	42	42	42	42	42	42
Tanker 25k-45k DWT	43	23	23	23	23	23
Tanker 45k-60k DWT	336	275	253	253	252	252
Tanker 60k-80k DWT	17	29	29	29	29	29
Tanker 110k DWT	0	23	31	31	31	31
Bulker 15k DWT	16	15	14	14	14	14
Bulker 25k DWT	16	15	14	14	14	14
Bulker 40k DWT	39	38	34	34	33	33
Bulker 60k DWT	7	8	7	7	7	7
Bulker 80k DWT	0	0	4	4	4	4
General Cargo Ship-15k DWT	46	46	46	46	46	46
General Cargo Ship-15k-25k DWT	57	57	57	57	57	57
General Cargo Ship-25-35k DWT	26	26	26	26	26	26
General Cargo Ship-35-40k	22	22	22	22	22	22
Ferry Ship	221	221	221	221	221	221
Cruise Ship-Luxury - 400 passengers	59	59	59	59	59	59
Cruise Ship-Small - 1200 passengers	64	64	64	64	64	64
Cruise Ship-Contemporary - 2600 passengers	552	552	552	552	552	552
Cruise Ship-Large - 4000 passengers	56	56	56	56	56	56
Cruise Ship-Oasis Class - 5400 passengers	147	147	147	147	147	147
Total	5,252	5,099	5,064	5,061	5,059	5,059

Note: More details for each vessel class are shown in Section 11.3.1, Table 45.

11 Evaluation of Alternatives via HarborSym

To determine transportation cost savings, total transportation costs must first be determined. Total transportation costs were calculated using the Corps-certified HarborSym simulation model[38].

11.1 Model Overview

The Corps-developed HarborSym model was used to calculate transportation costs for entire routes and time in port for all vessel calls projected throughout the period of analysis. HarborSym was created by CDM-Smith (under contract) to serve as the primary economic model for deep draft navigation projects. For this study HarborSym version 1.5.5 was used for all final production modeling, and total transportation cost calculations. The HarborSym Model has been certified for use on all deep draft navigation studies in accordance with Engineering Circular 1105-2-412, Assuring Quality of Planning Models.

HarborSym performs data-driven Monte Carlo simulations of vessel transits through harbors, based on user input. The model incorporates uncertainty through randomizing parameters over multiple model iterations, based on a user-inputted range for parameters such as vessel speed through a specified area (reach), loading and unloading times at docks, docking and undocking times, at-sea distances, etc.

The simulations are based upon vessels moving through reaches from the harbor entrance to their destination dock. At each time increment (step) the model determines if each vessel can move from one node to the next, without violating transit rules. If a transit rule would be violated by a vessel entering a reach, such as passing another vessel when the channel width is too narrow, then the vessel waits until the next time step. This waiting continues until the rule is no longer violated and the vessel resumes its journey.

Harbor5ym records and accumulates the total time and cost of vessel transits through the harbor and at sea. Since many variations of events can occur over a total voyage, many iterations of the simulation were run to obtain the average values for time in the harbor, time waiting, and total operating costs of vessels in the harbor and at sea.

11.2 Modeling Assumptions

Assumptions that were included in the development of the Harbor5ym model and limitations of using the model are described in the following lists. The limitations of the model were not considered significant for the purposes of this study.

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[38] The HarborSym model estimates a subset of total transportation costs, bound by the limitations of the model. There are some additional transportation costs that are not captured by the model, such as tug assists, dockage fees, etc. The limitations of the model are listed in Section 11.2.

HarborSym Model limitations:

- Tug use and tug costs are not included.
- Wind is not simulated.
- Loading/unloading costs at the port of origin/destination (for imports/exports respectively) are not included.
- Additional handling fees at the study port or foreign port are not included.
- Pilotage costs and other terminal fees for the study port are not included.
- Hinterland transportation costs are not included.
- Ability to account for other fixed costs is not included.

Assumptions in model:

- HarborSym predefined assumptions:
    - All vessels can be classified into classes of similar representative vessels which exhibit similar operating costs and other characteristics.
    - All vessels of a similar type will have a similar commodity transfer rate for a specific commodity at a specific dock.
    - "Priority" vessel arrival times will not be randomized
    - Arrival times for non-priority vessels will vary randomly within a 24 hour window of the originally designated arrival time.
    - Costs external to the port are the same for all conditions.
- Study-specific assumptions:
    - All vessels are foreign flagged except U.S. flagged tankers and barges
    - Vessels in a vessel class for a specific commodity have the same commodity loads transferred and sailing drafts for a specific project alternative and year.
    - Dry Bulk, Liquid bulk and General Cargo vessels are assumed to load to full capacity (when channel depth allows)
    - Dry Bulk and General Cargo are assumed to have similar loads per vessel call within a class
    - Safety Zone active for all vessel types:
        - 2000 ft fore and aft for petroleum and cruise
        - 1000 ft fore and aft for all other vessel types
    - No passing or overtaking in any of the reaches from entrance channel inward to harbor

Vessel loading assumptions:

- Usable Tide: 1.5 ft
- % Empties & Vacant slots, Laden TEU weights by Benefitting Containership Trade Route are shown in Table 43.

Table 43. Containership Loading Assumptions by Trade Route

Route	Avg. Laden TEU Weight	% Empty TEUs	% Vacant Slots
ECUS-MED-EU-GMEX	10.31	18.9%	4.65%
ECUS-ECSA	7.57	23.2%	6.15%
ECUS-WCSA	8.31	24.7%	6.15%

Source: Port Everglades 2012 Harbormaster's Detailed Vessel Call Data

11.3 Model setup & calibration

HarborSym is a data-driven model. All port features, vessel types, vessel movements, and their associated parameters must be manually entered into the model, or otherwise supplied by the modeler. Data sources for this information included the USACE Waterborne Commerce Statistics Center (WCSC), USACE Institute for Water Resources, GIS mapping tools, local sponsor, port shippers, port tenants, port cargo-handlers, and harbor pilots. Figure 35 shows an example of all the necessary input data to make HarborSym function properly.

The first data entered into the model are various settings that define the location of the port, simulation parameters, and parameters to define the limits of acceptable user-inputted data. Figure 36 shows the main screen of HarborSym used to input data and set up simulation runs.

Validation settings are used to help the modeler determine the reasonableness of the data inputs. Each project alternative can be individually "validated" before performing simulation runs to check for potential input values that are outside of a normal range. For this study, only the vessel speed in reach validation settings were adjusted to better match the speeds of Port Everglades. The validation settings have no impact on the model performance.

Simulation settings are used to fine tune some of the parameters that apply to all simulation runs. These parameters can affect model performance and several values were adjusted to better represent the actual system. Only adjusted values are discussed below; other parameters were left as default.

Vessel Leg Wait Limit Count = 432

The "Vessel Leg Wait Limit Count" parameter specifies the number of time steps that a vessel should wait at any node before the vessel is "deleted" from the system, meaning that the model assumed it was stuck and could not move. This parameter was adjusted to better represent the system because the default parameter was *50*, and with a 10 minute time step, that meant that each vessel would only wait for 8.33 hours before being deleted. Since the Port Everglades has significant amounts of congestion in the future without-project condition, and arrival times were randomized, the value was increased to 437, which equates to a 3-day maximum wait time. Also, the Port has bulk commodities that move very slowly, such as aggregate and fuel oil, and the maximum wait time assumes that a ship would wait for

nearly the entire maximum load or unload time of two other ships in port at its intended berth before turning away.

Hours Added to Priority Simulation = 150

This value was changed from 50 to 150 hours to allow "priority" vessels additional time to complete their vessel calls at the end of the simulation. This ensures that all priority vessels remain in the call list, and are not left stuck in the system at the end of the simulation. Only cruise vessels were considered to be priority vessels for this project.

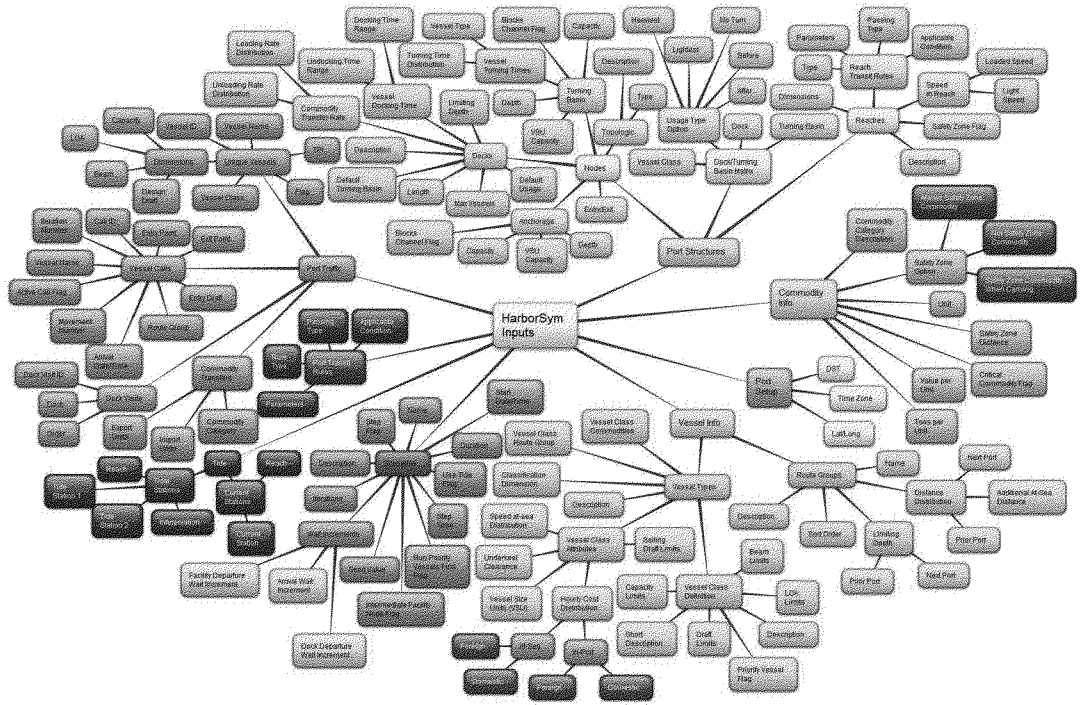

Figure 35. HarborSym Input Diagram

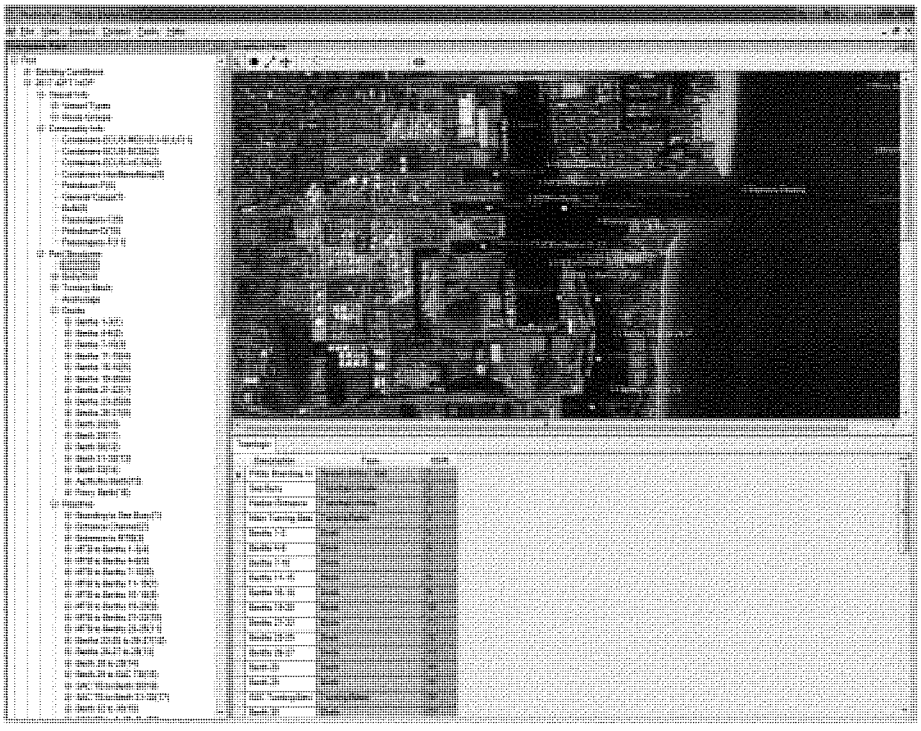

Figure 36. Example HarborSym Screen Shot

Tide and current stations are used in the model to facilitate vessel transit rules based on tide and current conditions. For this project, IWR Tide Tool (version 1.1.0) was used to determine the correct tide stations to use. No current stations were used because no transit rules were dependent on current conditions. IWR Tide Tool is a separate software program that allows the user to view tide and current station data from all over the world that has been calculated based on harmonics equations which were observed from actual data. HarborSym can then load these virtual stations into the model to be used during the simulation runs.

IWR Tide Tool contained two appropriate tide stations that were used in the model:

- Port Everglades, Turning Basin, Fort Lauderdale, FL
- South Port Everglades, ICWW, Fort Lauderdale, FL

All of the reaches from the entrance channel, to the inner channel, to the main turning basin, and the Southport Access Channel (SAC) to berths 24-25 referenced the *Port Everglades, Turning Basin* tide station. The reaches in the SAC from berths 26-27 southward used the *South Port Everglades, ICWW* tide

station. The reach from berths 24-25 to berths 26-27 used an average value of the tides from both stations.

Once all inputs are entered into the HarborSym model, it must be calibrated and the inputs adjusted to ensure that the model behaves as closely as possible to actual conditions. Existing conditions (42FT project depth and no widening features), and vessel fleet from 2012 Harbormaster's data, and 2010 Waterborne Commerce Statistics Center detailed data were used to calibrate the model. Output files that detailed the times that each vessel spent doing different activities in the port (waiting, transiting, loading/unloading, etc.) were analyzed. Numerous adjustments were then made to vessel loading times, rules, and dock capacities and dimensions. Vessel call lists that were originally provided by the harbor pilots were cleaned to match the vessel sizes used in HarborSym and vessels were set to call the correct docks with correct commodity categories. After each set of inputs were adjusted, the simulation was run again and results were compared to the previous results. This process was repeated until all model inputs satisfactorily represented real-world conditions as closely as possible.

Existing condition data was used to calibrate the model for vessel times in system, loading rates, time at dock, dock distribution for calls by vessel type, commodity transfer rates, and dock capacities. Once the future conditions were simulated, some of these parameters were recalibrated to account for changes in port infrastructure and changes in the vessel fleet. If any remaining deleted vessel calls occurred after the final calibration, then these were attributed to "noise" in the system from random arrival dates and these calls would be manually rescheduled to ensure the vessel would not be deleted.

11.3.1 Vessel Types

Vessels are defined in the HarborSym model at the type-level, and then at the class-level, a subset of vessel types. Vessel types and classes must be set up carefully because other parameters of the model are defined at either only the type-level or class-level. For example, vessel speeds in reaches and docking/undocking times are both defined at the vessel class level of detail, while turning times and commodity transfer rates are defined at the vessel type level of detail. The goal is to make vessel types and classes broad enough to encompass a large number of vessels in the fleet with similar traits, but narrow enough to have separate features compared to another class to more accurately represent the system.

Vessel types are specified manually in the vessel call list, but vessel classes are automatically classified by HarborSym based on a specific attribute (dimension) when vessels are loaded into HarborSym from a vessel call list. The vessel types and attribute upon which automatic classification is based is shown in Table 44. The classification option dimension is used to separate vessel classes within a vessel type. For example, if *Beam* is selected as the classification option, then in the vessel class definition settings each class will be given a discrete range of lengths that vessels in a class will fall into, such as 107 ft to 139 ft.

Table 44. HarborSym Vessel Types and Classification Options

Vessel Type		Classification Options			
Type	Description	LOA	Beam	Draft	Capacity
Sub-Panamax	Sub-Panamax Containerships	☐	☐	☐	☑
Barge	US-Flag Tank Barge	☐	☐	☐	☑
Tanker	Tanker Ship	☐	☐	☐	☑
Bulker	Bulker Ship	☐	☐	☐	☑
Gen Cargo	General Cargo Ship	☐	☐	☐	☑
Ferry	Ferry Ship	☐	☐	☐	☑
Cruise	Cruise Ship	☐	☐	☐	☑
Panamax	Panamax Containership	☐	☐	☑	☐
Post-Panamax	Post-Panamax Containerships	☐	☑	☐	☐

One of the main assumptions of HarborSym is that the fleet of vessels calling the study port can be represented by a fleet of vessels that fall into definitive categories, or classes, which exhibit similar characteristics in transit speeds, loading rates, and other maneuvering times. Many of the vessel classes were separated to correspond with actual clusters of vessel sizes calling Port Everglades and/or were based on Corps'-published Vessel Operating Cost tables from Engineering Guidance Memorandum (EGM) 11-05, developed by the Institute for Water Resources. Vessel class attributes define the Vessel Size Units[39] (VSUs), underkeel clearance, speeds at sea, sailing draft limits, and hourly operating costs for each vessel class. Table 45 shows all of the vessel classes and their attributes that were used to represent the fleet of vessels that are expected to call Port Everglades in the future with- and without-project conditions.

[39] VSU is further described below in Section 11.3.2

Table 45. Vessel Classes and Dimensions Used in HarborSym

Vessel Type	Vessel Class Name	Classification Category	Classification Criteria	Typical Max Cargo Capacity	Typical LOA (ft)	Typical Beam (ft)	Typical Design Draft (ft)	Typical DWT	Underkeel Clearance (ft)
Sub-Panamax Container	SPX1	DWT	0-12,500 DWT	600 TEU	433.0	70.6	25.2	9,500	2
Sub-Panamax Container	SPX2	Capacity	12,501-42,999 DWT	2,200 TEU	669.2	93.5	36.8	31,900	2
Panamax Container	PX1	Draft	< 42 ft	3,500 TEU	797.9	106.4	40.4	46,400	2.5
Panamax Container	PX2	Draft	>= 42 ft	4,800 TEU	935.3	106.4	43.6	65,000	3
Post-Panamax Container	PPX1	Beam	107-139 ft	6,500 TEU	1,027.0	131.5	45.7	80,700	3
Post-Panamax Container	PPX2	Beam	140 ft +	8,700 TEU	1,119.1	143.5	48.1	103,000	3.5
Barge	US Tank Barge	Capacity	20k DWT	18,000 DWT	630.0	86.0	33.1	20,000	3
Tanker	Tank 20k DWT	Capacity	<25k DWT	18,000 DWT	518.6	80.2	32.3	20,000	3
Tanker	Tank 25-45kDWT	Capacity	25k-44.9k DWT	32,200 DWT	575.2	91.3	35.5	35,000	3
Tanker	Tank 45-80kDWT	Capacity	45k-79.9k DWT	55,200 DWT	662.9	108.4	40.6	60,000	3.5
Tanker	Tank 90kDWT	Capacity	80k+	82,800 DWT	757.5	127	46.2	90,000	4
Tanker	Tank 110kDWT	Capacity	110k DWT	109,900 DWT	806.8	140.3	49.1	101,000	4
Bulker	Bulk 15kDWT	Capacity	0-20k	13,500 DWT	510.0	78.8	29.6	15,000	2
Bulker	Bulk 25k DWT	Capacity	20-30k	23,000 DWT	549.9	84.7	32.3	25,000	2
Bulker	Bulk 40k DWT	Capacity	30-50k	36,800 DWT	607.0	93.1	36.2	40,000	2
Bulker	Bulk 60k DWT	Capacity	50-70k	55,200 DWT	677.7	103.8	41.0	60,000	2.5
Bulker	Bulk 80k DWT	Capacity	70-100k	73,600 DWT	742.2	113.9	45.3	80,000	3
Gen Cargo	GC-15k	Capacity	<15 k DWT	9,900 DWT	433.2	65.5	26.4	11,000	2
Gen Cargo	GC 15-25k	Capacity	15k-25k DWT	18,000 DWT	520.6	78.8	32.0	20,000	2
Gen Cargo	GC 25-35k	Capacity	25-35k DWT	27,000 DWT	587.9	89.2	36.1	30,000	2
Gen Cargo	GC 37.5k	Capacity	35k+	33,750 DWT	635.1	96.5	39.0	37,500	2.5
Ferry	Ferry	Capacity	400-500 pass.	500 pass	241.5	85.3	9.5	197	2
Cruise	Cruise-400	Capacity	200-600 pass.	600 pass	650.2	85.3	20.9	5,000	2
Cruise	Cruise-1200	Capacity	600-1,400 pass.	1,400 pass	719.1	101.1	25.3	7,637	2
Cruise	Cruise-2600	Capacity	1,800-3,200 pass.	2,600 pass	949.9	118.2	27.9	8,418	2
Cruise	Cruise-4000	Capacity	3,600-4,400 pass.	4,400 pass	1,111.9	126.6	28.9	10,600	2
Cruise	Cruise-5400	Capacity	5,400 pass.	5,400 pass	1,184.4	154.2	30.5	15,000	2

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11.3.2 Port structures

The port structures entered into HarborSym provide a framework for simulated vessel movements to interact in the harbor. They are supposed to represent the actual structures and features of the port, but they are sometimes consolidated or adjusted in the model for the purposes of simplification or to work around limitations of the model. Figure 37 shows the nodes and reaches, which make up the visual representation of the harbor channel and detailed port/dock layout as they appear in HarborSym. Note that some reaches may not be to scale.

Port Everglades only has one direct connection to the ocean. Therefore, only one Entry/Exit feature was included in the model with the name "Pilots Boarding Area". The entry/exit point is also the point where arriving vessels will wait until the channel is clear for them to transit through to their designated dock.

The Atlantic Intracoastal Waterway (AIWW) also intersects with the main turning basin in Port Everglades Harbor. However, no cargo vessels use this route when arriving at or departing from the port. Therefore, the AIWW entry/exit was not included in the model. Expansion of the Dania Cutoff Canal (DCC) was dropped from the analysis and therefore it was not included in the model either.

Port Everglades Harbor has two turning basins that were evaluated in the analysis. Both were included in the model. The parameters for these turning basins in the model are shown in Table 46 below.

Table 46. HarborSym Turning Basin Parameters

Description	Vessel Capacity	Limiting Depth	Blocks Channel?	VSU Capacity
Main Turning Basin	1	42 ft	NO	185
SAC Turning Basin	1	42 ft	YES	160

Note: Limiting Depth shown is for existing conditions. Limiting depth increases with project depth for with-project simulations.

Vessel size units (VSUs) are an arbitrary measure of vessel sizes that are used to determine maximum capacity of nodes such as turning basins, anchorages, and docks. For this study, VSUs were calculated as LOA * Beam / 1000, rounded to the nearest 5. Then, VSU capacities for docks and the turning basin were adjusted to put realistic limits on these nodes. For the main turning basin, since only one vessel could occupy it at a time, 185 VSU maximum capacity would not restrict any vessel from using the turning basin, as the largest VSU value for any ship is 185. For the SAC Turning Basin, the largest vessel that would use it has a VSU rating of 160.

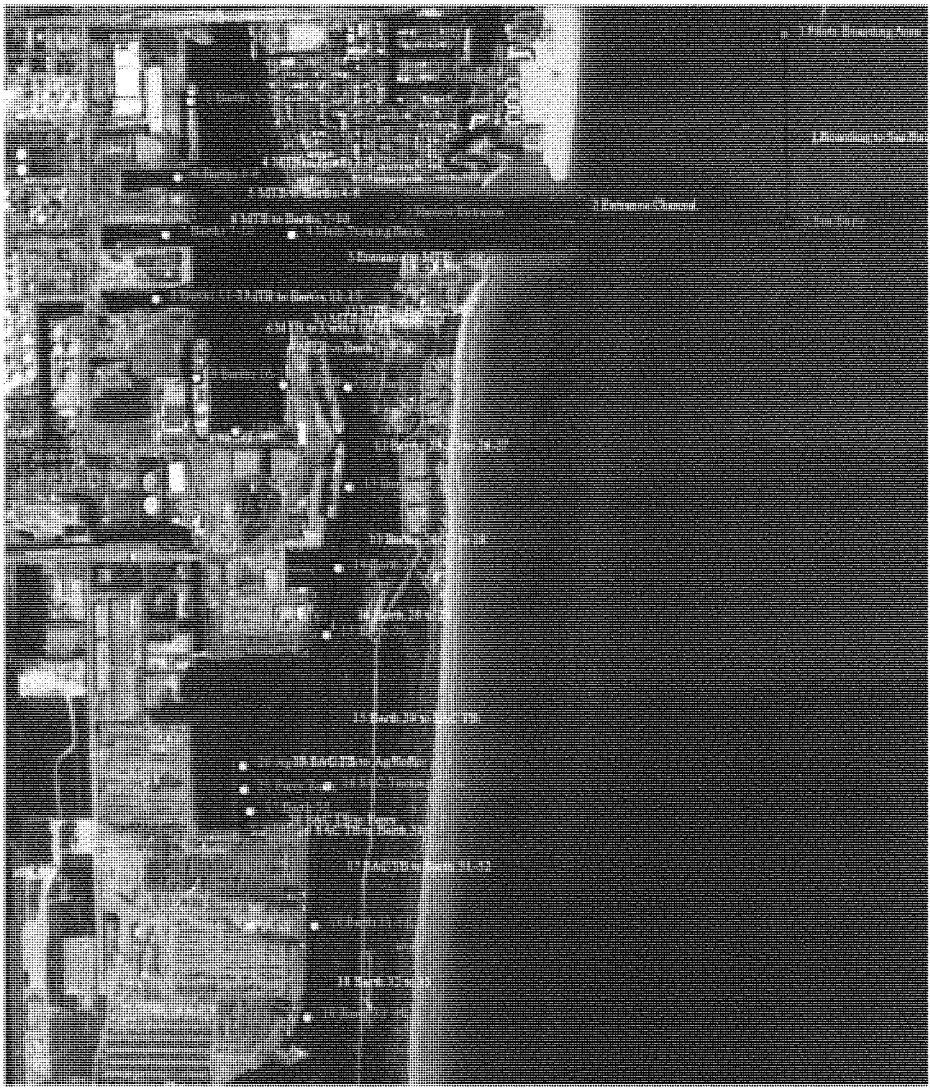

Figure 37. HarborSym Linked Node Network

Every ship must turn before or after docking. While the use of the turning basin before or after docking is determined at the dock level, the turning basin times are specified for the turning basin by vessel

type. Table 47 shows the turning-times for each vessel type that were used in the model. The same times were used for all vessel types and for both turning basins.

Table 47. HarborSym Turning Basin Times by Vessel Type

	Turning Time (hrs)		
Vessel Type	Min	Most Likely	Max
Sub-Panamax	0.25	0.3	0.4
Barge	0.25	0.3	0.4
Tanker	0.25	0.3	0.4
Bulker	0.25	0.3	0.4
Gen Cargo	0.25	0.3	0.4
Ferry	0.25	0.3	0.4
Cruise	0.25	0.3	0.6
Panamax	0.25	0.3	0.6
Post-Panamax	0.25	0.3	0.6

In the HarborSym model, "docks" are designated to represent the berthing areas of the port. For simplification purposes, several berths can be combined into a single dock in the model. For this study, some single berths were designated as a single dock, while some combinations of multiple berths were combined into a single dock. The parameters specified for each dock are description, length, limiting depth, maximum number of vessels, default turning basin to use, default time or condition to use turning basin, and vessel size unit (VSU) capacity. VSUs were discussed above in this section. The dock parameters used for each project condition are shown in Table 48, below.

Table 48. HarborSym Dock Parameters

Dock Description	Length (ft)	Limiting Depth (ft)	Max Vessels	Default Turning Basin	Default Usage	VSU Capacity
Berths 1-3	1601	31	4	Main Turning Ba	After	170
Berths 4-6	1150	46	5	Main Turning Ba	Before	145
Berths 7-10	1200	46	4	Main Turning Ba	Before	220
Berths 11-15	1226	46	4	Main Turning Ba	Before	170
Berths 16-18	1648	38	2	Main Turning Ba	After	190
Berths 19-20	1300	36	2	Main Turning Ba	Before	150
Berths 21-22	1475	36	2	Main Turning Ba	Before	150
Berths 23-25	1369	46	2	Main Turning Ba	Lightest	190
Berths 26-27	1337	46	2	Main Turning Ba	Lightest	150
Berth 28	550	46	5	Main Turning Ba	NoTurn	35
Berth 29	800	46	2	SAC Turning Bas	After	145
Berth 30	2400	46	4	SAC Turning Bas	Before	280
Berth 31-32	2000	46	4	SAC Turning Bas	Before	260
Berth 33	1100	46	3	SAC Turning Bas	Before	130
Ag/RoRo Berth	1000	46	2	SAC Turning Bas	Before	90
Ferry Berth	600	46	1	SAC Turning Bas	Before	25

Note: Limiting Depth shown is for existing conditions. Limiting depth increases with project depth for with-project simulations.

Each dock also allows for specification of vessel docking and undocking times by vessel class (Table 49). All vessel docking and undocking times were based on information supplied by the harbor pilots and port tenants. Docking/undocking times remained the same for all docks across all project conditions.

Table 49. HarborSym Docking and undocking times

Docking Time (hrs)		Undocking Time (hrs)	
Min	Max	Min	Max
0.5	0.75	0.333	0.5

Reaches in HarborSym represent the channel lengths that vessels must travel from the ocean to reach their docks. Each reach has the parameters of length, width, depth, description, and a flag of whether or not the safety zone is active (Table 50).

Table 50. HarborSym Reach parameters

Length (ft)	Width (ft)	Depth (ft)	Description
12152	1000	60	Boarding to Sea Buoy
10633	450	42	Entrance Channel
1216	1200	42	Entrance to MTB
2387	1200	31	MTB to Berths 1-3
1682	1200	42	MTB to Berths 4-6
1373	1200	42	MTB to Berths 7-10
1435	1200	42	MTB to Berths 11-15
1961	1200	38	MTB to Berths 16-18
2330	1200	36	MTB to Berths 19-20
1590	1200	36	MTB to Berths 21-22
1645	400	42	MTB to Berths 23-25
1532	400	42	Berths 23-25 to 26-27
855	400	42	Berths 26-27 to 28
659	400	42	Berth 28 to 29
2154	400	42	Berth 29 to SAC TB
1075	400	42	SAC TB to Berth 30
1455	400	42	SAC TB to Berth 31-32
1136	400	42	Berth 32 to 33
1500	400	42	SAC TB to Ag/RoRo
1800	400	42	SAC TB to Ferry

Each reach has parameters for vessel speed by vessel type and transit rules. Vessel speeds were provided by the harbor pilots, and are shown in Table 51 below.

Table 51. HarborSym Speeds in reaches

Reach	Light Speed (knots)	Loaded Speed (knots)
Boarding to Sea Buoy	12	11
Entrance Channel	7	6
Entrance to MTB	5	4
MTB to all berths in MTB (berths 1-22)	2	1
MTB to SAC	3	2
SAC	3	2
SAC TB to all berths in Southport (berths 30-33)	2	1

11.3.3 Commodity Types

Commodities in HarborSym require several parameters in their definition: Description, Unit, Tons per unit, Value per unit, Critical Commodity, Safety Zone Type, and Safety Zone Distance. The primary parameters for each commodity used in this study are shown in Table 52. The commodity units must be selected from either tons, passengers, containers, or automobiles. Commodity units and tons per unit will affect commodity transfer rates, which are specified in commodity units per hour, commodity loads, which are specified in commodity units, and vessel tones per inch (TPI) immersion rates, which are specified in metric tons per inch. All of the bulk cargoes are specified as the "Tons" unit, and their "Tons per unit" are all 1. The "passengers" unit was used for passengers, and the "containers" unit was used for containers.

Table 52. HarborSym Commodity Types and Tons per Unit

Description	Unit	Tons Per Unit
Containers-ECUS-MED-EU-GULF	Containers	10.36
Containers-ECUS-ECSA	Containers	7.81
Containers-ECUS-WCSA	Containers	8.26
Containers-NonBenefitting	Containers	9.22
Petroleum-F	Tons	1
General Cargo	Tons	1
Bulk	Tons	1
Passengers-C	Passengers	0.1
Petroleum-D	Tons	1
Passengers-F	Passengers	0.1

11.3.4 Rules

In HarborSym, vessel transit rules govern the way vessels interact with each other and how they move in the system. Transit rules may be created to better simulate actual conditions and practices, or they may represent rules that restrict movements which are imposed by the harbor pilots. For this study, rules were created for both of these reasons.

Transit rules may be defined at the port level and at the reach level. Port-level rules will apply to all "projects" (alternative scenarios) within the model (Table 53). These rules are best suited for transit restrictions that will *not* change from the without-project to the with-project condition. Reach-level rules are specific to each reach and are contained within an individual project. These rules are best suited to transit restrictions that will change from the without-project to the with-project condition, and those that will change across different project depths.

Table 53. HarborSym Port-Level Transit Rules

Active	Rule Type	Applicable Condition	Vessel Passing Type
☑	Maintain Safety Zone	Always	Not Applicable
☑	Draft Exceeds Depth Using Tide/Underkeel	Always	Not Applicable

The "Maintain Safety Zone" rule at the port-level is meant to simulate a normal transit distance between all vessels in the channels. The safety zone was set to 2000 ft fore and aft of all cruise vessels and petroleum-carrying vessels, and 1000 ft fore and aft of all other vessel types. The "Draft Exceeds Depth Using Tide/Underkeel" rule activates the underkeel clearance parameters and use of tide for each vessel transiting throughout the harbor.

11.3.5 Routes

Route groups represent the distances that vessels travel outside the study port to other ports along their respective routes. For this study, most of the route groups that were included apply to cargoes and vessel types that will benefit from channel deepening. Other vessel types and commodities that will not benefit from channel deepening were assigned to the "Default Route Group," "CARIB-Non-Benefitting," "FF-Incidental," or "DF-Incidental" routes, which only have a placeholder insignificant distance of 1 nautical mile for each leg of the journey. Route group distances are summarized in Table 54.

Table 54. HarborSym Route Groups[40]

		Prior Port			
Name	Description	Min Distance	Most Likely	Max Distance	Limiting Depth
Default RtGrp	Default route group created by HarborSym	1	1	1	85
ECUS-MED-EU-GMEX	Container route for US East Coast, Gulf Coast, Mediterranean and Europe	380	513	779	85
ECUS-ECSA	Container route for US East Coast & East Coast South America	302	302	411	85
ECUS-WCSA	Container route for US East Coast & West Coast South America	411	777	1143	85
CARIB-Non-Benefitting	Containerized cargo on non-benefitting Caribbean trade	1	1	1	85
PetroleumRoute	Foreign-flagged petroleum tanker routes	180	3223	9827	85
DryBulk Route	Foreign-flagged dry bulker routes	78	995	9896	85
FF-Incidental	Other cargo & passengers on non-benefitting foreign-flagged vessels	1	1	1	85
DF-Incidental	Other cargo on non-benefitting domestic-flagged vessels	1	1	1	85

	Next Port				Additional Sea Distance			
Name	Limiting Depth	Min Distance	Most Likely	Max Distance	Limiting Depth	Min	Most Likely	Max
Default RtGrp	85	1	1	1	85	1	1	1
ECUS-MED-EU-GMEX	85	78	1881	4536	85	6604	9390	12176
ECUS-ECSA	85	3015	3015	3815	85	9305	9795	10285
ECUS-WCSA	85	945	1044	1143	85	7304	7688	8072
CARIB-Non-Benefitting	85	1	1	1	85	1	1	1
PetroleumRoute	85	78	840	8972	85	1	1	1
DryBulk Route	85	180	730	9896	85	1	1	1
FF-Incidental	85	1	1	1	85	1	1	1
DF-Incidental	85	1	1	1	85	1	1	1

11.4 Model runs

Once the model was fully set up and calibrated, the with- and without-project conditions were simulated by loading each project condition with its corresponding fleet of vessel calls and commodity transfers. Since simulating every single depth and every model year would have been an enormous task, only a representative sample of model years and project depths were simulated, with other values interpolated (Table 56). The interpolations between depths and years were a standard linear interpolation.

[40] The limiting depth of 85 feet is the default depth input in the HarborSym model. The default input was used in the analysis based on the assumption that the limiting port on each trade route is Port Everglades at 42 feet. Vessels were not allowed to sail inbound/outbound greater than the limitations of Port Everglades at each alternative depth.

Table 55. Management measure descriptions and short name reference

Management Measures	Short Name
Outer Entrance Channel (OEC) Deepening & Widening	OEC
Inner Entrance Channel (IEC) Deepening	IEC
Main Turning Basin (MTB) Deepening	MTB
"Widener" - Widening of turn to Southport Access Channel; shoaling area	Widener
Southport Access Channel (SAC) Widening	SAC
Turning Notch Deepening	TN

Table 56. Matrix of model runs

	Depths									
Project Alternatives	**42 ft**	**43 ft**	**44 ft**	**45 ft**	**46 ft**	**47 ft**	**48 ft**	**49 ft**	**50 ft**	**51 ft**
Without Project	✓									
OEC + IEC + MTB + Widener + SAC + TN + Deepening (43'-51')			✓		✓	✓	✓		✓	

Notes: Simulation years were 2017, 2030, 2040, and 2067. After running 46 ft, 47 ft, 48 ft, and 50 ft depth alternatives it became evident that 44 ft alternative would not be justified, and therefore it was dropped from the modeling.

11.5 Model Outputs

The primary output of the model used to determine transportation cost savings is total transportation costs[41] for each alternative by year. These total transportation cost values were determined based on the averages of multiple iterations of model runs. In this case, 100-iteration model runs were used to determine the average total transportation costs. Initial runs were conducted for 10 iterations, and the average total transportation cost per year per condition varied from the 100 iteration runs by less than 0.1%. The results were interpolated over the period of analysis and across project depths and then annualized and present-valued. Table 57 and The figures below display the benefits by commodity type. As can be seen, at a 47 foot project depth, containerized cargo and petroleum make up approximately 97% of the total benefits. At a 48 foot project depth, these two trade concepts generate about 95% of the total benefits.

[41] "Total transportation costs" in this context refers only to the total transportation costs that are calculated by the HarborSym model. The model does not account for all costs as mentioned in Section 11.2.

Table 57. Total Transportation Costs by Project Condition for Each Model Year

Year	W/O-Project Transportation Costs	45 FT Project Transportation Costs	46 FT Project Transportation Costs	47 FT Project Transportation Costs	48 FT Project Transportation Costs	49 FT Project Transportation Costs	50 FT Project Transportation Costs
2023	$ 591,119,605	$ 560,784,822	$ 557,710,241	$ 554,016,717	$ 553,502,629	$ 553,495,814	$ 553,488,999
2024	$ 606,890,797	$ 575,605,692	$ 572,116,664	$ 568,617,269	$ 567,852,876	$ 567,845,010	$ 567,837,143
2025	$ 622,661,988	$ 590,426,562	$ 586,523,087	$ 583,217,821	$ 582,203,123	$ 582,194,206	$ 582,185,288
2026	$ 638,433,180	$ 605,247,432	$ 600,929,510	$ 597,818,373	$ 596,553,370	$ 596,543,401	$ 596,533,432
2027	$ 654,204,371	$ 620,068,302	$ 615,335,934	$ 612,418,925	$ 610,903,618	$ 610,892,597	$ 610,881,577
2028	$ 669,975,563	$ 634,889,172	$ 629,742,357	$ 627,019,478	$ 625,253,865	$ 625,241,793	$ 625,229,721
2029	$ 685,746,754	$ 649,710,042	$ 644,148,780	$ 641,620,030	$ 639,604,112	$ 639,590,989	$ 639,577,866
2030	$ 701,517,946	$ 664,530,913	$ 658,555,203	$ 656,220,582	$ 653,954,359	$ 653,940,185	$ 653,926,011
2031	$ 706,836,128	$ 669,552,105	$ 663,552,990	$ 661,303,582	$ 659,078,553	$ 659,064,261	$ 659,049,970
2032	$ 712,154,310	$ 674,573,297	$ 668,550,777	$ 666,386,582	$ 664,202,747	$ 664,188,338	$ 664,173,930
2033	$ 717,472,492	$ 679,594,490	$ 673,548,564	$ 671,469,582	$ 669,326,941	$ 669,312,415	$ 669,297,889
2034	$ 722,790,675	$ 684,615,682	$ 678,546,351	$ 676,552,583	$ 674,451,135	$ 674,436,492	$ 674,421,848
2035	$ 728,108,857	$ 689,636,874	$ 683,544,137	$ 681,635,583	$ 679,575,329	$ 679,560,569	$ 679,545,808
2036	$ 733,427,039	$ 694,658,067	$ 688,541,924	$ 686,718,583	$ 684,699,523	$ 684,684,645	$ 684,669,767
2037	$ 738,745,221	$ 699,679,259	$ 693,539,711	$ 691,801,583	$ 689,823,717	$ 689,808,722	$ 689,793,727
2038	$ 744,063,404	$ 704,700,451	$ 698,537,498	$ 696,884,583	$ 694,947,911	$ 694,932,799	$ 694,917,686
2039	$ 749,381,586	$ 709,721,644	$ 703,535,285	$ 701,967,584	$ 700,072,105	$ 700,056,876	$ 700,041,646
2040	$ 754,699,768	$ 714,742,836	$ 708,533,071	$ 707,050,584	$ 705,196,299	$ 705,180,952	$ 705,165,605
2041	$ 760,017,950	$ 719,764,028	$ 713,530,858	$ 712,133,584	$ 710,320,493	$ 710,305,029	$ 710,289,565
2042	$ 765,336,133	$ 724,785,221	$ 718,528,645	$ 717,216,584	$ 715,444,688	$ 715,429,106	$ 715,413,524
2043	$ 770,654,315	$ 729,806,413	$ 723,526,432	$ 722,299,584	$ 720,568,882	$ 720,553,183	$ 720,537,484
2044	$ 775,972,497	$ 734,827,605	$ 728,524,219	$ 727,382,585	$ 725,693,076	$ 725,677,259	$ 725,661,443
2045	$ 781,290,679	$ 739,848,798	$ 733,522,005	$ 732,465,585	$ 730,817,270	$ 730,801,336	$ 730,785,403
2046	$ 786,608,861	$ 744,869,990	$ 738,519,792	$ 737,548,585	$ 735,941,464	$ 735,925,413	$ 735,909,362
2047	$ 791,927,044	$ 749,891,182	$ 743,517,579	$ 742,631,585	$ 741,065,658	$ 741,049,490	$ 741,033,321
2048	$ 797,245,226	$ 754,912,375	$ 748,515,366	$ 747,714,585	$ 746,189,852	$ 746,173,566	$ 746,157,281
2049	$ 802,563,408	$ 759,933,567	$ 753,513,153	$ 752,797,585	$ 751,314,046	$ 751,297,643	$ 751,281,240
2050	$ 807,881,590	$ 764,954,760	$ 758,510,939	$ 757,880,586	$ 756,438,240	$ 756,421,720	$ 756,405,200
2051	$ 813,199,773	$ 769,975,952	$ 763,508,726	$ 762,963,586	$ 761,562,434	$ 761,545,797	$ 761,529,159
2052	$ 818,517,955	$ 774,997,144	$ 768,506,513	$ 768,046,586	$ 766,686,628	$ 766,669,873	$ 766,653,119
2053	$ 823,836,137	$ 780,018,337	$ 773,504,300	$ 773,129,586	$ 771,810,822	$ 771,793,950	$ 771,777,078
2054	$ 829,154,319	$ 785,039,529	$ 778,502,087	$ 778,212,586	$ 776,935,016	$ 776,918,027	$ 776,901,038
2055	$ 834,472,502	$ 790,060,721	$ 783,499,873	$ 783,295,587	$ 782,059,210	$ 782,042,104	$ 782,024,997
2056	$ 839,790,684	$ 795,081,914	$ 788,497,660	$ 788,378,587	$ 787,183,404	$ 787,166,180	$ 787,148,957
2057	$ 845,108,866	$ 800,103,106	$ 793,495,447	$ 793,461,587	$ 792,307,598	$ 792,290,257	$ 792,272,916
2058	$ 850,427,048	$ 805,124,298	$ 798,493,234	$ 798,544,587	$ 797,431,792	$ 797,414,334	$ 797,396,875
2059	$ 855,745,231	$ 810,145,491	$ 803,491,021	$ 803,627,587	$ 802,555,987	$ 802,538,411	$ 802,520,835
2060	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2061	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2062	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2063	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2064	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2065	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2066	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2067	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2068	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2069	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2070	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2071	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794
2072	$ 861,063,413	$ 815,166,683	$ 808,488,807	$ 808,710,588	$ 807,680,181	$ 807,662,487	$ 807,644,794

Notes: Orange-shaded cells are actual model results. Blue-shaded cells were interpolated based on surrounding depths. Un-shaded cells were linearly interpolated between years, or held constant from year 2060 on. Widening-only, 44 ft., and 51 ft. results are not shown.

The figures below display the benefits by commodity type. As can be seen, at a 47 foot project depth, containerized cargo and petroleum make up approximately 97% of the total benefits. At a 48 foot project depth, these two trade concepts generate about 95% of the total benefits. These two project alternatives are presented since 47 feet is the NED plan, and 48 feet is the LPP (see section 12).

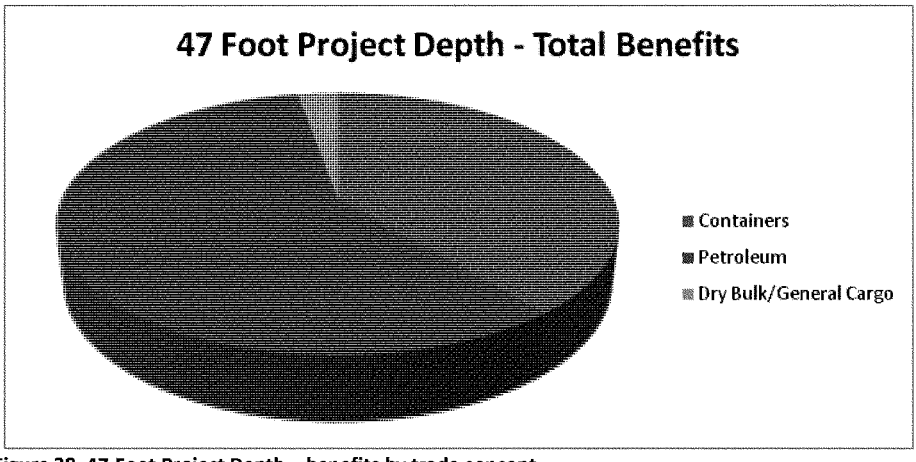

Figure 38. 47-Foot Project Depth – benefits by trade concept

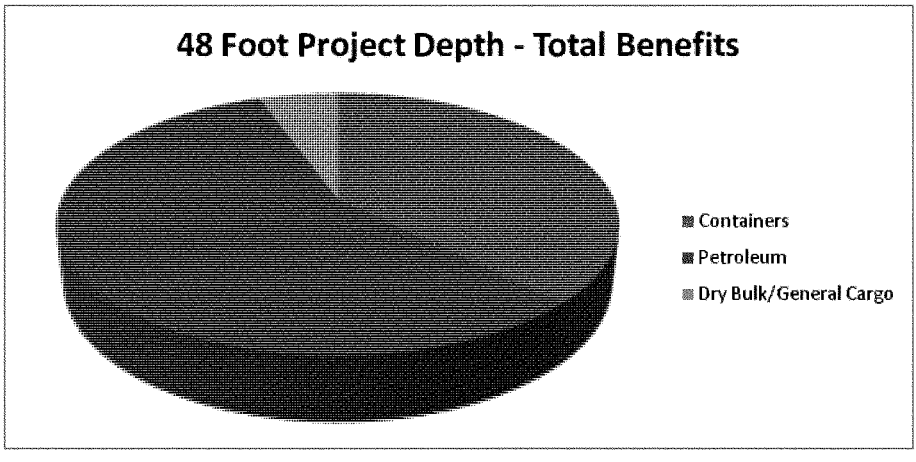

Figure 39. 48-Foot Project Depth – benefits by trade concept

Table 58. Total Present Value and Average Annual Benefits

Project (Depth)	44'+Widening	45'+Widening	46'+Widening	47'+Widening	48'+Widening	49'+Widening	50'+Widening	51'+Widening
Sum of Present-Value Benefits	$785,000,000	$921,000,000	$1,056,000,000	$1,097,000,000	$1,130,000,000	$1,130,000,000	$1,131,000,000	$1,131,000,000
Annualized Cost Savings	$33,500,000	$39,300,000	$45,000,000	$46,800,000	$48,200,000	$48,200,000	$48,200,000	$48,200,000

*numbers have been rounded to the nearest thousand

Additionally, HarborSym model runs produce many other outputs which can measure changes from the without-project condition, such as wait time reduction (Table 59).

Table 59. Wait-Time Reduction Summary by Vessel Class for 48 ft Project

	Average Vessel Wait Time Reduction (hrs)		
	2023	2030	2060
Panamax 1 (3,500 TEU)	-1.0	-1.9	-1.8
Panamax 2 (4,800 TEU)	-3.0	-3.0	-4.1
Post-Panamax 1 (6,500 TEU)	-2.2	-2.5	-3.0
Post-Panamax 2 (8,700 TEU)	-3.4	-5.5	-5.1
Weighted Average for All Vessels	-0.3	-0.5	-0.9
Total Wait Time Reduction for all Vessels	-1,073	-2,491	-4,398

12 National Economic Development Benefits

The purpose of this section is to compare the benefits based on HarborSym model outputs to project costs, to determine net benefits. National Economic Development (NED) benefits are based on differences in total transportation costs[42] between with the future with-project condition and the future without-project condition. Average annual benefits were compared to average annual costs to determine average annual net benefits. Based on the results of the transportation cost savings analysis, the National Economic Development (NED) plan is to widen and deepen to a project depth of 47 feet. The 48-foot alternative did result in higher net benefits by approximately $400,000, however in accordance with USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c which states "when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan" a corporate decision determined that 47 feet was the NED plan. The non-federal sponsor, Broward County, requested a locally preferred plan (LPP) of 48-feet. Therefore, the Recommended Plan

[42] "Total transportation costs" in this context refers only to the total transportation costs that are calculated by the HarborSym model. The model does not account for all costs as mentioned in Section 11.2.

is the LPP which includes deepening the Federal channel to 48 feet. It provides average annual net benefits of $31,380,000 and has a benefit-cost ratio (BCR) of 2.90:1 at 3.375%. (Table 60). The results of the net benefits and BCR analysis are shown graphically in Figure 40 and Figure 41.

Table 60. Summary of National Economic Development Benefits Compared to ROM Costs

Project (Depth)	44'+Widening	45'+Widening	46'+Widening	47'+Widening	48'+Widening	49'+Widening	50'+Widening	51'+Widening
Total First Cost	$311,000,000	$323,000,000	$335,000,000	$353,000,000	$371,000,000	$388,000,000	$405,000,000	$422,000,000
Interest During Construction (IDC)	$18,420,000	$20,820,000	$23,350,000	$27,660,000	$32,310,000	$37,440,000	$42,930,000	$48,790,000
Total Investment Costs (incl. IDC)	$329,420,000	$343,820,000	$358,350,000	$380,660,000	$403,310,000	$425,440,000	$447,930,000	$470,790,000
Average Annual Costs incl. IDC	$13,730,000	$14,330,000	$14,940,000	$15,860,000	$16,810,000	$17,730,000	$18,670,000	$19,620,000
Avg. Ann. Increased O&M Costs	$55,500	$55,500	$55,500	$55,500	$55,500	$55,500	$55,500	$55,500
Total Avg. Ann. Costs	$13,780,000	$14,380,000	$14,990,000	$15,910,000	$16,860,000	$17,780,000	$18,720,000	$19,670,000
Sum of Total Present Value Benefits	$804,000,000	$943,000,000	$1,083,000,000	$1,124,000,000	$1,157,000,000	$1,158,000,000	$1,158,000,000	$1,159,000,000
Average Annual Benefits	$33,520,000	$39,320,000	$45,120,000	$46,860,000	$48,240,000	$48,260,000	$48,270,000	$48,280,000
Avg. Ann. Net Benefits	$19,740,000	$24,940,000	$30,130,000	$30,950,000	$31,380,000	$30,480,000	$29,550,000	$28,610,000
BCR	2.40	2.70	3.00	2.90	2.90	2.70	2.60	2.50

Notes: Costs and benefits annualized at 3.375%. Total first cost, and sum of total present value benefits rounded to nearest $1,000,000. All other cost and benefit numbers rounded to nearest $10,000. Finalized costs will be presented in the Main Report

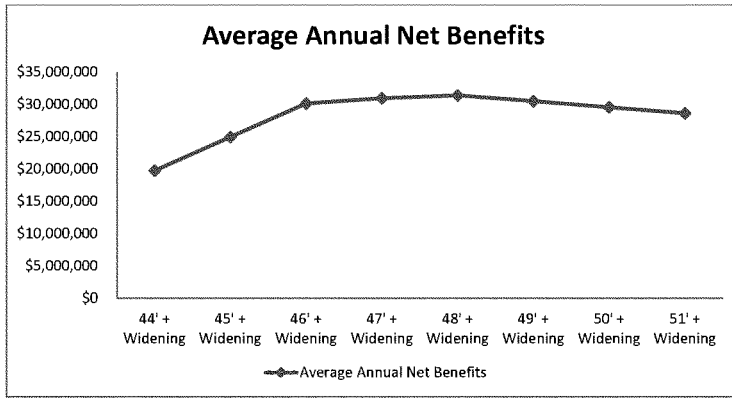

Figure 40. Graph of Average Annual Net Benefits by Project Depth

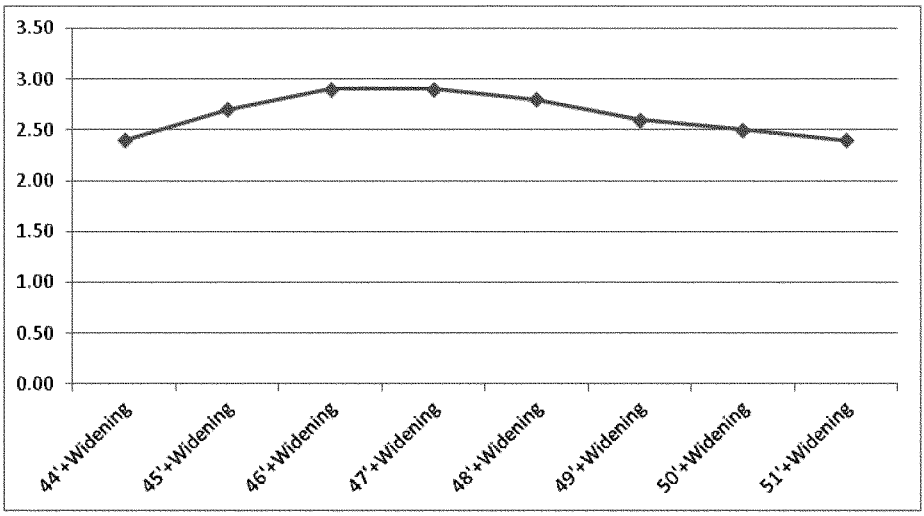

Figure 41. Graph of Benefit-Cost Ratios by Project Depth

13 Regional Economic Development Benefits

The main difference between Regional Economic Development (RED) and National Economic Development (NED) benefits is that RED benefits are associated with the local or regional economy, whereas NED benefits accrue to the entire Nation.

The U.S Army Corps of Engineers (USACE) Institute for Water Resources, the Louis Berger Group and Michigan State University has developed a regional economic impact modeling tool called RECONS (Regional ECONomic System) to provide estimates of regional and national job creation, and retention and other economic measures such as income, value added, and sales. This modeling tool automates calculations and generates estimates of jobs and other economic measures, such as income and sales associated with USACE's ARRA spending, annual Civil Work program spending and stem-from effects for Ports, Inland Water Way, FUSRAP and Recreation. This is done by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations. These multipliers were then imported to a database and the tool matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. The tool is a means to document the performance of direct investment spending of the USACE. The Tool also allows the USACE to evaluate project and program expenditures associated with the annual expenditure by the USACE.

The total project cost would include expending approximately $371,000,000. Of this total project expenditure around $206,000,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made for various services and products are

expected to generate additional economic activity in that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation.

Table 61 displays the input assumptions (Spending and LPC's) that were calculated using RECONS.

Table 62 shows the results of applying these assumptions to the total first cost of construction of the project.

Table 61. Regional Economic Development Spending Assumptions

Category	Spending (%)	Spending Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Dredging Fuel	4%	$14,469,000	37%	42%	90%
Metals and Steel Materials	10%	$35,245,000	14%	27%	90%
Textiles, Lubricants, and Metal Valves and Parts (Dredging)	2%	$5,565,000	8%	24%	65%
Pipeline Dredge Equipment and Repairs	4%	$12,985,000	15%	28%	100%
Aggregate Materials	5%	$17,066,000	53%	65%	97%
Switchgear and Switchboard Apparatus Equipment	1%	$4,081,000	11%	34%	80%
Hopper Equipment and Repairs	2%	$7,420,000	1%	5%	97%
Construction of Other New Nonresidential Structures	17%	$61,586,000	63%	100%	100%
Industrial and Machinery Equipment Rental and Leasing	12%	$43,036,000	46%	91%	100%
Planning, Environmental, Engineering and Design Studies and Services	5%	$17,066,000	39%	94%	100%
USACE Overhead	4%	$13,356,000	44%	99%	100%
Repair and Maintenance Construction Activities	3%	$11,501,000	50%	100%	100%
Industrial Machinery and Equipment Repair and Maintenance	8%	$27,825,000	66%	86%	100%
USACE Wages and Benefits	7%	$26,712,000	75%	100%	100%
Private Sector Labor or Staff Augmentation	18%	$68,264,000	100%	100%	100%
Dredging Food and Beverages	1%	$4,823,000	12%	42%	90%
Total	**100%**	**$371,000,000**	-	-	-

Table 62. Regional Economic Development Benefits from Construction Expenditures

Impact Areas Impacts		Regional	State	National
Total Spending		$371,000,000	$371,000,000	$371,000,000
Direct Impact				
	Output	$206,102,764	$295,902,712	$361,865,062
	Job	3,515.71	4,296.01	4,539.75
	Labor Income	$127,959,087	$167,779,578	$186,242,068
	GRP	$146,809,011	$198,125,601	$224,085,332
Total Impact				
	Output	$300,039,972	$599,284,185	$973,379,490
	Job	4,374.39	6,587.84	8,210.73
	Labor Income	$157,464,092	$273,425,182	$385,829,877
	GRP	$201,982,676	$381,638,366	$568,350,438

14 Sensitivity and Scenario Analyses

Since many assumptions go into conducting an economic analysis of a Federal navigation improvement project, risk and uncertainty can be addressed through sensitivity and scenario analysis. This section describes the performance of the NED plan throughout a range of more conservative assumptions and possible futures to address risk and uncertainty.

Multiple sensitivities were conducted on the 48 foot project alternative based on the results of the HarborSym model runs (Table 63). First, in the "7% Discount Rate" sensitivity analysis, future benefits and costs were discounted at a higher rate than the FY14 discount rate of 3.375% by using a 7% discount rate. With the "7% Discount Rate" the commodity and vessels fleet forecasts remain consistent with the base growth scenario which used the IHS Global Insight forecast provided for the South Atlantic. This rate is often used by the Office of Management and Budget to compare the results of different studies across different years. Second, in the "No Growth After 20 years" sensitivity analysis, the vessel traffic, commodity movements, and the shift in the vessel fleet was held constant after 20 years from the base year (2023 to 2042). After 20 years the commodity throughput and the vessel fleet were held constant. Third, a "No Growth after Base Year" sensitivity analysis was modeled. In the no growth scenario, there is no growth it the total tonnage transported through the harbor after the base year of the analysis (2023). This scenario assumes the lowest level of commodity growth analyzed. These three scenarios were developed to demonstrate the level of risk associated with the construction of the project.

Table 63. Sensitivity Analysis Results

Sensitivity	Avg. Ann. Net Benefits	Benefit-Cost Ratio
7% Discount Rate	$14,550,000	1.50
No Growth after 20 years (@ 3.375%)	$30,280,000	2.80
No Growth after Base year (@ 3.375%)	$20,760,000	2.20

Additional scenarios were developed as well to more fully investigate the risk associated with modifying Port Everglades to a depth of 48 feet. The benefits by commodity were evaluated to determine how reliant the project justification is on each specific trade concept. In these scenarios, each trade concept is assumed to be the only benefiting commodity. Also, the "No growth after Base year" scenario was adjusted to assume lower growth in the tonnage being transported through the harbor up to 2023. In this scenario, the tonnage assumed at the harbor in 2023 is just over 23.8 million tonnes (In the base forecast, this tonnage is forecasted to become over 26.9 million tonnes). Petroleum makes up approximately 16.4 million of those tonnes and Containerized cargo consists of an additional 6.2 million tonnes. Dry Bulk and General Cargo is another 1.6 million tonnes. In FY2013, the Port Everglades reported over 22.4 million tonnes. The adjusted "No growth after Base year" assumes a compound annual growth rate of 0.58% between 2013 and 2023 opposed to the 1.82% compound annual growth currently assumed in the base analysis.

Table 64. Additional Sensitivity Analysis

	Avg. Ann. Net Benefits	Benefit-Cost Ratio
Petroleum Tonnage Only (Base Analysis)	$ 10,200,000	1.59
Containerized Tonnage Only (Base Analysis)	$ 616,000	1.04
Dry Bulk/General Cargo Tonnage Only (Base Analysis)	$ (14,600,000)	0.16
Reduced Commodity Growth to Base Year (2023)	$ 22,900,000	2.33

15 Summary

In conclusion, the analysis presented in this appendix has been robust, with consideration given to nearly every aspect of economic activity at the port. Based on the results of the transportation cost savings analysis, the National Economic Development (NED) plan is to widen and deepen to a project depth of 47 feet. The 48-foot alternative did result in higher net benefits by approximately $400,000 annually, however in accordance with USACE policy guidance ER 1105-2-100 Exhibit G-1 3.c which states "when two cost-effective plans produce no significantly different levels of net benefits; the less costly plan is to be the NED plan" a corporate decision determined that 47 feet was the NED plan. The non-federal sponsor, Broward County, requested a locally preferred plan (LPP) of 48-feet. Therefore, the Recommended Plan is the LPP which includes deepening the Federal channel to 48 feet. It provides average annual net benefits of $31,400,000 and has a benefit-cost ratio (BCR) of 2.90:1 at 3.375%. The selected plan is a reasonable, beneficial, and cost-effective alternative that meets the project objectives to improve navigational conditions in the harbor. These improvements are expected to reduce congestion, improve navigational safety, accommodate recent and anticipated future growth in cargo and cruise vessel traffic, improve the efficiency of operations for cargo vessels and cruise ships within the Port complex, and allow for larger cargo vessels to use Port Everglades more efficiently through increased vessel loading.

APPENDIX C

REAL ESTATE PLAN

January 9, 2015

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

PORT EVERGLADES HARBOR
BROWARD COUNTY, FLORIDA
NAVIGATION STUDY
FEASIBILITY REPORT

REAL ESTATE PLAN

APPENDIX C

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REAL ESTATE PLAN
PORT EVERGLADES HARBOR
BROWARD COUNTY, FLORIDA
NAVIGATION STUDY
FEASIBILITY REPORT

1. STATEMENT OF PURPOSE.

a. The purpose of this report is to determine the feasibility of improving the existing Federal navigation project at Port Everglades Harbor, Florida. The study consists of developing and evaluating alternative plans to decrease costs associated with vessel delays from congestion, and channel passing restrictions, decrease transportation costs through increasing economies of scale for container and petroleum vessels, increase channel safety and maneuverability for existing vessel use as well as for larger vessels, and to avoid and minimize environmental impacts.

b. This real estate plan is tentative in nature for planning purposes only and both the final real property acquisition lines and estimates of value are subject to change even after approval of this report.

2. PROJECT AND STUDY AUTHORIZATION.

The Port Everglades Federal Navigation Project was initially authorized in the River and Harbors Act of 1930 and has been amended as shown in Table C-1.

Table C-1 – Authorizations

Act	Document, Congress/Session	Work Authorized
R&H Act 1930	HD 357, 71/2	Federal maintenance of entrance channel, turning basin, and jetties constructed by local interests.
R&H Act 1935	HR Committee of R&H Doc. 25, 74/1	Construction and maintenance of an enlarged entrance channel, and a 1,200 foot square turning basin to a depth of 35 feet.
R&H Act 1938	HD 545, 75/3	Construction and maintenance of a 350 foot wide trapezoidal area on the north side of the main turning basin.
R&H Act 1946	HD 768, 78/2	Construction and maintenance of a 200 foot northerly and 500 foot southerly extensions to the main turning basin.
R&H Act 1958	HD 346, 85/2	Construction and maintenance of outer entrance channel deepening to 40 feet, inner entrance channel deepening to 37 feet, expanding the main turning basin to the north and south.

Public Law 89-298 Section 201, 1974	HD 93-144	Deepen outer entrance channel to 45 feet at a width of 500 feet, inner entrance channel to 42 feet at a width of 450 feet, main turning basin to 42 feet, channel opposite Pier 7 to 36 feet, maintain channel opposite Berth 18 to 36 feet.
WRDA 1992	HD 103-126, 103/1	Federal maintenance of locally constructed Southport Access Channel dredging to 42 feet, and locally constructed turning notch to a depth of 42 feet.

R&H = Rivers and Harbors, HD = House Document

Beginning in 1928 numerous reports have been completed for the Port Everglades Navigation Project and are shown in Table C-2.

Table C-2 – Prior Port Everglades Federal Navigation Reports

Study Type[1]	Report Date	Congressional Documents				Authorizing Act
		Type	No.	Cong.	Session	
PA	1928	-	-	-	-	-
PA	1929	-	-	-	-	-
SR	1930	H	357	71	2	R&H 1930
PA	1932	-	-	-	-	-
SR	1933	-	-	-	-	-
SR	1935	H	25	74	1	30 Aug 1925
SR	1937	H	545	75	3	20 June 1938
SR	1944	H	768	78	2	24 July 1946
SR	1946	-	-	-	-	-
SR	1958	H	346	85	2	3 July 1958
SR	1971	H	144	93	1	9 and 31 May 1974
FR	1991	H	126	103	1	WRDA 1992, Title I Sec 101(9)
LRR[2]	1998	-	-	-	-	WRDA 2000 Sec 515

[1] PA = Preliminary Assessment, SR = Survey Report,
FR = Feasibility Report, LRR = Limited Re-Evaluation Report, H = House
[2] Reimbursement of $15,003,000 was authorized by Congress

This feasibility study was authorized by resolution dated May 9, 1996, by the Committee on Transportation and Infrastructure of the United States House of Representatives. The resolution states:

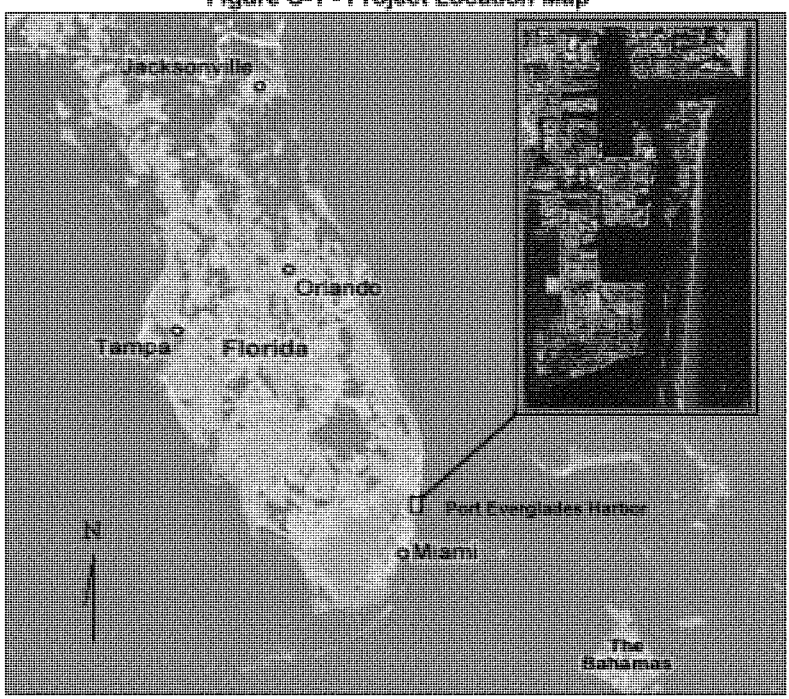
> Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is

requested to review the reports of the Chief of Engineers on Port Everglades Harbor, Florida, published as House Document 126, 103rd Congress, 1st Session, and House Document 144, 93rd Congress, 1st Session, and other pertinent reports to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of navigation and related purposes, with particular reference to navigation into and within the part of the project known as the Southport Channel.

3. PROJECT LOCATION AND DESCRIPTION.

Port Everglades Harbor, originally named Bay Mabel Harbor and later Hollywood Harbor, is located in the southeastern portion of Broward County at the adjoining city limits of Fort Lauderdale, Hollywood, and Dania, approximately 25 miles north of Miami, Florida and 328 miles south of Jacksonville, Florida. The harbor has the deepest access of any along the eastern seaboard between Miami, Florida and Norfolk, Virginia. The port is currently ranked 35th nationally in tonnage.

Figure C-1 - Project Location Map



Initial construction of Port Everglades began in 1925 and continued through 1928. Construction was accomplished through the excavation of Lake Mabel, a shallow water body separated from the Atlantic Ocean by a low sand ridge. The port was the result of a cooperative effort between the cities of Hollywood, Fort Lauderdale, and a private investor. The Federal government became involved with the port after the passage of the River and Harbor Act of 1930 which provided the locally constructed project with Federal maintenance. Since 1931, eleven Federal maintenance dredging projects at Port Everglades have been completed.

Table C-3 - Maintenance Dredging Events at Port Everglades

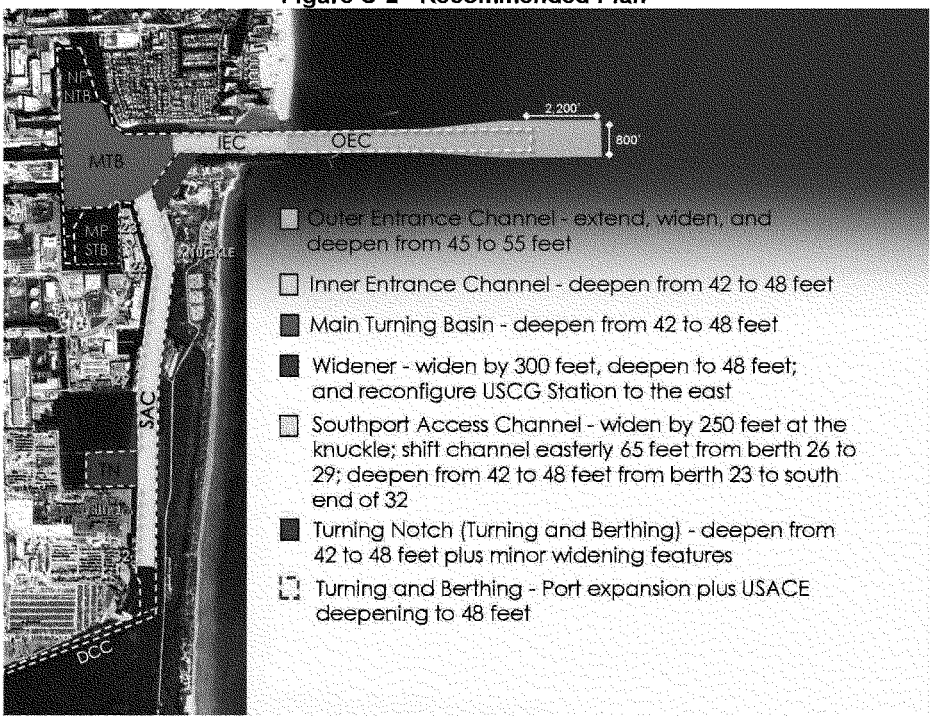
Year	Location	Volume (cy)	Disposal
1934	Entrance Channel and Turning Basin	139,900	Ocean
1935	Entrance Channel and Turning Basin Turning Basin	97,400 73,100	Ocean Upland
1939	Entrance Channel and Turning Basin	48,300	Upland
1948	South side of Turning Basin Entrance Channel and N. side of Turning Basin	93,900 206,300	Upland Ocean
1950	Northern portion of Turning Basin	47,300	Upland
1953	Entrance Channel Turning Basin	97,300 179,800	Ocean Upland
1954	Turning Basin	101,200	Upland
1960	Entrance Channel Turning Basin	38,700 179,800	Ocean Upland
1961-1962	Entrance Channel Turning Basin Turning Basin	22,500 9,600 12,200	Beach/Ocean Upland Ocean
1978	Turning Basin	144,500	Ocean
2005	Turning Basin	46,700	Ocean

The Port Everglades Harbor navigation project, as currently authorized, consists of an entrance channel project depth of 45 feet over bottom width of 500 feet from the ocean to the jetty area; an inside channel project depth of 42 feet over a width of 450 feet from inside the jetties to the main turning basin; basins to the north and south of the main basin have a project depth of 31 feet; a channel, south from the main basin along the west side of the south basin, has project depths of 37 and 36 feet which the sponsor deepened to 38 feet to be same as the south basin; north and south jetties at the ocean entrance; a channel with project depth of 42 feet over a bottom width of 400 feet from the main basin south along the Intracoastal Waterway for a distance of 5,200 feet before narrowing to a width of 390 feet for a distance of 2,800 feet; and a turning notch to a project depth of 42 feet over a bottom area 750 feet by 1,000 feet to the north of the Southport terminal berths.

The recommended plan changes the authorized project to include the following navigation improvements: deepening and widening of the outer entrance channel from an existing 45-foot project depth over a 500-foot channel width to 55 feet by 800 feet and extend 2,200 feet seaward; deepening the inner entrance channel from 42 feet to 48 feet; deepening the main turning basin from 42 feet to 48 feet; widening the rectangular shoal region to the southeast of the main turning basin (widener) by about 300 feet and deepen to 48 feet; widening the Southport Access Channel in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and reconfiguring the U.S. Coast Guard (USCG) facility easterly on USCG property; shifting the existing 400-foot wide Southport Access Channel 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; deepening the Southport Access Channel from about berth 23 to the south end of berth 32 from 42 feet to 48 feet; deepening the turning notch, including project sponsor expanded portion from 42 feet to 48 feet with an additional 100-foot widening parallel to the channel on the eastern edge of the Southport Access Channel over a length of about 1,845 feet and widening the western edge of the Southport Access Channel for access to the turning notch 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 turning notch.

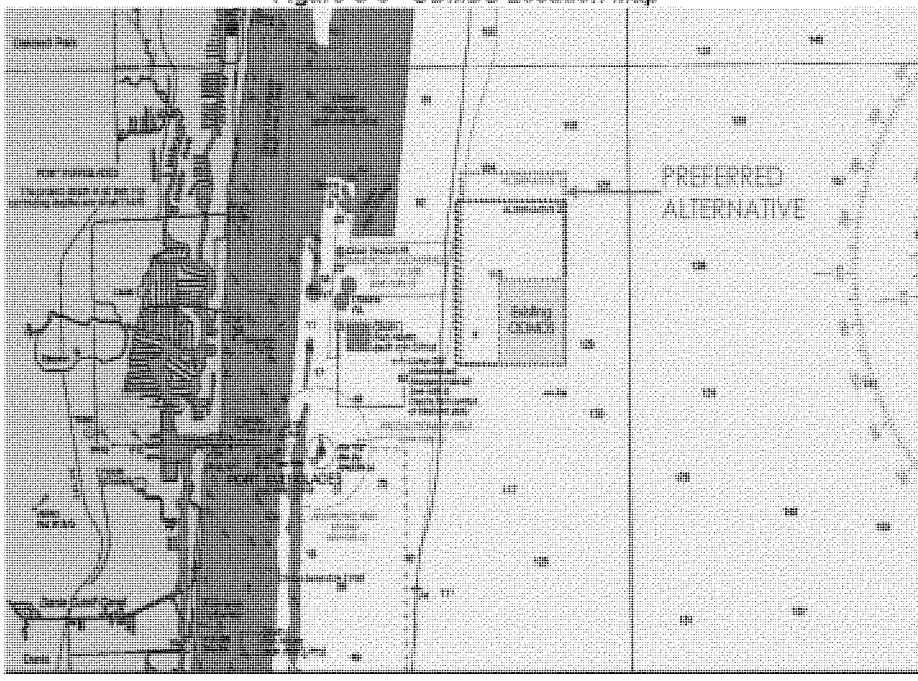
The recommended plan for the Port Everglades Harbor Feasibility Report is the Locally Preferred Plan (LPP). The LPP consists of deepening and widening. The only difference between the National Economic Development Plan (NED) and the LPP is the channel depth. The NED recommends -47 feet MLW whereby the LPP is -48 feet MLW.

Figure C-2 - Recommended Plan



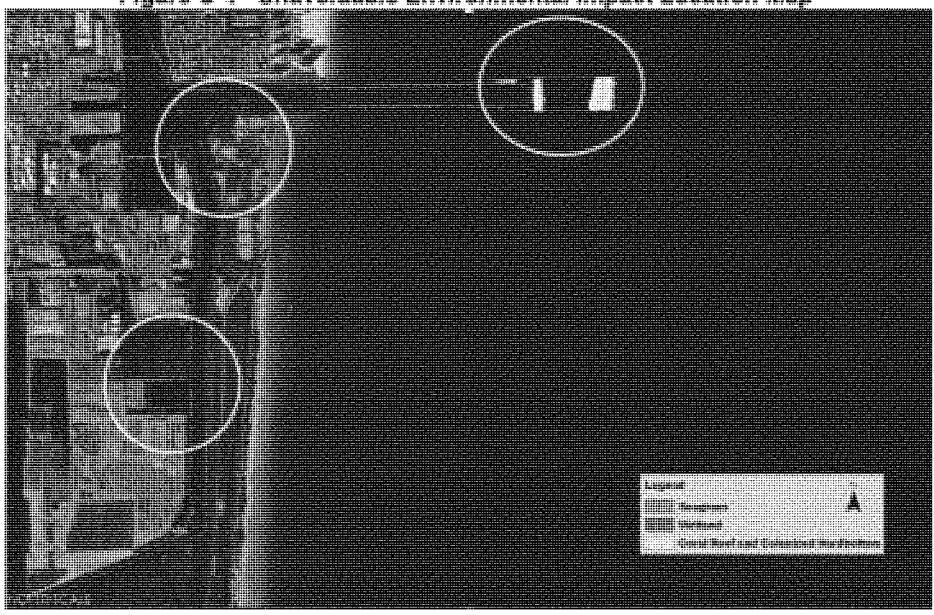
The primary disposal site for the excavated material, except hardbottoms (rock), will be placed within an existing disposal site, designated by U.S. Environmental Protection Agency (EPA) as an Ocean Dredged Material Disposal Site (ODMDS). The site is located approximately three nautical miles offshore from the port entrance channel. The ODMDS is in the process of being expanded by the EPA. The expansion of this site is currently required for operation and maintenance of the existing Federal channel. Costs from the ODMDS expansion are not included as part of this Port Everglades project.

Figure C-3 - ODMDS Location Map



Compensatory mitigation is planned for unavoidable impacts to hardbottom, coral reef habitats, mangroves, and seagrasses. Impacts to hardbottom communities are associated with deepening and widening of the outer entrance channel and would include removal of approximately 10.10 acres of hardbottoms within the middle and outer reef tracts. The benthic communities in this impact area are comprised of complex, high-profile, linear and spur/grove reef habitat. The widening of the Southport Access Channel and the middle turning basin will negatively impact approximately 7.41 acres of vegetated and unvegetated seagrass habitat and approximately 1.16 acres of mangroves.

Figure C-4 - Unavoidable Environmental Impact Location Map



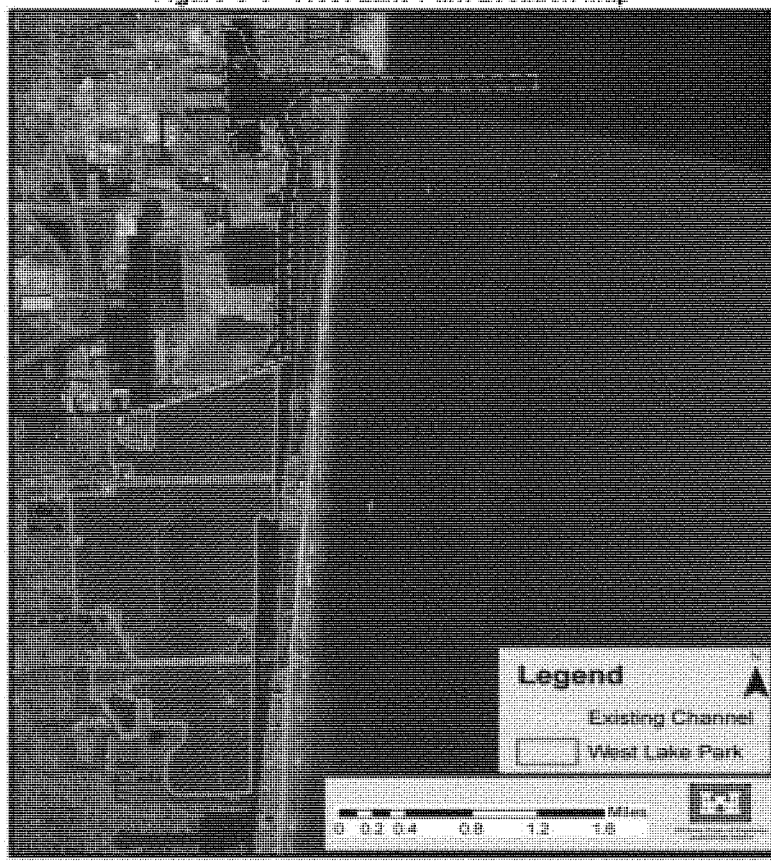
The proposed hardbottom mitigation plan includes relocating the excavated hardbottoms to a five acre artificial reef site north of the entrance channel and transplanting the disturbed coral communities. The transplantation will include approximately 11,502 corals from the impact site and outplanting approximately 103,000 nursery raised corals.

Impacts to mangroves and seagrasses will be compensated by the purchase of mitigation credits related to Broward County's environmental improvements within the State-owned West Lake Park located south of the project limits. West Lake Park is not a mitigation bank and is not available for purchase by public or private entities. The area is only available for Broward County, the project sponsor, to use for mitigation purposes on Broward County projects, specifically port and airport expansion projects. Broward County acknowledges responsibility for construction, monitoring, and success of mangrove and seagrass mitigation within the West Lake Park. The United States will enter into an agreement with Broward County for the provision of mitigation credits to offset project impacts, and Broward County will be responsible for appropriate ecological lift.

West Lake Park, a county-operated, state-owned natural area, includes previously permitted restoration, enhancement, and preservation of like habitats. Details of the

mitigation plan can be found in Appendix E, Environmental Impact Statement (EIS), and related sub-appendices of this feasibility report. The permits can be found in Exhibit C-1 of this plan.

Figure C-6 - West Lake Park Location Map

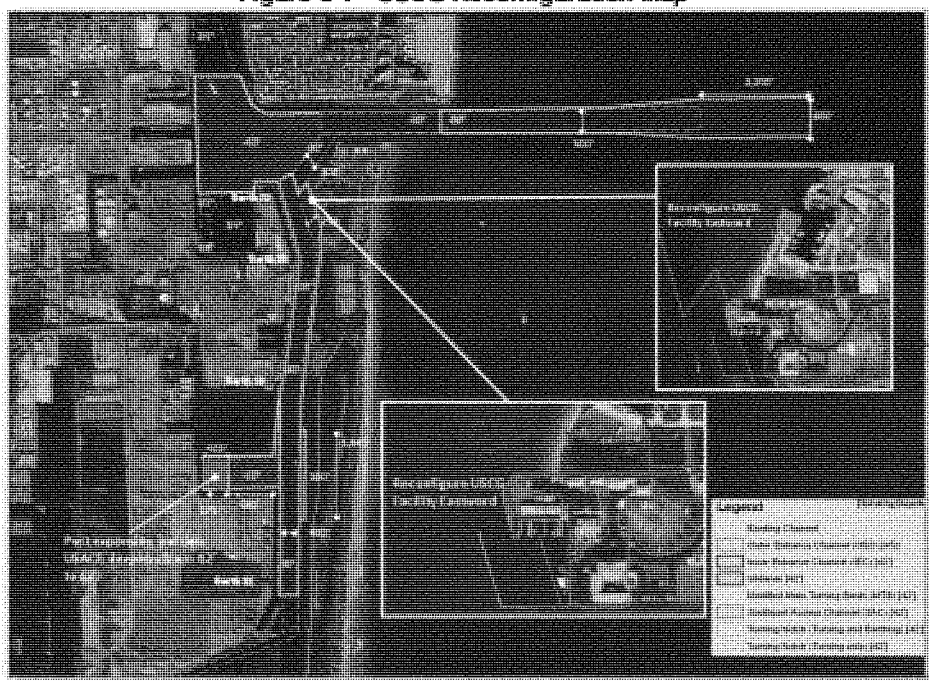


4. REAL ESTATE REQUIREMENTS.

The deepening of the outer entrance channel, inner entrance channel, middle turning basin, and the turning notch as well as widening of the outer entrance channel, turning notch, and the Southport Access Channel (knuckle) are within the navigable waters of the United States and are available to the United States by navigation servitude. The existing and expanded ODMDS are also available to the United States by navigation servitude.

The land required for the widening area at the north end of the Southport Access Channel is owned and operated by the U.S. Coast Guard. The U.S. Coast Guard owns a total of 7.8 acres and operates a multi-mission, search, rescue, and drug interdiction, facility on the property. Approximately one acre of uplands will be removed and turned into submerged lands to support the widening of the Southport Access Channel. Use of the U.S. Coast Guard property is necessary to allow deep draft vessels the ability to turn safely. The uplands being submerged will remain Federally-owned and be used for U.S. Coast Guard vessels.

Figure C-7 - USCG Reconfiguration Map



The reconfiguration also requires several U.S. Coast Guard structures, facilities, and utilities to be shifted to the east onto adjacent Federally-owned property. The cost for this reconfiguration is included in the cost-shared project construction costs as a general navigation feature and not as a real estate cost. The U.S. Coast Guard has been involved in the planning of this project and a final plan is still being developed. A Federal to Federal permit will be executed between the U.S. Coast Guard and the Department of the Army for construction purposes. A copy of the permit template is included in Exhibit C-1 of this appendix.

The primary disposal site is an existing disposal site, designated by the U.S. Environmental Protection Agency as an ODMDS. The U.S. Environmental Protection Agency has completed the draft Environmental Assessment on the expansion and has received public comments. The formal designation process including rule making and publication in the Federal Register of the expanded ODMDS is expected to be complete in 2015. No further real estate is needed for the ODMDS. The expansion of this site is required for current operation and maintenance of the channel and no additional costs are included from the ODMDS expansion for this project.

Should EPA 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), Section 103(b) of MPRSA authorizes USACE, with USEPA concurrence, to select a site for one time disposal of dredged material in ocean waters when the use of a site designated by USEPA is not feasible. This one-time use would be a permit for the entire construction event. After this use, USACE and EPA have the option to permit it beyond that time frame under Section 103. All maintenance material will be placed in the existing ODMDS site, which has more than enough capacity. The cost involved with this contingency plan would be approximately $100,000 (only labor funds for designation).

The submerged lands required for relocating excavated hardbottoms to a five acre artificial reef site and transplanting disturbed coral communities are within the navigable waters of the United States and are available by navigation servitude.

In lieu of a real estate fee acquisition for seagrass and mangrove mitigation, mitigation credits are being purchased from Broward County. Broward County is generating mitigation credits to offset impacts of Broward County projects at areas within West Lake Park. Broward County applied for and received permission to construct seagrass and mangrove features through South Florida Water Management District Environmental Resource Permit No. 06-04016-P and Department of the Army Regulatory Permit No. SAJ-2002-0072, as amended. The permits authorize Broward County to complete mitigation activities to offset impacts to tidal, saltwater, and wetland communities and accrue ecological functional value credits for the work within West Lake Park. The area is only available for Broward County projects, specifically port and airport expansion projects. Accrued credits will be purchased by the Federal government and applied to this project prior to construction. An agreement between the United States and Broward County will be executed to guarantee seagrass and mangrove mitigation in perpetuity.

5. FEDERALLY-OWNED LANDS.

A portion of the Federally-owned uplands under control of the U. S. Coast Guard will require removal in the north area of the Southport Access Channel. The uplands will become submerged lands and will remain Federally-owned.

6. NON FEDERAL-OWNED LANDS.

Broward County Port Everglades operates within 2,100 acres of which Broward County, the project sponsor, owns 910 acres. No sponsor-owned lands will be required for this project.

7. NON FEDERAL OPERATION AND MAINTENANCE RESPONSIBILITIES.

The Federal channels and basins will be maintained by the USACE, in accordance with Section 101(b)(1) of the Water Resources Development Act of 1986, as amended by Section 2103 of the Water Resources Reform Development Act of 2014; operation and maintenance is 100% Federal with a project depth under 50 feet. Port facilities such as berthing areas and port bulkheads will be maintained by the non-federal sponsor. Broward County will conduct operation and maintenance for mitigation areas in accordance with its permits.

8. NON-FEDERAL AUTHORITY TO PARTICIPATE IN THE PROJECT.

The project sponsor, Broward County, Fort Lauderdale, Florida, (formerly known as Port Everglades Authority) derived its authority to participate in the project from Special Act, Laws of Florida, Chapter 88-515, House Bill No. 1169, said act taking effect on January 1, 1989.

9. NAVIGATION SERVITUDE.

All lands required for deepening, widening, the ODMDS, and hardbottom mitigation areas are within the navigable waters of the United States and are available to the Federal Government via navigation servitude. The Federal Government will coordinate with the State of Florida and other environmental agencies to obtain concurrence with its conclusion that the project is consistent with the State's Coastal Zone Management Program and the Corps will coordinate with the State to obtain a Water Quality Certification.

10. ATTITUDE OF OWNERS.

All landowners impacted by the proposed project have been involved in the planning process and have indicated strong support for the project.

11. MINERALS.

There are no known minerals of value in the project area.

12. HAZARDOUS, TOXIC AND RADIOACTIVE WASTES (HTRW).

A phase I environmental assessment was completed for the proposed dredging and disposal activity areas and did not identify HTRW within the areas. Environmental records search discovered and have documented previous spills in the port. The contaminants have included fuel oil, diesel fuel, gasoline, and lubricants. These are commonly found in a busy port such as this. Prior to disposal of the dredged material additional testing will occur and contaminated materials will be coordinated with the appropriate environmental agencies and disposed of in accordance with Federal, State and local laws.

13. INDUCED FLOODING.

There will be no induced flooding directly associated with this project.

14. ZONING ORDINANCES.

Zoning ordinances are not of issue with this project. Application or enactment of zoning ordinances will not to be used in lieu of acquisition.

15. RELOCATIONS ASSISTANCE (PUBLIC LAW 91-646).

There are no persons or businesses that will need to be relocated due to project implementation.

16. RELOCATIONS, ALTERATIONS, VACATIONS AND ABANDONMENTS (UTILITIES, STRUCTURES AND FACILITIES, CEMETERIES, AND TOWNS).

One Florida Power and Light utility within the South Access Channel is being relocated below the feasibility study proposed depth at this time and is not associated with the Port Everglades project. Consequently, there are no costs associated with this utility relocation.

Several utilities, structures and facilities will be moved in conjunction with the USCG configuration and will be cost-shared accordingly. The costs are included as a general navigation feature within the construction costs for the project and cost shared accordingly. No other structures, facilities, cemeteries, and towns will be affected as part of the project.

17. STANDING TIMBER AND VEGETATIVE COVER.

There is no timber or unusual vegetative cover in the project area.

18. RECREATION RESOURCES.

There are no separable recreational lands identified for the project.

19. CULTURAL RESOURCES.

There are no known cultural resources that have been identified as being affected by the project.

20. OUTSTANDING RIGHTS.

There are no known outstanding rights in the project area.

21. MITIGATION.

Compensatory mitigation is planned for unavoidable impacts to hardbottom, coral reef habitats, mangroves, and seagrasses. Impacts to hardbottom communities are associated with deepening and widening of the outer entrance channel and would include removal of approximately 10.10 acres of hardbottoms within the middle and outer reef tracts. The benthic communities in this impact area are comprised of complex, high-profile, linear and spur/grove reef habitat. The widening of the Southport Access Channel and the middle turning basin will negatively impact approximately 7.41 acres of vegetated and unvegetated seagrass habitat and approximately1.16 acres of mangroves.

The proposed hardbottom mitigation plan includes relocating the excavated hardbottoms to a five acre artificial reef site north of the entrance channel and transplanting the disturbed coral communities. The transplantation will include approximately 11,502 corals from the impact site and outplanting approximately 103,000 nursery raised corals.

In lieu of a real estate fee acquisition for seagrass and mangrove mitigation, mitigation credits are being purchased from Broward County. Broward County is generating mitigation credits to offset impacts of Broward County projects at areas within West Lake Park. Broward County applied for and received permission to construct seagrass and mangrove features through South Florida Water Management District Environmental Resource Permit No. 06-04016-P and Department of the Army Regulatory Permit No. SAJ-2002-0072, as amended. The permits authorize Broward County to complete mitigation activities to offset impacts to tidal, saltwater, and wetland communities and accrue ecological functional value credits for the work within West Lake Park. The area is only available for Broward County projects, specifically port and airport expansion projects. Accrued credits will be purchased by the United States and applied to this project prior to construction. An agreement between the United States and Broward County will be executed to guarantee seagrass and mangrove mitigation in perpetuity.

22. ACQUISITION-ADMINISTRATIVE COSTS.

Federal administrative costs of $50,000 have been included within the preconstruction, engineering, and design (PED) phase account 30 and are not included under real estate account 01. The cost includes project real estate planning, mapping, review, oversight, and monitoring costs.

23. SUMMARY OF PROJECT REAL ESTATE COSTS.

The following cost figures are subject to change prior to construction:

a. Lands and Damages:		$ 0
b. Acquisition		$ 0
Federal	$0	
Non-Federal	$0	
c. Public Law 91-646		$ 0
d. Real Estate PED Federal Administrative		$50,000
e. Contingency (26.3%)*		$13,150
f. Total Estimated Real Estate Cost		$63,150

* The contingency percent is based on the risk cost analysis.

24. REAL ESTATE ACQUISITION SCHEDULE.

The only acquisition required for the project is a Federal to Federal permit between the Department of the Army and the U. S. Coast Guard for reconfiguration construction. Twelve months is being scheduled for the permit to allow negotiations of the permit's provisions and conditions as well as coordination and concurrence with higher authorities and execution of the document. The duration of construction is unknown at this time. Real Estate costs associated with the U. S. Coast Guard reconfiguration general navigation feature are included within preconstruction, engineering, and design (PED) costs.

25. NON-STANDARD ESTATES TO BE ACQUIRED.

A Federal to Federal permit for use of real property by other federal agencies will be executed by the Department of the Army and the U. S. Coast Guard for construction purposes because the property is already Federally-owned and can be provided to the Department of the Army at no cost. The permit does not provide an interest in real

estate but provides for the use of the U. S. Coast Guard property. A copy of the permit template is located in Exhibit C-1. The negotiated permit will be forwarded prior to use through Division to HQUSACE for appropriate coordination, review, and final determination.

In lieu of additional acquisition the South Florida Water Management District Environmental Resource Permit No. 06-04016-P and Department of the Army Regulatory Permit No. SAJ-2002-0072, as amended, was issued to Broward County Parks and Recreation Division and provides them:

> ... authorization for construction and operation of a mitigation project with the West Lake Park to provide compensation for future wetland impacts that may be associated with future Broward County Projects, specifically port and airport projects
>
> ....up-front compensation to be used for wetland impacts associated with future Broward county projects, the County has proposed a mitigation plan for upland, wetland, and seagrass creation, restoration, enhancement and preservation of mangroves and seagrasses within West Lake Park in Broward County.

The purchase of the mitigation credits secured by the local sponsor meets the standards and criteria of Section 33 Code of Federal Regulations, Part 332.3, General compensatory mitigation requirements. The permits are included in Exhibit C-1 of this plan. Approval for use of these permits for mangrove and seagrass mitigation in lieu of fee acquisition will be approved as part of this report.

26. MAPS.

Maps and figures are included within the text of this report.

27. REAL ESTATE CHART OF ACCOUNTS

01 LANDS AND DAMAGES		$ 0
01B-- ACQUISITION		$ 0
01B20 BY LOCAL SPONSOR (LS)	$0	
01B40 REVIEW OF LS	$0	
01R-- REAL ESTATE PAYMENTS		$ 0
01R10 LAND PAYMENTS		
01R1B BY LS	$0	
30 PED REAL ESTATE COSTS		$50,000
CONTINGENCY (26.3%)		$13,150
TOTAL PROJECT REAL ESTATE COST		$63,150

*The contingency percent is based on the risk cost analysis.

EXHIBIT C-1 – NON-STANDARD ESTATES

South Florida Water Management District Environmental Resource Permit No. 06-04016-P and Department of the Army Regulatory Permit No. SAJ-2002-0072

Attachments to the permits can be found in Appendix E.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENVIRONMENTAL RESOURCE PERMIT NO. 06-04016-P
DATE ISSUED: APRIL 14, 2004

FORM [illegible]
Rev. [illegible]

PERMITTEE: STATE OF FLORIDA
(WEST LAKE PARK)
DIVISION OF STATE LANDS,3900 COMMONWEALTH BOULEVARD
TALLAHASSEE , FL 32399

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE,STE 421
FT LAUDERDALE , FL 33301

PROJECT DESCRIPTION: AUTHORIZATION FOR CONSTRUCTION AND OPERATION OF A MITIGATION PROJECT WITHIN THE 1522.2 ACRE WEST LAKE PARK TO PROVIDE COMPENSATION FOR FUTURE WETLAND IMPACTS THAT MAY BE ASSOCIATED WITH FUTURE BROWARD COUNTY PROJECTS

PROJECT LOCATION: BROWARD COUNTY ,

SECTION 35,36 TWP 50S RGE 42E
SECTION 1,2,11 TWP 51S RGE 42E

PERMIT DURATION: See Special Condition No.1. See attached Rule 40E-4.321, Florida Administrative Code.

This Permit is issued pursuant to Application No. 011226-21 , dated December 13, 2001. Permittee agrees to hold and save the South Florida Water Management District and its successors harmless from any and all damages, claims or liabilities which may arise by reason of the construction, operation, maintenance or use of activities authorized by this Permit. This Permit is issued under the provisions of Chapter 373 , Part IV Florida Statutes (F.S.), and the Operating Agreement Concerning Regulation Under Part IV, Chapter 373 F.S., between South Florida Water Management District and the Department of Environmental Protection. Issuance of this Permit constitutes certification of compliance with state water quality standards where neccessary pursuant to Section 401, Public Law 92-500, 33 USC Section 1341 , unless this Permit is issued pursuant to the net improvement provisions of Subsections 373.414(1)(b), F.S., or as otherwise stated herein.

This Permit may be transferred pursuant to the appropriate provisions of Chapter 373, F.S, and Sections 40E-1.6107(1) and (2), and 40E-4.351(1), (2), and (4), Florida Administrative Code (F.A.C.). This Permit may be revoked, suspended, or modified at any time pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.351(1), (2), and (4), F.A.C.

This Permit shall be subject to the General Conditions set forth in Rule 40E-4.381, F.A.C., unless waived or modified by the Governing Board. The Application, and the Environmental Resource Permit Staff Review Summary of the Application, including all conditions, and all plans and specifications incorporated by reference, are a part of this Permit. All activities authorized by this Permit shall be implemented as set forth in the plans, specifications, and performance criteria as set forth and incorporated in the Environmental Resource Permit Staff Review Summary. Within 30 days after completion of construction of the permitted activity, the Permittee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual, pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.351 and 40E-4.381, F.A.C.

In the event the property is sold or otherwise conveyed, the Permittee will remain liable for compliance with this Permit until transfer is approved by the District pursuant to Rule 40E-1.6107, F.A.C.

SPECIAL AND GENERAL CONDITIONS ARE AS FOLLOWS:

SEE PAGES 2 - 7 OF 10 (41 SPECIAL CONDITIONS).
SEE PAGES 8 - 10 OF 10 (19 GENERAL CONDITIONS).

FILED WITH THE CLERK OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ON April 22, 2004
BY [signature]
DEPUTY CLERK

SOUTH FLORIDA WATER MANAGEMENT DISTRICT, BY ITS GOVERNING BOARD
BY [signature]
ASSISTANT SECRETARY

BOARD OF SOUTH FLORIDA WATER MANAGEMENT DISTRICT
STATE OF FLORIDA
SEAL
Established 1949

PAGE 1 OF 10

SPECIAL CONDITIONS

1. The construction phase of this permit shall expire on April 15, 2009.

2. The permittee shall be responsible for the correction of any erosion, shoaling or water quality problems that result from the construction or operation of the surface water management system.

3. Measures shall be taken during construction to insure that sedimentation and/or turbidity violations do not occur in the receiving water.

4. The District reserves the right to require that additional water quality treatment methods be incorporated into the drainage system if such measures are shown to be necessary.

5. Facilities other than those stated herein shall not be constructed without an approved modification of this permit.

6. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the District may require the permittee to provide appropriate mitigation to the District or other impacted party. The District may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

7. All barge activity shall occur in areas where a minimum one-foot bottom clearance is maintained.

8. All contractors must be provided with a copy of the staff report and permit conditions prior to the commencement of construction. The permittee is responsible for ensuring that all contractors adhere to the project construction details and methods indicated on the attached permit Exhibits and described herein.

9. The successful completion of the mitigation plan is heavily dependent on proper site grading. Therefore, prior to demobilizing equipment from the site and prior to planting, the permittee shall schedule an inspection by District Environmental Resource Compliance staff to ensure that appropriate elevations and slopes have been achieved.

10. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or other surface waters prior to disposal in a suitable upland spoil disposal area.

11. Prior to the commencement of construction in or adjacent to wetlands and/or other surface waters, the perimeter of the mitigation construction area(s) shall be enclosed with stakedand trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas. The permittee shall notify the District's Environmental Resource Compliance staff in writing upon installation of the silt fencing and/or turbidity screens and schedule an inspection of this work. The silt fencing and/or turbidity screens shall be subject to District staff approval. The permittee shall modify the silt fencing/turbidity screens if District staff determines that it is insufficient or is not in conformance with the intent of this permit. The silt fencing and/or turbidity screens shall remain in place until all adjacent construction activities are complete.

12. All temporary wetland impacts associated with mitigation construction activities shall be restored to preexisting wetland conditions immediately following completion of the mitigation element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time zero mitigation monitoring report and shall be maintained and monitored in conjunction with the mitigation monitoring program provided for in the enclosed exhibits.

13. This permit only applies to authorization from the South Florida Water Management District; it is possible that additional permits may be necessary from other agencies. Nothing contained herein relieves the permittee from timely complying with applicable laws of other federal, state or local governments.

14. Manatee exclusion grates shall be placed across the openings of existing or proposed culverts or pipes that are greater than eighteen inches but smaller than six feet in diameter. The installation of grates applies to any submerged or partially submerged pipes and culverts accessible to manatees during any tidal phase. Permittee shall keep all grates free and clear of debris.

15. Endangered species, threatened species and/or species of special concern have been observed onsite and/or the project contains suitable habitat for these species. It shall be the permittee's responsibility to coordinate with the Florida Fish and Wildlife Conservation Commission and/or the U.S. Fish and Wildlife Service for appropriate guidance, recommendations and/or necessary permits to avoid impacts to listed species.

16. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

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 of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

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 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.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (1-561-562-3909) in south Florida.

Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 81/2" by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. The U.S. Fish and Wildlife Service should also be contacted in Jacksonville (1-904-232-2580) for north Florida or in

Vero Beach (1-561-562-3909) for south Florida.

17. Due to the proximity of this project to areas of known manatee concentrations, all work conducted waterward of the existing shoreline during the months of December, January and February shall be subject to the following conditions:

a) The Bureau of Protected Species Management shall be notified one week prior to the commencement of the work;

b) at least one person shall be designated as a manatee observer at each site when in-water work is being performed. the manatee observer must be on site during all in-water construction activities and will advise personnel to cease operation upon sighting a manatee within 50 feet of any in-water construction activity. Movement of a work barge, other associated vessels, or any in-water work shall not be performed after sunset, when the possibility of spotting manatees is negligible; and

c) the permittee shall ensure that the contractor maintains a log detailing sightings, collisions, or injuries to manatees should they occur during the contract period. Following project completion, the logs shall be submitted to the Bureau of Protected Species Management, 620 South Meridian Street, Tallahassee, Florida 32399-1600;

18. The following exhibits for the permit are incorporated by reference herein and are located in the permit file:

Exhibit No. 14 List of Outparcels within West Lake Natural Preserve and Recreation Area, dated 12/19/01
Exhibit No. 17 Sublease Agreement for West Lake Park, between FDNR and Broward County, executed 12/22/88
Exhibit No. 18 Management Plan for West Lake Park, by Broward County Parks and Recreation Division
Exhibit No. 19 Management Plan Update for West Lake Park, authorized by FDEP on 2/7/02

19. No construction is authorized on land that the permittee does not own until the permittee acquires title to such land.

20. This permit does not eliminate the need to obtain any and all necessary easements and rights of way prior to the start of any activity approved herein. This permit does not convey to the permittee, or create for the permittee, any property right, or any interest in real property; nor does it authorize any entrance upon, or activities on, property which is not owned or controlled by the permittee; or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

21. As provided in Exhibit No. 10, Broward County Parks and Recreation Division shall be responsible for the mitigation construction, five year maintenance and monitoring and perpetual management of the proposed mitigation efforts at West Lake Park.

22. Perpetual maintenance of the mitigation area shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

23. The use of the mitigation units from this project shall be limited to projects undertaken by Broward County. Generally, the mitigation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater and/or estuarine wetland communities. The suitability of this mitigation area to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

The amount of potential credit generated by the mitigation efforts has been

determined using the Uniform Mitigation Assessment Method, 62-345, FAC (UMAM) through an assessment conducted jointly by District and Broward County Department of Planning and Environmental Protection staff and the applicant's representatives and is reflected in the UMAM worksheets provided in Exhibit No. 22. Use of the mitigation credits shall be addressed at the time of application for the wetland impact projects.

24. At the time of application for any that includes wetland impacts and proposes to use mitigation credit from this West Lake mitigation plan, the permittee shall demonstrate that an adequate portion of the mitigation plan has been or shall be executed and completed in a timely manner (i.e., concurrent with the wetland impacts) and that the specified mitigation will adequately offset the wetland impacts associated with that construction project.

25. A mitigation program for West Lake Park shall be implemented in accordance with the enclosed exhibits. The permittee shall create 51.7 acres of wetlands, restore 5.5 acres of wetlands, restore 13.4 acres of uplands, enhance 50.4 acres of wetlands, and preserve 53.3 acres of wetlands.

26. The District reserves the right to require remedial measures to be taken by the permittee if monitoring or other information demonstrates that adverse impacts to onsite or offsite wetlands, upland conservation areas or buffers, or other surface waters have occurred due to project related activities.

27. A mitigation monitoring program shall be implemented in accordance with the enclosed exhibits to ensure that the targeted success criteria are met. The monitoring program shall extend for a period of 5 years with annual reports submitted to District Environmental Resource Compliance staff. The permittee shall be responsible for ensuring that the mitigation areas described herein meet the specified percent coverage and/or survivorship of planted and/or recruited vegetation throughout the duration of the monitoring program, with replanting as necessary. If native wetland, transitional, and upland species do not achieve the specified percent coverage and/or survivorship at any time during the monitoring program, native species shall be planted in accordance with the maintenance program. At the end of the 5 year monitoring program the entire mitigation area shall contain an 80% survival of planted vegetation and an 80% coverage of desirable plant species suitable for that mitigation area.

28. A maintenance program shall be implemented in accordance with Exhibit Nos. 4 and 7 for the mitigation 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 conservation area is 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.

29. A time zero monitoring report for the West Lake Park mitigation project shall be conducted in accordance with Exhibit Nos. 4 and 7 for all completed mitigation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

30. The permittee shall comply with applicable state water quality standards including:
a) 62-302.500 - Minimum criteria for all surface waters at all places and all times;
b) 52-302.510 - Surface waters: general criteria
c) 62-302.560 - Class III waters; recreation, propagation and maintenance of a healthy, well balanced population of fish and wildlife;
d) 62-302.600 - Classified waters.

31. A turbidity control plan shall be implemented in accordance with Exhibit Nos. 4 and 7. Prior to the commencement of construction in or adjacent to the Intracoastal Waterway or other surface water bodies within West Lake Park, floating turbidity curtains with weighted skirts that extend to the submerged bottom shall be properly installed to isolate adjacent waters from the work area. The floating turbidity curtains shall be maintained and shall remain in place until all construction is complete and turbidity levels in the project area are within 29 NTUs of background levels. The permittee shall be responsible for ensuring that turbidity control devices are inspected daily and maintained in good working order so that there are no violations of state water quality standards outside of the turbidity screens.

32. A water quality monitoring program shall be implemented in accordance with Exhibit No. 4 and as outlined below:

Turbidity expressed in nephelometric turbidity units (ntu). Background samples shall be taken 200 feet upstream of any construction activity within adjacent surface waters Samples shall also be taken 200 feet downstream. Samples shall be taken at least twice daily, with at least a four-hour interval, during all work authorized by this permit involving spoil removal, grading or other forms of earthwork that may generate turbidity in other surface waters.

Monitoring shall begin on the first day of construction for all activities within or adjacent to surface waters. Monitoring shall cease when all construction activities are completed. The monitoring data must demonstrate that turbidity 200 feet downstream of all proposed activities is less than or equal to 29 NTU's above natural background turbidity (or meets OFW standards) and 200 feet upstream of each proposed activity for a period of 7 consecutive days after completion of construction. If monitoring shows such levels to be exceeded, construction shall cease and District compliance staff shall be notified immediately. Work shall not resume until District staff is satisfied that adequate corrective measures have been taken and turbidity has returned to acceptable levels.

All monitoring data shall be maintained on site and be available to District staff during regular business hours. The content of the data shall include:

1) permit and application number; (2) dates of sampling and analysis; (3) statement describing the methods used in collection, handling, storage and analysis of the samples; (4) a map indicating the sampling locations and (5) a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection and accuracy of the data.

Monitoring reports shall also include the following information for each sample that is taken:
(a) time of day samples taken;
(b) depth of water body;
(c) depth of samples;
(d) antecedent weather conditions;
(e) wind direction and velocity;

33. Documentation of ownership of the Priority 1 outparcels by the County identified in Exhibit Nos. 14 and 15 must be provided to the District in order to be credited as mitigation for preservation credit and before any other mitigation element is constructed which relies on those outparcels for their construction, access or other purposes.

34. Those portions of the park which are under County ownership and where mitigation is proposed that have been determined to potentially be vulnerable to subsequent alteration (refer to Exhibit No. 13) shall be placed under a conservation easement dedicated to the District. A draft conservation easement document along with boundary surveys and legal descriptions for the identified areas to be protected under the conservation easement shall be submitted for review by District staff and, upon their approval, shall be recorded in County records before mitigation credit for those areas may be used as compensation to offset wetland impacts associated

with other County projects.

35. Management items outlined in Exhibit No. 5 and described in Exhibit Nos. 4 and 7 may be later considered for mitigation credit through a modification of this permit if supporting information to justify mitigation credit for items has been sufficiently demonstrated to the District.

36. Any mitigation credit generated by the planned mitigation activities described herein shall only be eligible for use as compensation to offset tidal, saltwater or estuarine wetland impacts associated with projects proposed by Broward County. Use of such mitigation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the mitigation credit.

37. Early transplanting of seagrass from the impact site to the proposed seagrass creation areas shall be voluntary and shall not be subject to survival criteria. However, the recruitment and coverage criteria specified in this permit shall apply.

38. No modifications to this permit shall be required for construction methodology variations from those described in Exhibit No. 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that District staff concur with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by District regulatory and/or compliance staff.

39. Select mangrove trimming necessary to accomplish the planned mitigation efforts described herein shall be authorized by this permit.

40. Mitigation credit for the designated manatee protection areas shall be granted only after documentation of an agreement, easement or other necessary form of authorization for installation of the manatee protection barriers from the U.S. Army Corps of Engineers has been submitted to the District.

41. Activities associated with the implementation of the mitigation, monitoring and maintenance plan(s) shall be completed in accordance with the work schedule attached as Exhibit No. 21. Any deviation from these time frames will require prior approval from the District's Environmental Resource Compliance staff. Such requests must be made in writing and shall include (1) reason for the change, (2) proposed start/finish and/or completion dates; and (3) progress report on the status of the project development or mitigation effort.

GENERAL CONDITIONS

1. All activities authorized by this permit shall be implemented as set forth in the plans, specifications and performance criteria as approved by this permit. Any deviation from the permitted activity and the conditions for undertaking that activity shall constitute a violation of this permit and Part IV, Chapter 373, F.S.

2. This permit or a copy thereof, complete with all conditions, attachments, exhibits, and modifications shall be kept at the work site of the permitted activity. The complete permit shall be available for review at the work site upon request by District staff. The permittee shall require the contractor to review the complete permit prior to commencement of the activity authorized by this permit.

3. Activities approved by this permit shall be conducted in a manner which does not cause violations of State water quality standards. The permittee shall implement best management practices for erosion and pollution control to prevent violation of State water quality standards. Temporary erosion control shall be implemented prior to and during construction, and permanent control measures shall be completed within 7 days of any construction activity. Turbidity barriers shall be installed and maintained at all locations where the possibility of transferring suspended solids into the receiving waterbody exists due to the permitted work. Turbidity barriers shall remain in place at all locations until construction is completed and soils are stabilized and vegetation has been established. All practices shall be in accordance with the guidelines and specifications described in Chapter 6 of the Florida Land Development Manual; A Guide to Sound Land and Water Management (Department of Environmental Regulation, 1988), incorporated by reference in Rule 40E-4.091, F.A.C. unless a project-specific erosion and sediment control plan is approved as part of the permit. Thereafter the permittee shall be responsible for the removal of the barriers. The permittee shall correct any erosion or shoaling that causes adverse impacts to the water resources.

4. The permittee shall notify the District of the anticipated construction start date within 30 days of the date that this permit is issued. At least 48 hours prior to commencement of activity authorized by this permit, the permittee shall submit to the District an Environmental Resource Permit Construction Commencement Notice Form Number 0960 indicating the actual start date and the expected construction completion date.

5. When the duration of construction will exceed one year, the permittee shall submit construction status reports to the District on an annual basis utilizing an annual status report form. Status report forms shall be submitted the following June of each year.

6. Within 30 days after completion of construction of the permitted activity, the permitee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual as authorized by law, utilizing the supplied Environmental Resource Permit Construction Completion/Certification Form Number 0881. The statement of completion and certification shall be based on onsite observation of construction or review of as-built drawings for the purpose of determining if the work was completed in compliance with permitted plans and specifications. This submittal shall serve to notify the District that the system is ready for inspection. Additionally, if deviation from the approved drawings is discovered during the certification process, the certification must be accompanied by a copy of the approved permit drawings with deviations noted. Both the original and revised specifications must be clearly shown. The plans must be clearly labeled as "As-built" or "Record" drawing. All surveyed dimensions and elevations shall be certified by a registered surveyor.

7. The operation phase of this permit shall not become effective: until the permittee has complied with the requirements of condition (6) above, and submitted a request for conversion of Environmental Resource Permit from Construction Phase to Operation Phase, Form No. 0920; the District determines the system to be in compliance with the permitted plans and specifications; and the entity approved by the District in

accordance with Sections 9.0 and 10.0 of the Basis of Review for Environmental Resource Permit Applications within the South Florida Water Management District, accepts responsibility for operation and maintenance of the system. The permit shall not be transferred to such approved operation and maintenance entity until the operation phase of the permit becomes effective. Following inspection and approval of the permitted system by the District, the permittee shall initiate transfer of the permit to the approved responsible operating entity if different from the permittee. Until the permit is transferred pursuant to Section 40E-1.6107, F.A.C., the permittee shall be liable for compliance with the terms of the permit.

8. Each phase or independent portion of the permitted system must be completed in accordance with the permitted plans and permit conditions prior to the initiation of the permitted use of site infrastructure located within the area served by that portion or phase of the system. Each phase or independent portion of the system must be completed in accordance with the permitted plans and permit conditions prior to transfer of responsibility for operation and maintenance of the phase or portion of the system to a local government or other responsible entity.

9. For those systems that will be operated or maintained by an entity that will require an easement or deed restriction in order to enable that entity to operate or maintain the system in conformance with this permit, such easement or deed restriction must be recorded in the public records and submitted to the District along with any other final operation and maintenance documents required by Sections 9.0 and 10.0 of the Basis of Review for Environmental Resource Permit applications within the South Florida Water Management District, prior to lot or units sales or prior to the completion of the system, whichever comes first. Other documents concerning the establishment and authority of the operating entity must be filed with the Secretary of State, county or municipal entities. Final operation and maintenance documents must be received by the District when maintenance and operation of the system is accepted by the local government entity. Failure to submit the appropriate final documents will result in the permittee remaining liable for carrying out maintenance and operation of the permitted system and any other permit conditions.

10. Should any other regulatory agency require changes to the permitted system, the permittee shall notify the District in writing of the changes prior to implementation so that a determination can be made whether a permit modification is required.

11. This permit does not eliminate the necessity to obtain any required federal, state, local and special district authorizations prior to the start of any activity approved by this permit. This permit does not convey to the permittee or create in the permittee any property right, or any interest in real property, nor does it authorize any entrance upon or activities on property which is not owned or controlled by the permittee, or convey any rights or privileges other than those specified in the permit and Chapter 40E-4 or Chapter 40E-40, F.A.C..

12. The permittee is hereby advised that Section 253.77, F.S. states that a person may not commence any excavation, construction, or other activity involving the use of sovereign or other lands of the State, the title to which is vested in the Board of Trustees of the Internal Improvement Trust Fund without obtaining the required lease, license, easement, or other form of consent authorizing the proposed use. Therefore, the permittee is responsible for obtaining any necessary authorizations from the Board of Trustees prior to commencing activity on sovereignty lands or other state-owned lands.

13. The permittee must obtain a Water Use permit prior to construction dewatering, unless the work qualifies for a general permit pursuant to Subsection 40E-20.302(3), F.A.C., also known as the "No Notice" Rule.

14. The permittee shall hold and save the District harmless from any and all damages, claims, or liabilities which may arise by reason of the construction, alteration, operation, maintenance, removal, abandonment or use of any system authorized by the permit.

15. Any delineation of the extent of a wetland or other surface water submitted as part

of the permit application, including plans or other supporting documentation, shall not be considered binding, unless a specific condition of this permit or a formal determination under Section 373.421(2), F.S., provides otherwise.

16. The permittee shall notify the District in writing within 30 days of any sale, conveyance, or other transfer of ownership or control of a permitted system or the real property on which the permitted system is located. All transfers of ownership or transfers of a permit are subject to the requirements of Rules 40E-1.6105 and 40E-1.6107, F.A.C.. The permittee transferring the permit shall remain liable for corrective actions that may be required as a result of any violations prior to the sale, conveyance or other transfer of the system.

17. Upon reasonable notice to the permittee, District authorized staff with proper identification shall have permission to enter, inspect, sample and test the system to insure conformity with the plans and specifications approved by the permit.

18. If historical or archaeological artifacts are discovered at any time on the project site, the permittee shall immediately notify the appropriate District service center.

19. The permittee shall immediately notify the District in writing of any previously submitted information that is later discovered to be inaccurate.

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
4400 PGA BOULEVARD, SUITE 500
PALM BEACH GARDENS, FLORIDA 33410

REPLY TO
ATTENTION OF

FEB 03 2011

Palm Beach Gardens Section
SAJ-2002-00072(IP-LAO)
Modification-5

Broward County Parks and Recreation Division
c/o Pat Young
Administrative Manager
950 NW 38th Street
Oakland Park, Florida 33309

Dear Mr. Young:

The U.S. Army Corps of Engineers has completed the review and evaluation of your modification request received 24 January 2011 in which you asked to modify Department of the Army permit number SAJ-2002-00072, for activities at the West Lake Park and adjacent wetlands, issued February 28, 2006. The project is located in navigable waters of the U.S, west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2, and 11, Township 50 south, Range 42 east), Broward County, Florida.

The proposed modification is to extend the expiration date to complete your proposed project. This authorization is hereby extended for five years from the date of this letter.

The impact of your proposal on navigation and the environment has been reviewed and found to be insignificant. The permit is hereby modified in accordance with your request. You should attach this letter to the permit. All other conditions of the permit remain in full force and effect.

If you have any questions concerning permit modification, please contact the project manager Melody White at the letterhead address, by telephone at 561-472-3508 or by electronic mail at Melody.J.White@usace.army.mil.

Thank you for your cooperation with our permit program. The Corps Jacksonville District Regulatory Division is committed to improving service to our customers. We strive to perform our duty in a friendly and timely manner while working to preserve our environment. We invite you to take a few minutes to visit http://per2.nwp.usace.army.mil/survey.html and complete our automated Customer Service Survey. Your input is appreciated - favorable or otherwise.

Please be aware this web address is case sensitive and should be entered as it appears above.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

Alfred A. Pantano, Jr.
Colonel, U.S. Army
District Commander

Enclosure

Copies Furnished:

Miller Legg
c/o Dylan Larson
2005 Vista Parkway
Suite 100
West Palm Beach, FL 33411
Email: Jennifer Shipley: jshipley@millerlegg.com
Dylan Larson: dlarson@millerlegg.com

CESAJ-RD-PE

DEPARTMENT OF THE ARMY PERMIT

DUPLICATE

Permittee: Broward County Parks and Recreation Division
Attn: Pat Young
Administrative Manager
950 N.W. 38th Street
Oakland Park, FL 33309

Permit No: SAJ-2002-00072(IP-LAO)

Issuing Office: U.S. Army Engineer District, Jacksonville

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To provide up-front compensation to be used for wetland impacts associated with future Broward County projects, the County has proposed a mitigation plan for upland, wetland, and seagrass creation, restoration, enhancement and preservation of mangroves and seagrasses within West Lake Park in Broward County.

The project is to install culvert connections to increase flushing of a 1500+ acre mangrove forest, tidal flushing channels, construct a riprap/crib structure for shoreline stabilization along approximately 3 miles of shoreline adjacent to the mangrove edge along the ICW and for approximately 1.5 miles along the Dania Cutoff canal. The riprap/crib structure shall be created using piling supports on one or both sides of the riprap with pilings parallel to the shoreline with horizontal reinforcing bars to create the support structure for the riprap. A geotube base filled with clean fill will be laid within the crib structure for stabilization. Where the structure is adjacent to resources, as shown in the attached drawings, riprap placement will be within a 5-foot wide crib structure which is vertical on both sides with pilings and stringers. Where the riprap will not be placed adjacent to resources, the piling support structure will be only built on the landward edge of the mangrove fringe and the riprap will be placed against and waterward of it with the waterward slope of the riprap being no steeper than 1.5 horizontal to 1 vertical.

The project will also include the scrape down and/or removal of exotic vegetation from approximately 63 acres of upland soil to create mangrove, mudflat, tidal flats and pools, seagrass, and maritime hammock habitat. Additionally, exotic vegetation removal will occur in smaller areas throughout the park. A temporary expansion of an existing road involving 0.03 acres of impacts will be installed to allow spoil removal.

The project is proposed to create ±24.2 acres of mangrove habitat, 7.0 acres of mud flats/tidal pools, 8.6 acres of tidal channels, 8.0 acres of seagrass habitat, 13.4 acres of maritime hammock, 1.9 acres of structural habitat in the form of a riprap crib structure along the ICWW, and 2.0 acres of supplemental structural habitat (riprap) along the Dania Cut-off Canal. Project restoration would consist of 1.5 acres of mud flats/tide pools, and improving 3.5 acres of flushing channels within the Dania Salt Marsh, and removing derelict barges which currently shade 0.5 acres of potential seagrass habitat within Whiskey Creek. Project enhancement/creation consists of 32 acres of mangroves, removal of 8.4 acres of exotic vegetation and replanting of sea oxeye daisy, and removing and preventing future exotic infestations in 10 acres. Project preservation consists of 23.3 acres of outparcel acquisition, and 30 acres of seagrass/manatee protection areas.

The work described above is to be completed in accordance with the 33 pages of drawings and 8 attachments affixed at the end of this permit instrument, specifically Attachment 4 which outlines the projects construction methodology, monitoring requirements, and timing.

Project Location: The project is located in West Lake Park, a county park composed almost entirely of a mangrove forest west of the Intracoastal Waterway and south of the Dania Cutoff Canal, Dania Beach (Sections 1, 2 and 11, Township 50 south, Range 42 east, Broward County, Florida.

Directions to site: From I-95 in Fort Lauderdale, exit east at Sheridan Street and go east 2.6 miles. The project is on both sides of Sheridan Street.

Latitude & Longitude: Latitude: 26° 2′ 20" North
Longitude: 80° 7′ 10" West

Permit Conditions

General Conditions:

1. The time limit for completing the work authorized ends on **February 28, 2011**. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature and the mailing address of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. Submittals required herein shall be directed to:

Department of the Army
Jacksonville District Corps of Engineers
Regulatory Division, Enforcement Section
P.O. Box 4970
Jacksonville, Florida 32232-0019

A courtesy copy of any required enhancement/creation reports will also be provided to:

U.S. Army Corps of Engineers
South Permits Branch Office
4400 PGA Boulevard, Suite 500
Palm Beach Gardens, FL 33410

2. Prior to commencement of construction in or adjacent to wetlands and/or Waters of the United States, the perimeter of the enhancement/creation construction area(s) shall be enclosed with staked and trenched silt fencing and/or turbidity screens so as to prevent encroachment or disturbance into adjacent protected areas.

3. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.

4. The permittee shall conduct a pre-construction meeting prior to commencement of construction in order to notify in-house staff, field crews, contractors, subcontractors, and all persons involved in the construction of West Lake Park Enhancement/creation Project of the conditions of this permit. The permittee shall educate and inform staff members and contractors of these procedures. Copies of the permit and specific conditions shall be displayed at the construction site.

5. All storage or stockpiling of tools or materials (i.e. lumber, pilings, etc.) shall be limited to uplands or within the impact areas authorized by this project.

6. All temporary wetland impacts associated with the enhancement/creation construction activities shall be restored to preexisting wetland conditions immediately following completion of the construction element that caused the temporary wetland impacts. All restored temporary impact areas shall be identified in the time-zero enhancement/creation monitoring report and shall

be maintained and monitored in conjunction with the enhancement/creation monitoring program provided for in the enclosed exhibits.

7. This permit is issued based on the applicant's submitted information which reasonably demonstrates that adverse water resource related impacts will not be caused by the completed permit activity. Should any adverse impacts caused by the completed project occur, the Corps may require the permittee to provide appropriate enhancement/creation to the Corps. The Corps may require the permittee to modify the project, if necessary, to eliminate the cause of the adverse impacts.

8. Spoil generated from the excavation authorized by this permit must be stockpiled in upland areas and contained in such a manner as to prevent erosion into wetlands or Waters of the United States prior to disposal in a suitable upland spoil disposal area or placement in the geotube base for the riprap crib.

9. The permittee shall comply with the attached Manatee Construction Conditions enclosed in attachment #3 which are also outlined in this condition. The permittee shall instruct all personnel associated with the project of the potential presence of manatees and the need to avoid collisions with manatees. All construction personnel are responsible for observing water-related activities for the presence of manatee(s).

The permittee shall advise all construction personnel that there are civil penalties and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972, The Endangered Species Act of 1973, and the Florida Manatee Sanctuary Act.

Siltation barriers shall be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exist from essential habitat.

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 where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will follow routes of deep water wherever possible.

If manatee(s) are seen within 100 yards of the active daily construction/dredging operation or vessel movement, all

appropriate precautions shall be implemented to ensure protection of the manatee(s). these precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. Operation of any equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment. Activities will not resume until the manatee(s) has departed the project area of its own volition.

Any collision with and/or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.
Temporary signs concerning manatees shall be posted prior to and during all construction/dredging activities. All signs are to be removed by the permittee upon completion of the project. A sign measuring at least 3 ft. by 4 ft. which reads Caution: Manatee Area will be posted in a location prominently visible to water related construction crews. A second sign should be posted if vessels are associated with the construction, and should be placed visible to the vessel operator. The second sign should be at least 8 ½ by 11" which reads Caution: Manatee Habitat. Idle speed is required if operating a vessel in the construction area. All equipment must be shutdown if a manatee comes within 50 feet of operation. Any collision with and/or injury to a manatee shall be reported immediately to the U.S. Fish and Wildlife Service in Jacksonville (1-904-232-2580) for north Florida or Vero Beach (772-562-3909) in south Florida.

10. The permittee shall install and maintain permanent manatee awareness signs/education displays.

11. As provided in Attachment 4, Broward County Parks and Recreation Division shall be responsible for the enhancement/creation construction, five year maintenance and monitoring and perpetual management of the proposed enhancement/creation efforts at West Lake Park.

12. 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.

13. A time zero monitoring report for the West Lake Park enhancement/creation project shall be conducted in accordance with Attachment 5 for all completed enhancement/creation activities. The time zero monitoring report shall include a survey of the areal extent, acreage and cross-sectional elevations of the created/restored areas and panoramic photographs for each habitat type. The report shall also include a description of planted species, sizes, total number and densities of each plant species within each habitat type as well as mulching methodology.

14. The permittee shall submit annual monitoring reports to the Corps for a period of five years, the first not later than one year after the submission of the time-zero report. Each monitoring report shall provide a narrative, professional biological opinion of the condition of the enhancement/creation improvements. The monitoring report shall also contain a plan view describing the vegetative community, the percent cover for each community, a list of species and their percent cover for each community, the percent cover of wetland and of exotic plant species, the sum of the survivors of those planted plus those recruited, a description of any unusual climatic or other factors, and photos from the same point as where the photos for the time-zero report.

15. Perpetual maintenance of the enhancement/creation areas shall include regular maintenance of the created tidal flushing channels to ensure regular tidal flushing to the adjacent mangrove wetlands. Such maintenance shall include, but may not be limited to, periodic removal of any accumulated material or sediment and any other measures necessary to prevent obstruction of tidal flushing through the created channels.

16. Generally, the enhancement/creation activities authorized by this permit are intended to be used as compensation to offset impacts to tidal, saltwater, and/or estuarine wetland communities. The use of mitigation units from this project shall be limited to projects undertaken by or for Broward County. The Corps will determine if the use of mitigation credits from this project is warranted and appropriate for use as mitigation on other projects. The suitability of this enhancement/creation area

to offset impacts to any given project will be determined on a case-by-case review of the project for which impacts are proposed.

17. The amount of potential credit generated by the enhancement/creation efforts must be confirmed through post-project monitoring to reveal if actual habitat creation and enhancement/creation occurs. These ecological benefits were estimated using the Uniform Mitigation Assessment Method (UMAM) and are summarized in Attachment 6. The values are presumed correct, but are adjustable by the Corps if adequate lift has not been achieved or if proposed acreages for mitigation areas are not enhanced/created as proposed. Verification methods to determine actual acreages for Improvement and verification of potential credits generated from this creation/enhancement project are shown in Attachment 7. Use of such enhancement/creation credit shall require a concurrent modification of this permit at the time of application for the impact projects proposing to use the enhancement/creation credit. Any habitat restoration/enhancement/creation that occurs as a result of this project does not preclude the need to fully adhere to the federal sequential enhancement/creation requirements on future regulated activities.

18. Management items identified in Attachment 8 and described in Attachment 4 may be later considered for enhancement/creation credit through a modification of this permit if supporting information to justify enhancement/creation credit for items has been sufficiently demonstrated to the Corps.

19. No modifications to this permit shall be required for construction methodology variations from those described in Attachment 4 provided that they do not increase incidental impacts to adjacent wetlands and provided that Corps staff concurs with any such deviations in the construction methodology. Field adjustments to the methodology may be made upon agreement by Corps regulatory or compliance staff.

20. Select mangrove trimming necessary to accomplish the planned enhancement/creation efforts described herein shall be authorized by this permit.

21. Since the installation of the buoys for the "boating exclusion zone" is located within the Federal right-of-way for the Federal Channel, **a Department of the Army Consent to Easement is also required *prior* to commencement of installation of the**

buoys. By copy of this letter, the permit is being forwarded to the Corps Real Estate Division for action on the Consent.

22. Enhancement/creation credit for the designated manatee/seagrass protection areas shall be granted only after documentation of a Consent to Easement for installation of the manatee protection barriers from the U.S. Army Corps of Engineers Real Estate Division has been submitted to the offices as outlined in Special Condition #21.

23. The Permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structures or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the Permittee will be required, upon due notice from the U.S. Army Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

24. Fill material used with this project (temporary road expansion and geotube creation) shall be limited to suitable, clean fill material, which excludes materials such as trash, debris, car bodies, asphalt, construction materials, concrete block with exposed reinforcement bars, and any soils contaminated with any toxic substance in toxic amounts (see Section 307 of the Clean Water Act).

25. Following completion of the crib installation, the permittee shall complete a post-installation seagrass survey from the riprap crib structure waterward for a distance 50 feet. This post construction seagrass survey will be conducted in the growing season (April 1-August 31) following the crib construction and shall be submitted to Corps no later than October 1 that year. The seagrass survey shall be compared with the 2002 seagrass survey done by Miller Legg and Associates, Inc. If the post construction seagrass survey shows that seagrasses have been impacted or are no longer growing in their previous locations (adjacent to the crib structure), a UMAM analysis on the seagrass habitats affected based on the Corps earlier UMAM analysis of the West Lake Seagrass areas should be conducted by the permittee and submitted to the Corps for approval. The UMAM debits from the areas affected shall be deducted from any actual seagrass creation/enhancement credits earned through this overall

project. If sufficient actual mitigation credits are not available to offset the impacts caused to seagrasses by the crib structure, the Corps will require remedial measures and will require additional mitigation as necessary to fully offset impacts resulting from the installation of the crib structure.

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

( ) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, State, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal projects.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision: This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (see 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions: General Condition 1 establishes a time limit for the completion of the activity authorized by this permit.

PERMIT NUMBER: SAJ-2002-72(IP-LAO)
PERMITTEE: Broward County Parks and Recreation Division
PAGE 12 of 15

Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

PERMIT NUMBER: SAJ-2002-72(IP-LAO)
PERMITTEE: Broward County Parks and Recreation Division
PAGE 13 of 15

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

(PERMITTEE) 2/28/06 (DATE)

PAT YOUNG
(PERMITTEE NAME-PRINTED)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

(DISTRICT ENGINEER) 3-2-2006 (DATE)
Robert M. Carpenter
Colonel, U.S. Army

Federal to Federal Permit

U.S. DEPARTMENT OF HOMELAND SECURITY U.S. COAST GUARD CG -4122 (Rev 6-04)	PERMIT FOR USE OF REAL PROPERTY BY OTHER FEDERAL AGENCIES	PERMIT NUMBER

This permit to use the U.S. Government property hereinafter described is issued by the U. S. Coast Guard, Department of Homeland Security to the Permittee named below for the purpose herein specified upon the terms, conditions, and general provisions set forth below. By the execution hereof, the Permittee agrees to comply with all such terms, conditions, and general provisions.

GENERAL PROVISIONS

a. The Permitter hereby grants to the Permittee the non-exclusive permission to use the premises or facilities specified in item 3, together with the necessary rights of ingress and egress.

b. This Permit shall be effective during the period stated in item 2 and is revocable at any time without notice at the option and discretion of the Permitter or its duly authorized representative.

c. The use to be made of the subject premises shall be limited to that specified in item 4.

d. This Permit shall be neither assignable nor transferable by the Permittee.

e. If utilities and services are furnished the Permittee for its use of the premises, the cost thereof will be reimbursed to the Permitter pursuant to applicable statutes and regulations governing such reimbursement.

f. The Permittee shall protect, maintain, and keep in good order the premises or facilities Permitted hereby. This obligation includes responsibility for all costs incurred for any maintenance and repair (including long-term maintenance) which the Permittee shall consider necessary or desirable in connection with its occupancy hereunder.

g. Any item of long-term maintenance, or any additions to, or alterations of, the premises or facilities which the Permittee shall consider necessary or desirable in connection with its use and occupancy shall be made only with the prior approval and consent of the Permitter and at the sole cost and expense of the Permittee. Upon revocation, expiration or surrender of this Permit, and to the extent directed by the Permitter the Permittee shall remove all alterations, additions, betterments and improvements made, or installed and restore the premises or facilities to the same or as good condition as existed on the date of entry under this Permit reasonable wear and tear excepted.

h. All activities authorized hereunder shall be subject to such rules and regulations as regards supervision or otherwise, as may, from time to time, be prescribed by the local representative of the Permitter designated in item 5.

1. COAST GUARD ACTIVITY (Property location)	2. DATES COVERED (Inclusive) FROM: TO:

3. DESCRIPTION OF PROPERTY (Include rooms and buildings where appropriate)

4. PURPOSE OF PERMIT (Specific use)

5. PERMITTER U.S. Coast Guard PREVIOUS EDITION IS OBSOLETE	NAME AND TITLE OF OFFICIAL (Type)	DATE SIGNATURE OF OFFICIAL
6. PERMITTEE (Give full Agency designation)	NAME AND TITLE OF OFFICIAL (Type)	DATE SIGNATURE OF OFFICIAL

EXHIBIT C-2

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY FOR PORT EVERGLADES HARBOR, FLORIDA, NAVIGATION PROJECT

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **YES**
b. Does the sponsor have the power of eminent domain for this project? **YES**
c. Does the sponsor have "quick-take" authority for this project? **YES**
d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? **NO**
e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **YES. The United States Coast Guard (USCG) owns property that will be affected by the project.**

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require technical training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? **NO**
b. If the answer to IIa. is "yes," has a reasonable plan been developed to provide such training? **N/A**
c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **YES**
d. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? **YES**
e. Can the sponsor obtain contractor support, if required in a timely fashion? **YES**
f. Will the sponsor likely request USACE assistance in acquiring real estate? **NO**

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site? **YES**
b. Has the sponsor approved the project/real estate schedule/milestones? **YES**

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? **YES**
b. With regard to this project, the sponsor is anticipated to be: highly capable/fully capable/moderately capable/marginally capable/insufficiently capable. **HIGHLY CAPABLE**

V. Coordination:

a. Has this assessment been coordinated with the sponsor? **YES**
b. Does the sponsor concur with this assessment? **YES**

Date: 24 November 2014

Prepared by:

Lynn H. Zedlak
Realty Specialist
Real Estate Division
Jacksonville District

Reviewed by:

Hansler A. Bealyer
Chief, Acquisition Branch
Real Estate Division
Jacksonville District

Reviewed and approved by:

Audrey C. Ormerod
Chief, Real Estate Division
Real Estate Division
Jacksonville District

EXHIBIT C-3

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF
Real Estate Division

David Anderton, AICP, PPM
Assistant Director of Port Everglades
Strategic Planning and Development
Office of Chief Executive – Port Director
1850 Eller Drive
Fort Lauderdale, Florida 33316

Dear Mr. Anderton:

The intent of this letter is to formally advise Broward County, Florida, Port Everglades Department, as the non-Federal sponsor for the Port Everglades Navigation Project, of the risks associated with land acquisition prior to the execution of the Project Partnership Agreement (PPA) or prior to the Government's formal notice to proceed with acquisition. If a non-Federal sponsor deems it necessary to commence acquisition prior to an executed PPA for whatever reason, the non-Federal sponsor assumes full and sole responsibility for any and all costs, responsibility, or liability arising out of the acquisition effort.

Generally, these risks include, but may not be limited to, the following:

1. Congress may not appropriate funds to construct the proposed project;

2. The proposed project may otherwise not be funded or approved for construction;

3. A PPA mutually agreeable to the non-Federal sponsor and the Government may not be executed and implemented;

4. The non-Federal sponsor may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA, as amended;

5. The non-Federal sponsor may acquire interests or estates that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project;

6. The non-Federal sponsor may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under P.L. 91-646 as well as the payment of additional fair market value to affected landowners which could have been avoided by delaying acquisition until after PPA execution and the Government's notice to commence acquisition and performance of LERRD; and

7. The non-Federal sponsor may incur costs or expenses in connection with its decision to acquire or perform LERRD in advance of the executed PPA and the Government's notice to proceed which may not be creditable under the provisions of Public Law 99-662 or the PPA.

We appreciate the County's participation in this project. Should you have questions or concerns pertaining to this letter please feel free to contact Mrs. Lynn Zediak at (904) 232-3811.

Sincerely,

Audrey C. Ormerod

Audrey C. Ormerod
Chief, Real Estate Division
Jacksonville District

APPENDIX D

PERTINENT CORRESPONDENCE

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

BROWARD COUNTY
FLORIDA

PORT EVERGLADES DEPARTMENT – Chief Executive/Port Director's Office
1850 Eller Drive, Fort Lauderdale, Florida 33316
954-468-0140 FAX 954-523-8713

August 14, 2014

Colonel Alan M. Dodd
US Army District Commander
U.S. Army Corps of Engineers, Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Dodd:

I am in receipt of your letter dated July 25, 2014 and have been briefed by members of your staff concerning the selection of 47-feet as the National Economic Development (NED) Plan for Port Everglades. The analysis of channel improvements at Port Everglades conducted by the U.S. Army Corps of Engineers (USACE) Jacksonville District and the Deep Draft Navigation Center has identified 48-feet as the channel depth that maximizes net benefits. However, the USACE has determined that the net benefits for the 48-foot channel are "not significantly different" from the benefits of the 47-foot channel, and thereby identified the 47-foot channel as the NED plan.

Broward County recognizes the value of a 48-foot channel to the nation as well as to the state, regional and local economy. After careful consideration by our executive team and the Broward County Board of County Commissioners, Broward County, as the non-federal sponsor, supports the 48-foot channel and requests that the 48-foot channel be implemented as the Locally Preferred Plan (LPP). The 48-foot channel is instrumental to the Port Everglades Master/Vision Plan and will contribute greatly to the future economic growth of the region.

By selecting 48-feet as the LPP, Broward County understands and is prepared to meet all of the commitments as the local sponsor that this depth represents in terms of deepening expenses.

As Broward County's primary liaison with the USACE on this project, I am very appreciative of you and your team's efforts to move this very important project forward in a timely manner given its lengthy history.

If additional information is needed, please do not hesitate to contact me at (954) 468-3516.

Sincerely,

Steven M. Cernak, P.E., PPM
Chief Executive/Port Director
Port Everglades

SMC:DA:kwr

Attachment

CC: Bertha Henry, Broward County Administrator
Glenn Wiltshire, Deputy Director, Port Everglades
David Anderton, II, AICP, PPM, Assistant Director, Port Everglades
Edward Labrador, Director, B.C. Intergovernmental Affairs and Professional Standards

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

F/SER3: DMB
SER-2012-03723

MAY 01 2014

Mr. Eric Bush
Jacksonville District Corps of Engineers
Department of the Army
P.O. Box 4970
Jacksonville, Florida 32232

Re: Port Everglades Expansion Project, Broward County, Florida

Dear Mr. Bush:

This letter is intended to memorialize the discussions of our April 17, 2014, meeting, regarding the March 7, 2014, Endangered Species Act (ESA) biological opinion the National Marine Fisheries Service (NMFS) issued for the Port Everglades Expansion Project. I believe that the meeting helped us resolve all the major remaining concerns. A number of clarifications and corrections for the biological opinion were identified in the meeting. We do not believe that any of these issues are significant changes to the biological opinion that would require us to amend it. In response to a March 18 email from you, we have previously provided clarifications on the biological opinion in an April 4 letter from me and, informally, in an April 9 email from David Bernhart. This letter builds on those earlier responses. Please include this letter in your record for the Port Everglades Expansion Project and your ESA consultation with us.

An overarching issue seems to be our language concerning "refining" or "finalizing" the blended coral mitigation plan. We agree that the blended coral mitigation plan that has been developed is fully sufficient for review at the feasibility study level of detail. Our comments are referring to retaining the flexibility to coordinate the construction level of details, as the project gets closer to implementation and allowing the incorporation of lessons learned into those fine-scale mitigation details before the final implementation of the mitigation plan. The "finalization" that we are envisioning would not change the scope of the blended coral mitigation plan, including associated monitoring and adaptive management actions, outside the current feasibility study level of detail.

The following clarifications and corrections relate to and follow the order of the eight recommended changes in your March 18 email and which guided the discussions during our meeting.

Density of Acropora cervicornis colonies
On page 103 and in Appendix C, the opinion refers to a density of *Acropora cervicornis* of 1.0 colonies/m^2. That value was used to calculate the potential conservation value – based on conservation goals being considered by the *Acropora* Recovery Team – of areas of critical habitat that will be impacted by the project. It was then used to compare the lost value from

hardbottom impacts against the positive impacts of *Acropora* propagation in the blended mitigation plan. That analysis was detailed in section 9 of the biological opinion. The specific value of 1.0 colonies of >0.5m^2 in size per m^2 was not intended to specify the density at which the *Acropora cervicornis* outplanting under the mitigation plan must occur.

Acreage of Acropora critical habitat impacted
The opinion uses a value of 15.55 acres permanently removed, which is derived from the laser air-borne depth sounder data set for the project area from 2001. Subsequent to the drafting of this section of the opinion, the Corps and the resource agencies agreed to use a different data set, collected in 2008, which yields a value of 15.33 acres. At other locations in the opinion, the opinion discusses a total amount of critical habitat impacted of 23.62 acres, which includes the 15.55 value. Based on the later agreement to use 15.33 acres, this combined value would also be revised to 23.40 acres. Due to the very small difference between these values, we do not believe they are significant differences that impact the opinion's analysis or determinations.

Ocean Dredged Material Disposal Site consultation with U.S. Environmental Protection Agency
The opinion was issued to both the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency (EPA). Because NMFS determined that the EPA's expansion of the Port Everglades Ocean Dredged Material Disposal Site (ODMDS) was an interrelated and interdependent activity, its effects were considered in the Port Everglades expansion opinion. NMFS considers our consultation with EPA to be concluded with the issuance of the biological opinion and no additional concurrence or consultation is required. NMFS staff will follow up with the EPA project manager on the ODMDS expansion and ensure EPA has no further questions regarding EPA's consultation responsibilities.

Acreage of channel walls and bottom impacted
During the meeting, your staff presented the Corps' analysis of the impacted acreage, which totaled 111.5 acres. NMFS staff involved in drafting the biological opinion re-reviewed the Corps' information. We agree that the 133 acre value used in the opinion is in error. The 133 acre value is used in two ways in the opinion: in the context of *Acropora* critical habitat analysis and in the estimation of numbers of proposed species of corals impacted. The critical habitat analysis concluded that the channel walls and bottom did not provide the essential feature of critical habitat, so the error in the impacted acreage is irrelevant. In the case of the numbers of proposed corals listed, the use of 133 acres would produce an overestimate in numbers. Because the Corps and NMFS will have to coordinate later to convert the conference opinion to a biological opinion for the proposed species, if their listings are finalized, we will re-estimate the numbers of those species impacted at that time, considering the correct impact acreage as well as any additional information that may become available.

Authorization to propagate species of corals proposed to be listed
NMFS cannot authorize use of proposed coral species for collection and propagation without more detailed information regarding whether they will be used as part of the mitigation plan, how many of each species, what size colonies, where they would be collected from, etc. Given the imposed time constraints for the biological opinion we felt that waiting for that detailed information was not feasible. If those species prove amenable to propagation and they are included in the finalized blended mitigation plan, then we can include a take authorization at a

later time, either when the USACE requests that the conference opinion be adopted as a final biological opinion, or through some later amendment of the biological opinion.

Extent of coral outplanting and monitoring requirements
During the meeting, we agreed that this issue should be resolved by my April 4, 2014, letter, along with the further clarification I am providing in this letter that NMFS agrees that the blended coral mitigation plan is fully sufficient for review at the feasibility study level of detail. Further, we are committed to continue to work with the Corps to ensure that the blended mitigation plan can be implemented successfully and in compliance with the Corps' policies.

Typographical error on page 102 of the opinion
As David Bernhart had previously communicated, the value of 12,500 corals relocated was a hold-over value from an earlier draft of the opinion that should have been updated to the revised value of 11,502. The correct value occurs in other locations in the opinion.

Vegetated and unvegetated areas of seagrass
We had extensive discussions on the valuation and acreage calculations of seagrass habitat. The primary policy impact of those discussions relates to NMFS Essential Fish Habitat conservation recommendations and seagrass mitigation requirements. We agreed that the discussion of seagrass habitat in the biological opinion did not need to be modified and that, with respect to the listed Johnson's seagrass, it would be more conservative to retain the opinion's current treatment of seagrass habitat areas.

Thank you for your willingness to bring the Corps team to St. Petersburg for an in-person meeting to resolve these issues. I believe the in-person meeting contributed greatly to the successful resolution of these remaining issues. If you have further questions about the biological opinion for this project, please contact Mr. David Bernhart at (727)551-5767.

Sincerely,

Miles M. Croom

for Roy E. Crabtree, Ph.D.
Regional Administrator

File: 1514-22.F.4

BROWARD COUNTY FLORIDA

PORT EVERGLADES DEPARTMENT - Port Director's Office
1850 Eller Drive - Fort Lauderdale, Florida 33316
954-523-3404 FAX 954-523-8713

January 4, 2010

Mr. Michael W. Sole, Secretary
Florida Department of Environmental Protection
3900 Commonwealth Boulevard, Mail Station 49
Tallahassee, Florida 32399-3000

RE: BROWARD COUNTY'S "PORT EVERGLADES FEASIBILITY AND TECHNICAL STUDY FOR THE CREATION OF MANGROVE WETLANDS"
FOLLOW UP TO THE DECEMBER 11, 2009 MEETING

Dear Secretary Sole:

We appreciate you and your staff taking the time out of your busy schedules to meet with us at your offices in Tallahassee on December 11, 2009 regarding the above referenced project. As you know, Broward County's Port Everglades Department has been working diligently with your staff and other stakeholders for over a year on a proposal to create a functioning mangrove wetland habitat (Upland Enhancement) on port property as an offset for the release of approximately 8.68 acres west of the Turning Notch (TN) from the existing 48.27 acre Conservation Easement (CE) in Southport. After the submittal of our original proposal in February 2009, followed up by additional analysis and responses to comments from your staff in May and October and our meeting, we understand that the Department is willing to move forward with and approve this proposal under the following conditions:

- As shown in EXHIBIT I, the port would create approximately 16.5 acres of Upland Enhancement area in Sites A and B. At the Department's request, we will also remove the exotics on the former Sites C and D.

- The Port staff will recommend to the Broward County Board of County Commissioners that they approve the transfer of fee simple ownership to the Department of the approximately 60 acres (subject to verification by survey and boundary mapping) that make up the remaining portion of the existing CE, Sites A and B, the existing Manatee Nursery and the FP&L Discharge Canal adjacent to these areas (see EXHIBIT II). Broward County would continue to be granted access and other necessary easements to the Discharge Canal for port-related activities. FP&L would also retain an easement for the Discharge Canal.

- The Port will perform additional sampling and test for additional chemical compounds (Tributyltin and Copper) at the former Dry Marina location within Site A, and conduct additional soil boring testing in the new area added to Site B. These tests can be conducted at the time of creation of the Upland Enhancement.

- The Upland Enhancement area design would include the addition of culverts under the road west of the FP&L Discharge Canal Bridge currently under construction to hydrologically connect Sites A and B.

- One permit would be issued for the proposed Upland Enhancement area and removal of the existing approximately 8.68 acres of mangroves west of the TN. The Department would assist with expediting the permit process to the best of its ability, and is committed to completing the process within 2 years.

- The Department will work with Port Everglades on defining the criteria associated with "trending towards success" for the created Upland Enhancement area. It is understood that one year after the creation of the Upland Enhancement area is sufficient for a "trending towards success" determination and, assuming this is the case, the Department agrees that the CE will be released and the removal of the approximately 8.68 acres of mangroves west of the TN could begin at that time. The fee simple transfer of the approximately 60 acres to the Department would occur simultaneously.

- Broward County will post a bond or other form of performance guarantee in an amount to be determined to ensure the "success" of the Upland Enhancement area. The Department will work with Port Everglades on defining the criteria associated with "success."

As we discussed at our meeting, I do not have the authority to agree to the above provisions without the approval of my Board of County Commissioners. I would respectfully request that you provide me with a letter indicating your concurrence with the above so I may proceed with taking an agenda item to my Board in late January that authorizes me to enter into formal negotiations with the Department leading towards a two-party agreement.

We look forward to continuing to work with you and your staff on this very important project for the State of Florida, which I believe demonstrates the Port's commitment to striking a balance between economic development and environmental stewardship.

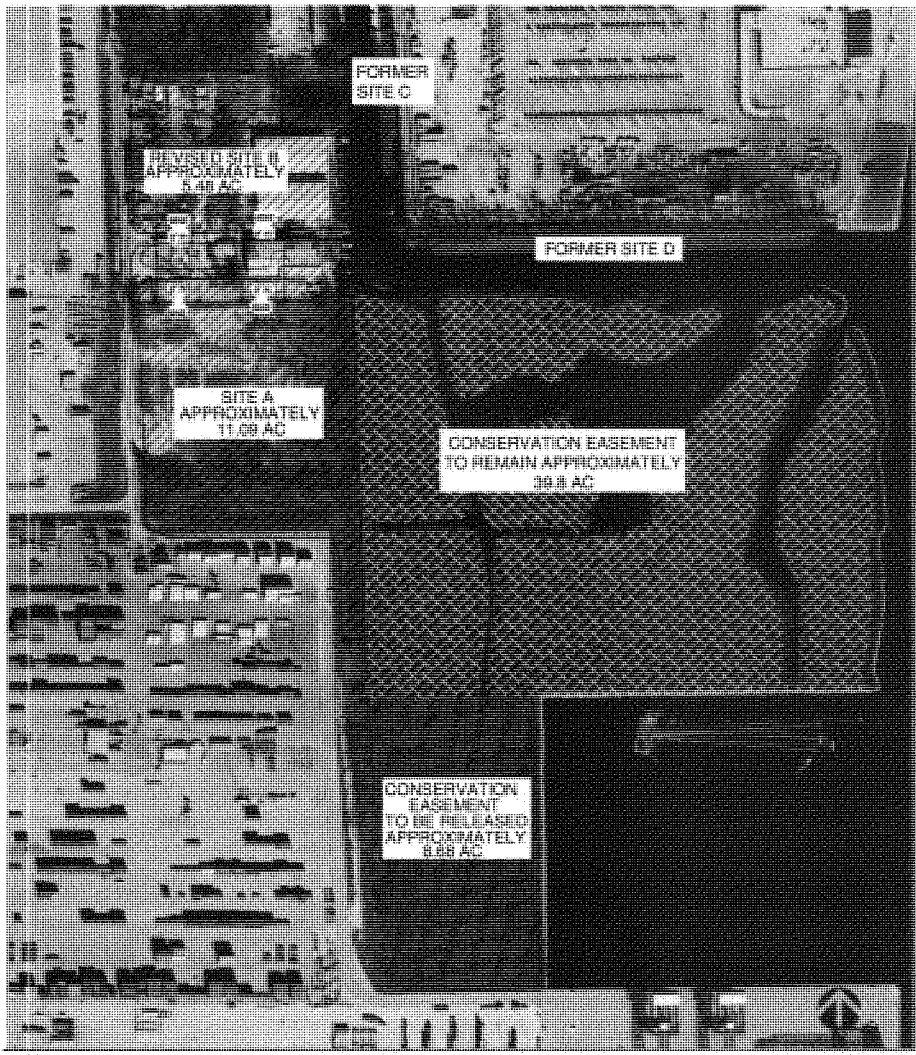
Please feel free to contact me if you have any questions or need any additional information.

Sincerely,

Phillip C. Allen
Port Director

Attachments

cc: David Anderton, AICP, Planning Manager, PEV
Linda Shelley, Fowler White Boggs
Bob Ballard, FDEP, Deputy Secretary
Mimi Drew, FDEP, Deputy Secretary
Janet Llewellyn, FDEP, DWRM
Michael Barnett, FDEP, BBCS
Martin Seeling, FDEP, BBCS
Steven MacLeod, FDEP, BBCS
Mary Poole, OPSC



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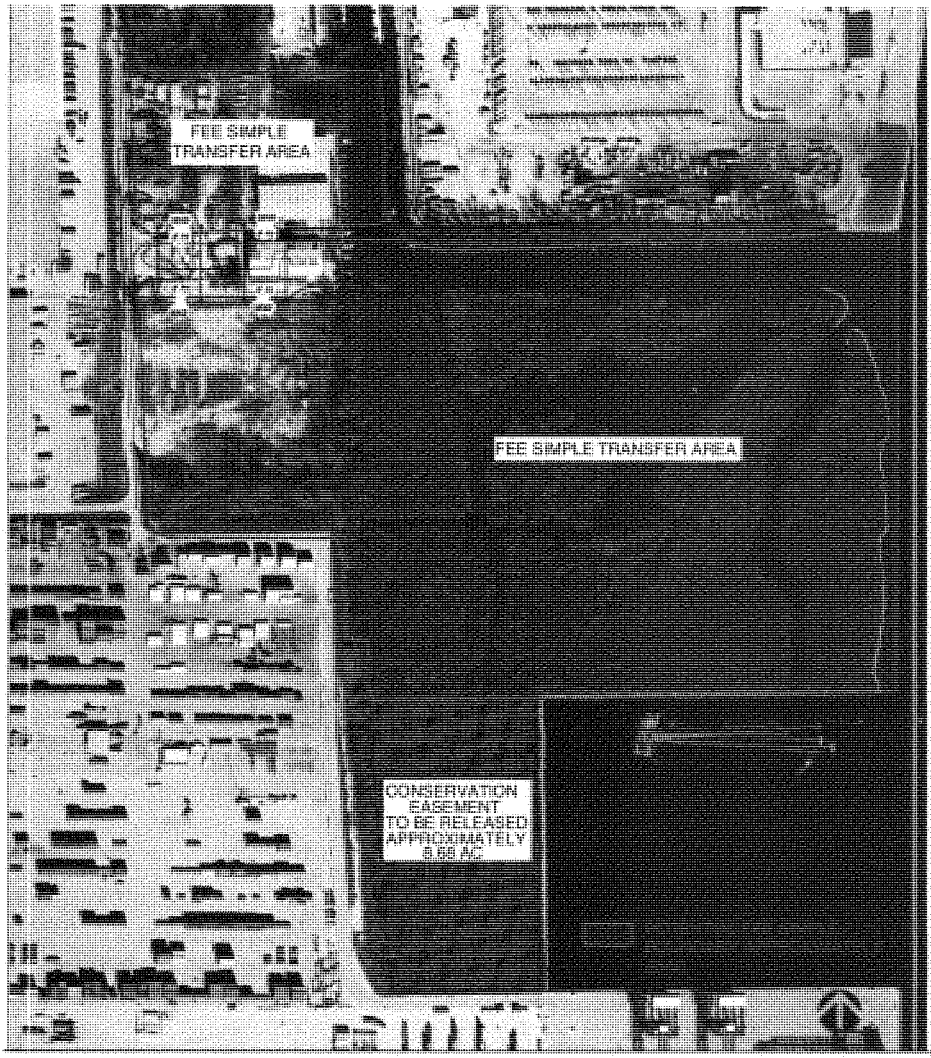
TIME: --
PLOT SCALE: --
DESIGNED: --
DRAWN: --
CHECKED: --
APPROVED: --
DATE: December 11, 2009

PORT EVERGLADES CONSERVATION EASEMENT
PORT EVERGLADES
BROWARD COUNTY, FL

EXHIBIT 1

CH2MHILL
4350 W Cypress
Suite # 600
Tampa, Florida
33607

JOB No. 172285
CAD FILE: CAD FILE
SHEET NUMBER
EX1
SHEET OF



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PLOT SCALE:	--
DESIGNED:	--
DRAWN:	--
CHECKED:	--
APPROVED:	--
DATE: December 11, 2009	

PORT EVERGLADES CONSERVATION EASEMENT

PORT EVERGLADES

BROWARD COUNTY, FL

EXHIBIT 2

CH2MHILL

4350 W Cypress
Suite # 600
Tampa, Florida
33607

JOB No.	172285
CAD FILE	CAD FILE
SHEET NUMBER	EX2
SHEET	OF

Florida Department of
Environmental Protection
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

January 25, 2010

Mr. Phillip C. Allen, Port Director
Broward County Port Everglades Department
1850 Eller Drive
Fort Lauderdale, Florida 33316

Re: Broward County's proposal for conservation easement release following the December 11, 2009, meeting in Tallahassee

Dear Mr. Allen:

Thank you for coming to Tallahassee on December 11, 2009, to discuss the latest developments on the Port's proposal to obtain the release of an existing 8.68-acre parcel of the conservation easement directly west of the existing turning notch. I felt the meeting was very productive. The Florida Department of Environmental Protection (DEP) agrees that if all the stipulations discussed in the meeting are met, then there will be a clear benefit to the natural environment which will be sufficient to justify the release of the turning notch portion of the easement.

DEP has reviewed your January 4, 2010 letter (attached), which includes a summary of the December 2009 meeting, and concurs with it subject to the following additions and clarifications:

- The "Upland Enhancement" referred to in your letter denotes the creation of mangrove wetlands in areas that are currently predominantly uplands.

- Regarding your second bulleted item, it is not clear that Florida Power & Light (FPL) currently holds a valid easement, but if not, DEP will support the issuance of a new easement to protect FPL's ability to utilize the Discharge Canal.

- Regarding the fifth bulleted item, combining the proposed enhancement/ restoration activities and the proposed excavation of the 8.68-acre parcel west of the turning notch (once the easement is released) is certainly possible. However, these two activities may be permitted separately if it is determined that it will help expedite the overall project. Further, we again wish to clarify that the proposed enhancement/restoration and preservation (through fee-simple transfer) of the areas north of the turning notch are only sufficient to release the existing conservation

easement currently maintained on the 8.68-acre parcel. Separate mitigation will be required for the actual elimination of mangrove wetlands during excavation of the parcel. DEP acknowledges that the Port intends to offset this impact with mitigation credits approved by the South Florida Water Management District for restoration and enhancement work in West Lake Park, immediately south of Port Everglades.

- Regarding your sixth bulleted item, construction of the extended turning notch could begin once the intermediate success criteria are achieved to show that the mangrove restoration is "trending toward success," at which point the 8.68-acre portion of the Conservation Easement would be released. The mangrove restoration activities must have been completed for at least one year before the "trending toward success" evaluation would be considered.

- Regarding your seventh bulleted item, the Port would remain responsible for the mangrove restoration project until the final success criteria have been achieved.

- Additionally, the Port confirmed that expansion of the turning notch is necessary to the Port regardless of whether or not expansion of the Port's entrance channel occurs.

We look forward to working with the Port on advancing the current proposal. If you have any questions, please contact Mr. Steven MacLeod, Environmental Specialist in DEP's Bureau of Beaches and Coastal Systems, by telephone at (850) 414-7806 or by e-mail at steven.macleod@dep.state.fl.us.

Sincerely,

Michael W. Sole
Secretary

Attachment: Letter from Phillip Allen (dated January 4, 2010)

cc: David Anderton, Port Everglades
Linda Shelley, Fowler White Boggs
Bob Ballard, Deputy Secretary, Land and Recreation, DEP
Mimi Drew, Deputy Secretary, Regulatory Programs, DEP
Steven MacLeod, Bureau of Beaches and Coastal Systems, DEP
Mary Ann Poole, Florida Fish and Wildlife Conservation Commission

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

0 2 AUG 2010

Planning Division
Plan Formulation Branch

Commander, Seventh Coast Guard District (dpw)
ATTN: (Mr. Joe Embres)
Federal Building
Brickell Plaza
909 Southeast 1st Avenue
Miami, Florida 33131-3050

Dear Sir:

The U.S. Army Corps of Engineers (USACE) requests your assistance in providing costs for potential relocation of aids to navigation in Port Everglades Harbor. Potential navigation improvements shown on the enclosed drawings may impact existing aids to navigation. While no decision has been made to accomplish the proposed navigation channel deepening and widening measures, we want to notify your agency of the ongoing navigation study and request your assistance in compiling initial and annual costs for changes to navigation aids incurred as a result of the enclosed plan.

At this phase of planning, a draft Tentatively Selected Plan (TSP) for Port Everglades currently consists of the following navigation improvements pending review and approval by USACE South Atlantic Division and Headquarters for public release. As shown in the enclosed figures, the draft TSP [Plan 2E cs (container ship)] of improvement includes: deepen and widen the Outer Entrance Channel (OEC) from an existing 45-foot project depth over a 500-foot channel width to 57 feet by 800 feet and extend 2,200 feet seaward; deepen the Inner Entrance Channel (IEC) from 42 feet to 50 feet; deepen ship simulator-optimized portion of the Main Turning Basin (MTB) from 42 feet to 50 feet; widen the rectangular shoal region to the southeast of the MTB (Widener) by about 300 feet and deepen to 50 feet; widen the South Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 feet and relocate the USCG facility 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 Southport Access Channel (SAC) from about berth 23 to the south end of berth 32 from 42 feet to 50 feet; deepen the Turning Notch (TN), including Sponsor expanded portion from 42 feet to 50 feet with an additional 100-foot widening parallel to the 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. If no net changes result in the costs for new navigation aids over the existing maintenance costs, please advise us.

Thank you for your cooperation in this matter. If you have any question or need clarification on the above matter, contact Dick Powell at 904-232-1694.

Sincerely,

REBECCA S. GRIFFITH, Ph.D, PMP
Chief, Planning Division

U.S. Department of Homeland Security
United States Coast Guard

Commander
United States Coast Guard
Sector Miami

100 MacArthur Causeway
Miami Beach, FL 33139
Staff Symbol: spw
Phone (305) 535-8724
Fax: (305) 535-8740

16670 /07-1762
January 23, 2008

Marie G. Burns
Acting Chief, Planning Division
Jacksonville District Corps of Engineers
Department of the Army
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Ms. Burns:

I am writing in response to your letter dated November 5, 2007. The U.S. Coast Guard is charged with ensuring the safe navigation of vessels and the protection of the environment. Having reviewed the proposed entrance channel alignments for Port Everglades, Florida, I am providing the following preliminary comments for the Feasibility Study that will be included in the National Environmental Protection Agency document:

1. Outer Entrance Channel Alternative 1

   USACE comment: "...would avoid dredging but would require placement of buoys/markers at the entrance of the gap and would require two 90-degree turns to access the existing entrance channel. This approach may also require the dredging of a turning basin to safely allow the incoming ships to enter the channel."

   USCG comment: The two required 90-degree turns would elevate the navigational risk for deep draft vessels that routinely call at this port to an unacceptable level. The narrow corridor and short turning basins this channel would create would restrict maneuverability thus increasing the risk of grounding.

2. Outer Entrance Channel Alignments #2 and #3

   USACE comment: "...would require direct impacts to the 2nd and 3rd hardground relic reef terraces by dredging, as well as placement of channel alignment buoys/markers to mark the entrance channel for deep draft vessel access."

   USCG comment: The addition of two turns in alternative #2 and one turn in alternative #3 also elevate the navigational risk for deep draft vessels that routinely call on the port. Strong North/South prevailing currents, often times unpredictable in terms of force, coupled with greater exposure to other risk factors such as submerged breakwaters, spoil areas, small craft congestion and Naval restricted areas, make these alternatives problematic.

3. Outer Entrance Channel Alignment #4

USACE comment: "...would avoid dredging but would require placement of channel buoys/markers at the entrance and on the transit route. This alignment would require the transit of the vessels entering the port for up to three miles from the southern reef gap, northward between the 2nd and 3rd relic reef terraces, to the current entrance channel alignment, and then a 90-degree left turn into the entrance channel. This turn would probably require widening to allow safe transit into the existing entrance channel."

USCG comment: Again the two required 90-degree turns would elevate the navigational risk for deep draft vessels that routinely call at this port to an unacceptable level. This option would require vessels to transit the entire Naval restricted area and lengthen their exposure to the reefs.

Other hazards may also arise with the construction of the proposed liquefied natural gas deepwater port, and from larger vessels that will soon begin calling on Port Everglades. For example, Royal Caribbean is building the world's largest cruise ship that will measure 1,180 ft in length, displace 220,000 tons and carry 8000 passengers/crew. This is one of nine new cruise ships scheduled for delivery in 2009. Many, if not all, of these ships will visit Port Everglades.

In regards to the installation and servicing of navigational aids that would be needed for the new channel alignments, expenses could reach upwards of $1.3 million for initial placement and approximately $42,000 for recurring costs.

My overall concern is to help prevent marine accidents that may ultimately cause harm to life and/or the environment. At this time I cannot recommend any of the aforementioned alternatives. For further info please contact LT Chaning Burgess - Waterways Division Chief at 305-535-8724 or by email at chaning.d.burgess@uscg.mil.

Sincerely,

KARL L. SCHULTZ
Captain, U.S. Coast Guard
Captain of The Port

Ross
DPC

BROWARD COUNTY
FLORIDA

ROGER DESJARLAIS, County Administrator
115 S. Andrews Avenue, Room 409 • Fort Lauderdale, Florida 33301 • 954-357-7350 • FAX 954-357-7360

September 28, 2004

Richard E. Bonner, P.E.
Deputy District Engineer for Project Management
Department of the Army
Jacksonville District
P.O. Box 4970
Jacksonville, FL 32232-0019

Re: **Port Everglades Mitigation Plan as Referenced in Port Feasibility Study**

Dear Mr. Bonner:

The current Feasibility Study of the Port Everglades harbor is extremely important to Broward County, Port Everglades and the South Florida region. As such, we understand that it is important that Broward County concurs with the proposed mitigation plan currently being developed for this project by the Army Corps of Engineers.

With that said, please keep in mind that Broward County policy provides that all projects that impact the wetland and aquatic resources of Broward County should provide the mitigation benefits associated with these impacts as close to the impacted area as possible. Therefore, it is our goal that all mitigation associated with this project takes place within West Lake Park or elsewhere in the vicinity of Port Everglades.

A program currently exists for wetland improvements to West Lake Park. The Broward County Parks and Recreation Division is in the process of obtaining the necessary permits from the various permitting agencies having jurisdiction over these improvements. The mitigation permitted as a result of this effort will be utilized by both the Airport and Seaport in their expansion programs. It is our desire that all impacts of the Port's project will be mitigated within the West Lake Park area.

Thank you for the opportunity to address your concerns. For further input, if needed, please contact Ken Krauter at (954) 523-3404, Extension 3601.

Sincerely,

Roger J. Desjarlais
County Administrator

RJD/ADS:keb:pm

cc: Ken Krauter, Director, Port Everglades
Christopher B. Novack, P.E., Construction Management & Planning, Port Everglades
Allan D. Sosnow, Construction Management & Planning, Port Everglades

Broward County Board of County Commissioners
Josephus Eggelletion, Jr. • Ben Graber • Sue Gunzburger • Kristin D. Jacobs • Ilene Lieberman • Lori Nance Parrish • John F. Rodstrom, Jr. • Jim Scott • Diana Wasserman-Rubin
www.broward.org

BROWARD COUNTY FLORIDA

PORT EVERGLADES DEPARTMENT - Port Director's Office
1850 Eller Drive - Fort Lauderdale, Florida 33316
954-523-3404 FAX 954-523-8713

Date: July 28, 2009

To: Mayor and Members of the
Broward County Board of County Commissioners

Through: Bertha Henry, County Administrator

From: Phillip C. Allen, Port Director
Kent George, Director of Aviation

Re: **Status Update on Use of Port Everglades Dredged Material as Fill Material for Airport Runway and Taxiway Construction**

This memo is to provide you with an update on the current status of the Port's and the Army Corps of Engineers' (ACOE) effort to identify management options for dredged material expected to be generated from the proposed deepening and widening program at the Port. The incompatibility of the latest proposed estimated construction schedules for both the Aviation Department's south runway extension project and the ACOE/Port Everglades Department's deepening and widening program, coupled with the lack of a suitable upland storage/disposal site for the projected volume of dredged material expected to be removed by the program, will result in the need to pursue offshore disposal of the material.

As a part of the ongoing ACOE Port Dredging Feasibility Study, various options were identified for managing the dredged material, including upland storage/disposal at two Confined Disposal Facilities (CDF) or offshore disposal at an Ocean Dredged Material Disposal Site (ODMDS). In the upland storage/disposal option, dredged material excavated as part of the program would be placed in the proposed CDF Site 1, a 107 acre site located in Southport and/or the proposed CDF Site 2, a 66 acre site near the Airport (See Attachment I for site locations).

In January 2003, the Port and Airport jointly commissioned a study to assess the suitability of using dredged material anticipated from the proposed deepening and widening program at the Port as fill material for future runway and taxiway construction at the Airport, as well as to assess the feasibility of storing this material at the proposed CDF Site 2 at the Airport. This study was referred to as the Eastside Engineering Study (EES).

At the time of the 2003 EES, the Airport had already completed the first Supplemental Draft Environmental Impact Statement (SDEIS) for the Airport's south runway extension project. It was assessed at that time that the proposed 66 acre CDF Site 2, a roughly rectangular area located southeast of US-1 on the south side of the Airport, bordered on

the north and northwest by Taylor Road and on the east by NE 7th Avenue, may be useable. However, one of the conclusions of the 2003 EES was that the estimated timeframe for implementation of the deepening and widening program at the Port and south runway extension project at the Airport may not be compatible. This has become more evident since the time of the completion of the EES.

At the time of the 2003 EES, the ACOE's estimated schedule for the Port's deepening and widening program anticipated the project being implemented over a seven year period, running from 2004 to 2010, with the final six years being the timeframe for delivering dredged material to the proposed CDF Site 2 near the Airport. Since then, there have been numerous changes to the projected ACOE schedule, with the latest revision indicating the construction phase of the deepening and widening program will not begin until 2014.

Since 2003, the Airport has conducted a number of additional studies for the south runway expansion project, leading up to the Record of Decision (ROD) being issued by the Federal Aviation Administration (FAA) in December 2008. Based on the projected runway construction schedule, implementation would begin in late 2010 to early 2011, with construction completion in 2014. Thus, the dredged material will not be available for use until well after the runway extension is expected to be completed. In addition, the airport land previously identified in 2003 for CDF 2 is no longer available since it is needed for the south runway.

During the same timeframe in 2003, the Port also began looking at further developing Southport based on initial recommendations in the 1999 Southport Master Plan. The Port had originally proposed 107 acres in Southport as the initial CDF Site 1 where the material could be stored and later used in the future development of Southport. However, with the update of the Port's Master/Vision Plan in 2006, a portion of the proposed CDF Site 1 was identified for development of a container cargo storage yard (Phase VIII), which is currently being constructed. Additionally, a portion of the proposed CDF Site 1 was identified in the Master/Vision Plan for development of an aggregate (crushed rock) facility, with a rail spur to tie with the Florida East Coast Railway. With this project identified to occur by 2012, it would be in place before the construction phase of the deepening project. Thus, only approximately 57 acres in Southport would be available for use as a CDF (See Attachment II).

The ACOE is currently completing an analysis of the feasibility and costs of various dredged material management options. While we do not expect to receive their report until September/October 2009, preliminary indications are that they will conclude that both the configuration and the reduced acreage of the modified Southport site render it unsuitable for storage/disposal of the dredged material associated with the deepening and widening project. It would also not provide sufficient storage capacity to be cost effective. The Port, as part of its 2006 Master/Vision Plan, did identify an approximately 6 acre site at the southwest corner of Southport for the storage of dredged material associated with on-going maintenance activities. The Port is discussing with the Florida Inland Navigation District (FIND), the potential of them using a portion of this site for the

temporary storage of dredged material associated with their proposed project to deepen the Dania Cut-off Canal west of the Port.

With upland storage/disposal no longer a viable option, the ACOE has identified an existing designated ODMDS east of Port Everglades as the primary disposal location (See Attachment III). However, this ODMDS has insufficient capacity to accommodate the up to 11 million cubic yards of dredged material expected to result from the deepening and widening program. The ACOE is in the process of beginning a study to assess the feasibility of enlarging the capacity of this existing designated ODMDS for the dredged material. I will continue to provide you with status updates regarding this effort as well as the general progress of this project.

Attachments

cc: Dick Brossard, Interim Deputy County Administrator
Glenn A. Wiltshire, Deputy Port Director
J. David Anderton II, AICP, Seaport Planning Manager
John C. Foglesong, Director, Seaport Engineering & Construction Division
Steve Ross, ACOE Project Manager
Tim Murphy, ACOE Project Manager
Allan Sosnow, Environmental Projects Manager, Seaport Engineering & Construction Division
Jamie McCluskie, Director of Planning, Airport Development

Attachment I

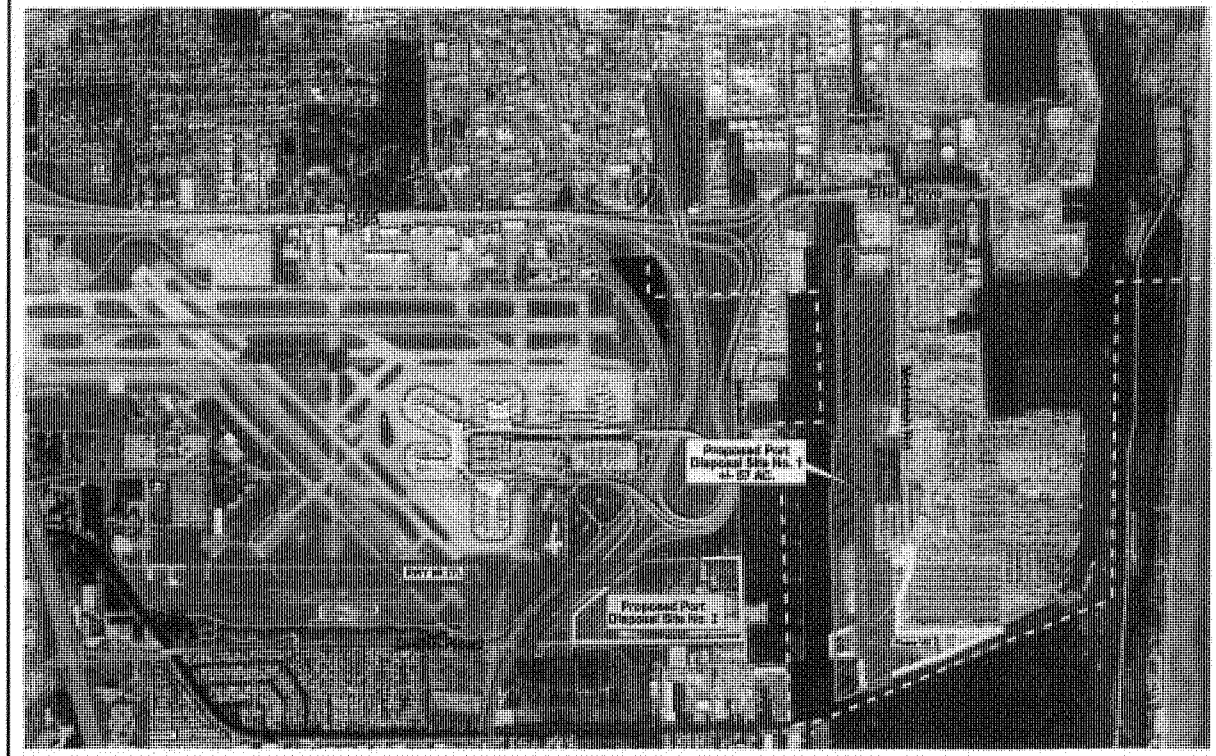
Port Jurisdictional Boundary

BROWARD

Public Works Department
Seaport Engineering and Construction and Division

August 2, 2007

Attachment II



Port Jurisdictional Boundary

BROWARD COUNTY

Note: Delineation of Proposed Port Disposal Site Subject to Change.

Public Works Department
Seaport Engineering and Construction and Division

N

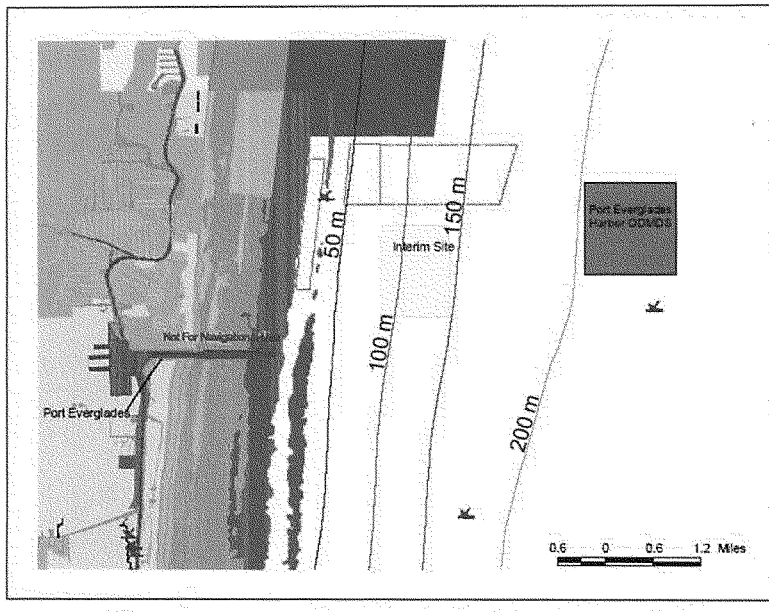
N.T.S.

August 2, 2007

5/19/09 - Modifications per Glenn A. Wilshire, Deputy Port Director

portdisr.apr

Attachment III



All depths in meters. 100 meters = 328 ft.

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO ATTENTION OF

0 4 AUG 2010

Planning Division
Plan Formulation Branch

Mr. Wayne Ivester
Florida Power and Lights
20 North West 19th Street
Ft. Lauderdale, Florida 33311

Dear Mr. Ivester:

The U.S. Army Corps of Engineers requests your assistance in providing costs for relocation of subaqueous utilities or transmission lines in Port Everglades Harbor. Potential navigation improvements shown on the enclosed drawings may impact utility lines crossing the Federal channels. While no decision has been made to accomplish the proposed navigation channel deepening and widening measures, we want to notify your agency of the ongoing navigation study and request your assistance in compiling information regarding utilities.

As a result of previous electronic mail correspondence in 2007 with FPL Wingate Service Center Senior System Project Manager Mr. Timothy Doe, we received a nonbinding ballpark estimate to relocate approximately 1,470 feet of power line in the Inner Entrance Channel and 1,085 feet from the Southport Access Channel at a potential depth of -56 ft MLLW (Department of the Army Permit, General Permit SAJ-14) estimated to be $1 million dollars, reference Enclosure 1 for potential navigation improvements and channel cross-sections, and Enclosure 2 for previously documented correspondence. At this time the U.S Army Corps of Engineers requests your assistance in addressing the same utility relocations and provide an updated cost estimate. It is requested that in addition to the cost estimate, an updated as-built drawing depicting the utilities crossing the channels, characteristics, and elevations or depths of utility lines crossing the proposed project areas be provided; the as-built drawing currently in our possession does not include all of these requested attributes, refer to Enclosure 3.

Thank you for your cooperation in this matter. Please provide a response prior to 31 Aug 2010, if possible. If you have any questions, please contact the Project Manager, Mr. Tim Murphy at 904-232-1671.

Sincerely,

REBECCA S. GRIFFITH, Ph.D, PMP
Chief, Planning Division

Enclosures

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
NAVAL SURFACE WARFARE CENTER
CARDEROCK DIVISION

9500 MACARTHUR BOULEVARD
WEST BETHESDA, MD 20817-5700

IN REPLY REFER TO:
3354
Ser 71/08019
20 Feb 08

From: Commander, Naval Surface Warfare Center, Carderock Division
To: Planning Division, Plan Formulation Branch, Department of The Army, Jacksonville District Corps of Engineers, P.O. Box 4970, Jacksonville, FL 32232-0019

Subj: PORT EVERGLADES ENTRANCE CHANNEL ALIGNMENT

Ref: (a) Ltr of 18 Jul 07, Jacksonville District Corps of Engineers, Plan Formulation Branch

Encl: (1) Sketch of the Navy Restricted Area

1. Reference (a) requested a review and response to the proposed Army Corp of Engineer's development of an Integrated Feasibility Study and Environmental Impact Statement for improvements at the Port Everglades Federal navigation project. The Naval Surface Warfare Center Carderock Division (NSWCCD), appreciates the opportunity to provide comment on the proposed project and alternatives.

2. These alternatives, all of which shift the entrance channel/shipping traffic south of the current alignment, are unacceptable to the Navy and directly impact our operations, both from a vessel safety stand point and the direct potential for the destruction of our facilities' underwater infrastructure.

3. All of the proposed alternatives have vessel traffic transiting directly into the Navy's Restricted Area. This action, if implemented, creates potential vessel conflicts between commercial and U. S. Navy vessels. Enclosure (1) provides an illustration of the location of the Navy's restricted area and the Naval Surface Warfare Center Carderock Division-South Florida Testing Facility (NSWCCD-SFTF) range (green box) in relationship to the proposed options.

4. During testing operations, naval vessels can and do operate throughout the restricted area. As apparent, the proposed

Subj: PORT EVERGLADES ENTRACE CHANNEL ALIGNMENT

option(s) places commercial vessel traffic in opposition to naval vessels operating within the restricted area thus jeopardizing the safety of both vessels.

5. As discussed in Reference (a), the Navy exercises jurisdiction over these waters as provided for in 33CFR § 334.580. Jurisdiction over this area is intended to protect the Navy's submerged infrastructure and assets. Infrastructure, consisting of numerous cable runs, multitude of underwater sensors and other structures are all required for the successful and safe operation of the facility. The Federal regulations further state that in the naval restricted area "anchoring, trawling, dredging, or attaching any object to the submerged sea bottom shall be prohibited…" Hence, the proposed alternatives involving dredging and/or placement of objects on the ocean's bottom within the restricted area would directly and severely impact the operations of this facility with the potential destruction of the infrastructure.

6. In summary, due to the potential of vessel safety issues and the destruction of our infrastructure, the NSWCCD-SFTF can not endorse any of the three proposed options. Your cooperation in this matter is respectfully requested. If you would like to discuss this issue in more detail please contact our South Florida Test Facility Site Director, Douglas Garbini, at (954)926-4005, or douglas.garbini@navy.mil.

MARK W. THOMAS

Florida Department of
Environmental Protection
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

May 18, 2007

Richard B. Powell
U.S. Army Corps of Engineers
Jacksonville District
Planning Division
701 San Marco Blvd
Jacksonville, FL 32207

Re: Port Everglades Feasibility Study - DRAFT Minutes for May 8-9, 2007, meeting

Dear Mr. Powell,

This letter is in response to your e-mail message sent May 23, 2007, which included a draft of the minutes for meetings held on May 8 and 9, 2007, at Port Everglades. You requested corrections and comments to the drafted minutes. Bureau of Beaches and Coastal Systems staff members were unable to attend. However, in the spirit of the Interagency Coordination Agreement (ICA) executed in 2006, this letter represents the Bureau's response to the meeting summary.

The attached version of the draft summary contains questions about statements that we wish to have clarified for the record, or expanded upon in the future. Because Bureau staff was not present in the discussions, no specific corrections have been recommended.

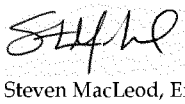
The Bureau recognizes the value and authority of the Port Everglades Pilots Association and the U.S. Coast Guard in determining safe parameters for the channel configuration. Nonetheless, it appears that a number of variables are still being evaluated to determine what expansion option, if any, can appropriately minimize potential impacts to resources. In addition, a substantial amount of debate has centered on HEA and UMAM assessments of mitigation (primarily for hardbottom, but also for mangrove, seagrass, etc.). It is important to note that this project has the potential of causing cumulative impacts, i.e., impacts to environmental functions that are not fully offset by mitigation within the surface water "basin". The cumulative impact test is not captured by UMAM or HEA, so this should be a point of discussion once a more precise impact estimate and mitigation design has been established.

Ms. Marie Burns wished to obtain a list of team members, including their roles and responsibilities. Below are the names of the two team members appointed by the Bureau.

> Dr. Vladimir Kosmynin (DEP Bureau of Beaches and Coastal Systems): Appointed to USACE planning team under ICA. Would perform primary technical review of benthic resource impacts and mitigation (including UMAM assessment) if application for state permit were submitted at this time.
>
> Steven MacLeod (DEP Bureau of Beaches and Coastal Systems): Appointed to USACE planning team under ICA. Would be lead processor for state permit if application were submitted at this time. Would gather interagency comments for final consistency determination, water quality certification and any state-owned submerged lands authorizations under a joint coastal permit or environmental resource permit.

Please feel free to contact me if you have any questions on this input by phone at 850-414-7806, or by e-mail at steven.macleod@dep.state.fl.us.

Sincerely,



Steven MacLeod, Environmental Manager
Bureau of Beaches and Coastal Systems

Attachment: DRAFT May 8-9 Meeting Summary with BBCS Edits

cc:
Allan Sosnow, Broward Co, Port Everglades
Steve Ross, USACE, Jacksonville
Marie Burns, USACE, Jacksonville
Terri Jordan, USACE, Jacksonville
Port Everglades Distribution List
Michael Barnett, DEP, BBCS-Chief
Roxane Dow, DEP, BBCS-BECP
Martin Seeling, DEP, BBCS-JCP
Vladimir Kosmynin, DEP, BBCS-JCP
BBCS Pre-Application File

Florida's Deepest Harbor

PORT EVERGLADES PILOTS' ASSOCIATION
Post Office Box 13017
PORT EVERGLADES, FLORIDA 33316
Telephone (954) 522-4491 / 7
Facsimile (954) 522-4498
E-mail: pilots@bellsouth.net

August 15, 2006

Ms. Terri Jordan
Biologist, Environmental Branch – Planning Division
Jacksonville District – SAD
US Army Corps of Engineers
701 San Marco Blvd.
Jacksonville, FL 32207

Dear Ms. Jordan:

The Port Everglades Pilots' Association has reviewed the alternative channel designs as depicted in OEC-Alt1.jpg, OEC-Alt2.jpg, OEC-Alt3.jpg that were emailed to us on July 26th of this year. I would like to remind you that we have already addressed these alternative plans and others during the original simulation phase and rejected them.

Our concerns are for the high level variations in current magnitude (many times in the 3-5 knot range) and direction which are frequently encountered in the areas surrounding the sea buoy, "PE", and the entire Outer Bar Cut. Some of the vessels that presently call at Port Everglades are frequently challenged by these cross-currents which often REVERSE direction at least once, if not TWO or THREE more times during the transit from the entrance to the jetties. The introduction of additional obstacles for even larger, heavier, less maneuverable vessels is not prudent. Any design other than a straight channel will be imposing a permanent risk of groundings that will forever increase as vessels get larger.

Since our only recommendation is a straight channel approach, it is not necessary to address (in any detail) the necessity of additional permanent, fixed structure aids to navigation that would themselves have significant environmental, economic and aesthetic impact, as well as presenting an additional allision danger.

We are charged by the State of Florida and the Federal Government to provide the safest possible transit of vessels in and out of Port Everglades. Undoubtedly, the straight channel approach that is in the current design study is the safest and therefore the most environmentally sound choice. It is the only option that we can endorse.

Thank you for your consideration in this matter.

Sincerely,

Port Everglades Pilots' Association

Captain Thomas G. Hackett
Co-Managing Pilot

Captain Bruce Cumings
Co-Managing Pilot

TGH:ljb

C:\Personal\Managing Pilot Info.ACOE Alternative Channels.ltr

DP-C

Florida's Deepest Harbor

PORT EVERGLADES PILOTS, INC
Post Office Box 13017
Port Everglades, Florida 33316
Telephone (954) 522-4491/7
Fax (954) 522-4498

March 22, 2007

U.S. Army Corps of Engineers
Jacksonville District
Attn: Richard Bonner
Deputy District Engineer
701 San Marco Blvd.
Jacksonville, FL 32207-8175

Dear Mr. Bonner:

In response to your continued request for our professional opinion on the various alternative channel designs, we would like to take this opportunity to expound on a previous letter sent to your office on August 15, 2006. These designs have been presented to us as alternatives to the straight design proposed years ago. While not professional channel designers, our job is to safely conduct the movement of vessels in and out of the port. We have experience in the movement of large vessels and consequently, we have consistently provided our input where appropriate to ensure that a viable channel design is achieved.

On at least five separate occasions over the last twelve years, we have participated in ship simulations of the channel at the Star Center. Through this process we have significantly whittled down the size and scope of the original proposed channel design. Our opinion emphatically remains that the straight channel design is the safest approach for the large deep draft containerships that intend to call at Port Everglades. We consider this channel design, specifically the 800 foot wide straight channel, to be the minimum size required for the targeted vessels and believe all of the Star Center simulations support this conclusion. A straight channel of this width would require sufficient depth to account for sea conditions and squat for a post-Panamax vessel transiting at a minimum of 12 knots. Anything other than a straight channel design would require significantly wider channels, wideners at the turns, and additional aids to navigation. Each of the alternative channel designs, using something other than a straight channel, would likely result in restrictions on vessel movements in periods of severe weather and extreme currents.

During the numerous simulations, actual transits with ACOE representatives, meetings, letters and conversations that we have participated in previously, we have continually

pointed out the hazards of shifting currents and weather conditions that make the outer channel challenging as it presently exists. Those hazards increase dramatically with anything other than a straight channel. It should be noted that we currently have the option and ability to approach the existing channel obliquely, but elect not to since we feel it introduces an excessive amount of risk. Instead, we dramatically increase risk to our person by boarding large vessels in the rougher offshore seas a significant distance from the sea buoy. This affords us the opportunity to maneuver in deep open water and line up on the ranges well in advance to timely evaluate the set and drift.

When trying to turn a vessel within a narrow channel, the probability of going aground is exponentially increased with the amount of rotation required. Additionally, the hydrodynamic effects of a vessel nearing the limits of a channel are significantly magnified with greater draft due to the increase of both inertia and shallow water effect. "Restricted bottom clearance in shallow water impedes the flow of water underneath the ship, causing a restricted lateral motion of the aftship. The less bottom clearance, the more build-up of water on the side of the ship that the stern moves toward and the lower the water level on the side the ship moves away from, leading to a smaller drift angle and consequently a wider turn in shallow water."[1] In simpler terms, ships do not turn as well or as quickly when they are experiencing Shallow Water Effect, which begins when the depth of the water equals 1.5 times the draft of the vessel, with Full Shallow Water Effect achieved when the depth of the water equals 1.2 times the draft of the vessel.[2] When turning a large, deeply laden vessel in such a channel , "the depth under the keel will cause the turning diameter to increase until, in shallow water, it may be as much as twice the diameter found for the same ship in deep water." [3] Additionally, the impact of shallow water effects on the handling characteristics of the vessels is exacerbated by the open ocean exposure to wind and sea experienced at Port Everglades. Consequently, construction of a channel with turns, permanently introduces a dramatic increase in risk due to the diminished ability to precisely position the ship within the dredged channel.

None of the proposed alternatives provides sufficient maneuvering space required by the larger, deeper draft vessels for which the dredging is being proposed. In two of these alternatives, the radius of each turn is less than that of the deep water turning circle of the targeted vessel. As outlined in previous paragraphs, the dimensions of these turning circles can not be relied upon in shallow water. This puts the third alternative into significant question.

When a ship maneuvers in shallow water, more of the ship's power is absorbed by the water due to increased friction. The ship's speed decreases. "Larger waves and troughs are formed and the ship sinks closer to the bottom than she would do at the same speed over the ground in deep water. At the same time, the ship's trim changes, changing the directional stability of the vessel. The turbulence caused by the limited bottom clearance interferes with the rudder and propeller effectiveness and the turning circle increases."[4] Since these vessels will only be able to maneuver within the confines of the channel, failure to complete the turn will result in grounding with potentially significant environmental and economic impacts.

While these general statements can be accurately applied to all vessels, the ability to transit a particular channel is different for each ship. Factors such as stopping power, ship's maneuverability, directional stability, draft, trim, cargo load, ship's physical construction, maintenance condition, current, wind, sea, traffic, visibility, bottom clearance and bottom contour all play an important role in the ability of a ship to remain within the channel. The larger the vessel in relation to the channel size, the more each of these factors has an effect on the success of the transit.

As we have discussed, the outer channel of Port Everglades is exposed to very strong and unpredictable currents from the Gulfstream. These currents run both north and south in the approaches to the channel. It is not uncommon for a large vessel to be experiencing a current acting in one direction at the bow and in an opposing direction at the stern. Under this situation, a couple is applied to the vessel which may be contrary to the desired direction of a turn. The force on the hull of a vessel is multiplied by the square of the actual current velocity. The effect of this current increases dramatically when bottom clearance decreases.[5] The resulting force can quickly exceed the turning force of the rudder and the total combined bollard pull of all six tugs at Port Everglades. It should be noted that the ability of a tug to render assistance decreases dramatically as the ship's speed increases. The tugs at Port Everglades have a top speed of 12-14 knots. Therefore, if a ship is making 10-12 knots of headway, the tug is already using the majority of its available horsepower merely to motivate itself. This leaves little reserve horsepower left to apply to the ship.

An additional consideration is that anything other than the straight channel design will require substantial additions of aids to navigation. Each of the channel options will absolutely require additional range lights and markers for each leg (Alternative channel design #1 and #2 will require two sets of additional range lights), as well as additional buoyage. The range towers will either have to be constructed on the reefs themselves, or in some cases on prime property along Fort Lauderdale beach. They would have to be of sufficient size and intensity to be visible from a bridge height of at least 130 feet and be able to be distinguished from the oftentimes intense background lights. Further complications will arise from alternatives #2 and #3 that pass through the Navy restricted area south of the channel. There are significant scientific research projects and exercises involving national security conducted in this area.

At its inception, the channel design was targeting the Susan Maersk, although the targeted depth of the channel was never sufficient to bring in this vessel at its designed draft. In 1996, the Susan Maersk was under construction as the largest container vessel in the world. At that time, the dredge project could have been considered forward looking and progressive. Since then, significantly larger containerships have been built and even larger ones are in the design phase. The question we should be addressing today is not how we can minimize the construction impact in order to barely fit the Susan Maersk into Port Everglades, but rather how the project should be expanded to address the subsequent generations of vessels which currently operate on the east coast of the United States and would likely call at Port Everglades if there was sufficient room.

More than 30% of the world's container tonnage capacity is on vessels as large, or larger than the design vessel. In fact, 70% of new container ship construction is of vessels larger than the design vessel. The Panama Canal will begin expanding to handle vessels of 12000 TEU's by the end of 2009. This is nearly double the size of the Susan Maersk. The originally accepted 800' wide straight channel design is already undersized for what are the largest containerships of today. The channel may be inadequate for vessels which will be common in the near future. Even to a casual observer, it should be apparent that worldwide container traffic is increasing and will continue to increase. There is simply insufficient land mass available at a single South Florida port to accommodate the anticipated future container traffic, thus necessitating several options for ships to call upon ports in Florida.

The Port Everglades Pilots have already rejected requests by companies wishing to immediately begin container services with post Panamax vessels in Port Everglades. These companies already operate services in our port and are currently operating post Panamax vessels of this size into Freeport, Bahamas and Savannah, Georgia. The new large vessel services were rejected pending completion of the dredge project. The entire Master planning process of Port Everglades depends on the completion of this dredging which seems to be at a standstill. It is increasingly likely that the Susan Maersk will be scrapped before any of the dredging begins.

When considering the current world fleet, and the economic projections for South Florida ports, we question the wisdom of the process which seeks to limit channel size and alter the configuration of the channel as these alternatives propose. We believe the straight channel design offers the best alternative and represents the safest approach for the large deep draft containerships that intend to call at Port Everglades.

Sincerely,

Port Everglades Pilots Association

Michael J. Cunningham

Cc: Allan Sosnow – Environmental Project Manager, Port Everglades

[1] Behavior and Handling of Ships by Henry H. Hooyer, pg 35

[2] Shiphandling for the Mariner, Third Edition, by Daniel H. MacElrevey, pg 8

[3] Shiphandling for the Mariner, Third Edition, by Daniel H. MacElrevey

[4] Port Revel Shiphandling Manuel, 1999, Jean Graff, p.65

[5] Port Revel Shiphandling Manuel, 1999, Jean Graff, p.64

February 14, 2011

Rebecca S. Griffith, Chief Planning Division
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-00019

Dear Ms. Griffith:

I am writing on behalf of the members of the Port Everglades Pilots' Association in response to your undated letter which we received at the end of last week. I will be sending this via e-mail in hopes that it will be in time for your deadline. We continue to support the portion of the plan regarding the OEC, Widener, Southport Access Channel and Turning notch. We offer the following comments on each of the 4 alternatives provided in figures 1 to 4 of the enclosures:

(Optimal Option) Figure 1 – Deepen Current Federal Project to 50 feet. This is clearly the option which we believe the most beneficial to the Port from now into the future. Reducing the geographic size of the Federal Channel, as first proposed to us on October 8, 2010, with the primary objective of handling dramatically larger vessels does not make sense to the members of our Association. While there may be an error in the labeling of your exhibits, the difference between the $18.5 million savings labeled in figure 1 and the $25 million savings of figure 3 is $6.5 million. Based upon traffic changes over the past decade, it would seem that the project economics will change sufficiently over the next 10 years to justify the additional expense, particularly with rapidly expanding vessel sizes.

Figure 3 - North and South Flare to Main Turning Basin – While this option limits maneuvering to the North, it should be workable in most cases for vessels up to the size of the Susan Maersk. It is, however, a reduction in the geographic size of the current Federal Project.

Figure 4 – Main Turning Basin dredge to western and southern limits of current federal project. This alternative does not seem to take into consideration the Master Plan outlined expansion of slip number 1. Tankers with a draft of 48 feet approaching the expanded slip would not have adequate room to maneuver to the north under this alternative. Furthermore, "Susan Maersk" sized container vessels turning in the basin would have restricted maneuvering space to the North. We do not view this option acceptable under those scenarios.

Figure 2 – Reduced Main Turning basin - We assume this was included for reference. This alternative is unacceptable as outlined in our letter of October 19, 2010.

This project began before the keel was laid for the Susan Maersk, at the time the largest container vessel in the world. Presently, our major container ship operator, Mediterranean Shipping Company, has 48 ships under construction and scores of vessels already in operation larger than the Susan Maersk. Based on our experience, regardless of the ultimate channel design, we will continue to be asked to push the limits and bring ever larger vessels into the limited confines of Port Everglades. We look forward to this project moving forward rapidly.

Sincerely,
Port Everglades Pilots Association
Captain Michael Cunningham
(954) 522-4491

BROWARD COUNTY FLORIDA

PORT EVERGLADES DEPARTMENT - Port Director's Office
1850 Eller Drive - Fort Lauderdale, Florida 33316
954-523-3404 FAX 954-523-8713

Difference in old -

September 2, 2008

Steven Ross, Senior Project Manager
US Army Corps of Engineers
Jacksonville District
Programs and Project Management Division
701 San Marco Boulevard
Jacksonville, Florida 32207

Re: WAM REVIEW

Dear Mr. Ross:

As previously discussed, the Port directed our Master Plan Consultant, DMJM Harris, to review the documents prepared by the ACOE, that have been placed on your FTP site, with respect to the proposed dredging/widening program at Port Everglades.

The Master Plan Consultant has reviewed these documents and all of us have participated in a discussion meeting pertaining to the proposed dredging/widening program along with your consultant, Dr. Kevin Horn. The Master Plan Consultant has identified the following items that we believe warrant further discussion.

1. RORO vessels should be assigned to Berths 33 A-C only ← Which vessel type does this represent on berth assignment.

2. Crane productivity seems excessively high
   - Even at 60 lifts/hr per crane with 5 cranes = 300 lifts/hr/berth
   - Year 2046 assumes 44 lifts /hr, which should be maximum
   - Also, assume linear growth tied to cargo growth

3. Limited lifts/call grossly underestimates time at berth and throughput
   - Post Panamax-min. 2,500 TEUs x 6.86 tons/TEU = 17,150 tons/call
   - WAM has 6,300 tons/call

4. Tie-up/release time is minimum 2 hrs/Vessel call
   - WAM uses 1 hr with 1/2 hr on each end

5. TPI to meet ACOE accepted tables of ton/inch immersion values
   - 280 tons/inch of immersion for deep draft vessels

6. Provide vessel queue statistics. Queue time should be reflected in ship operating costs.

Broward County Board of County Commissioners
Josephus Eggelletton, Jr • Sue Gunzburger • Kristin D. Jacobs • Ken Keechl • Ilene Lieberman • Stacy Ritter • John E. Rodstrom, Jr. • Diana Wasserman-Rubin • Lois Wexler
www.broward.org

Mr. Steven Ross
September 2, 2008
Page Two

7. Can the WAM provide a value for the queuing time to be used as a negative in benefits in the B/C? At some queuing wait time, that share of market business will go elsewhere.

We also received your breakdown of costs for the Turning Notch. Do you have similar documentation for the Dania Cut-Off Canal development?

After your review of the above items, I would like to suggest that we arrange a teleconference among us and our consultants to review these items in a team forum in order to achieve concurrence on the operational issues at the Port. I would like to schedule this teleconference for the week of September 8, 2008. If you have any questions of need further information, please contact me at (965) 468-0144.

Sincerely,

J. David Anderton II, AICP
Seaport Planning Manager
Port Director's Office

cc: Phillip C. Allen, Port Director
Glenn A. Wiltshire, Deputy Port Director
John Foglesong, P.E., Directory, Seaport Engineering and Construction
Alan Sosnow, Environmental Projects Manager, Seaport Engineering and Construction
Richard Heidrich, DMJM Harris, Inc.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

MAY 22 2009

Colonel Paul L. Grosskruger
District Commander
Jacksonville District
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel Grosskruger:

Please find enclosed revisions to the Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS) and the Palm Beach Harbor ODMDS Site Management and Monitoring Plans (SMMPs). Section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) requires that SMMPs be developed by the Environmental Protection Agency (EPA) in conjunction with the USACE for each ODMDS designated by EPA. These SMMPs were originally developed in 2004 as part of the site designation process. However, as a result of post disposal monitoring conducted by the Environmental Protection Agency (EPA) and a proposed change in use at the Port Everglades Harbor ODMDS, EPA determined that the SMMPs warranted revision. The enclosed revisions supersede the original SMMPs.

In revising these SMMPs, EPA and the U.S. Army Corps of Engineers (USACE) followed the procedures outlined in the 2007 Memorandum of Understanding (MOU) between USACE South Atlantic Division and EPA Region 4 on Ocean Dredged Material Disposal. EPA coordinated the proposed revisions with the National Marine Fisheries Service and the State of Florida. In addition, in accordance with the MPRSA and the MOU, this document underwent a 30-day public review through publication of a Public Notice and Notice of Availability of the proposed changes on January 23, 2009.

The management and monitoring requirements of the SMMPs should be included as permit conditions for all MPRSA Section 103 permits and should be incorporated in the contract language for all federal projects for ocean disposal in the ODMDSs. Templates for permit special conditions and contract specifications implementing these requirements are included with the SMMPs as appendices. If you have any questions, please contact Mr. Chris McArthur at (404) 562-9391.

Sincerely,

Stan Meiburg
Acting Regional Administrator

Enclosures

U.S. Department of Homeland Security
United States Coast Guard

Commanding Officer
U.S. Coast Guard
Civil Engineering Unit Miami

15608 SW 117th Avenue
Miami, FL 33177-1630
Staff Symbol: c
Phone: (305) 278-6770
Fax: (305) 278-6704
Email: Benjamin.L.Davis@uscg.mil

11000

OCT 05 2010

MEMORANDUM

From: B. L. DAVIS, COR
CG CEU Miami

Reply to Attn of: CG CEU Miami (s)
LCDR M. E. Kicklighter
(305) 278-6764

To: Department of the Army, Jacksonville District Corps of Engineers
Attn: Chief, Planning Division

Subj: PORT EVERGLADES CHANNEL WIDENING PROJECT

Ref: a) Your letter of 20 May 2011
b) Facility & Infrastructure Requirements for Station Fort Lauderdale Multi-Mission Facility, August 2009

1. In reference (a), you recommended modifying alternative 3 from reference (b) by shifting the boat basin 80 feet to the west. We confirm that the costs estimated in reference (b) should not change as a result of your proposed shifting of the basin. These costs could change as a result of other factors, in particular project sequencing and temporary facilities required for continuous USCG operations.

2. The layout of the basin and orientation of the entrance channel continue to be critical to USCG operations. The proposed boat basin in alternative 3 of reference (b) is appropriate as a basis for design, but the USCG must continue to be involved at every stage of design and construction to ensure operational requirements are not compromised.

3. If you have any questions or need additional information please contact LCDR Mike Kicklighter at (305) 278-6764.

#

Copy: CGD SEVEN (dm, dr)
CG SECTOR Miami
CG STA Fort Lauderdale
CG ANT Fort Lauderdale
CGC GANNET (WPB 87334)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO ATTENTION OF

MAY 20 2010

CESAJ-PD-PN

MEMORANDUM FOR U.S. Department of Homeland Security, United States Coast Guard, Attn: Commanding Officer U.S. Coast Guard, Civil Engineering Unit Miami

SUBJECT: Port Everglades Feasibility Study- USCG Station Ft. Lauderdale Relocation Plan

1. Reference the following:

   a. USCG Memorandum dated August 4, 2009, with enclosed report Facility and Infrastructure Requirements for Station Fort Lauderdale Multi Mission Facility, Fort Lauderdale, FL.

   b. USACE letter to USCG, dated May 23, 2008, requesting review of facility relocation plan and request for USCG to provide a cost estimate for the relocation of Station Fort Lauderdale.

2. Jacksonville District personnel have reviewed your Facility and Infrastructure Requirements, Enclosure 1 (reference a), which responded to our request also included in Enclosure 1 (or reference b). We agree with your revised design, but have proposed a revision to this alternative by moving the basin 80 feet to the west (Figure C of Enclosure 2), which in our opinion does not impact your cost estimate. This modification will allow you to retain existing property while avoiding impacts to Nova Southeastern University property to the north and to the existing Federal channel. Pending USCG verification that the layout of the basin and orientation of the entrance channel continue to meet USCG operational requirements, the Figure C relocated basin design will be adopted as the USCG boat basin design for inclusion in the Draft Port Everglades Harbor Feasibility Report.

3. We have completed a wave response model report of the newly proposed shifted basin, Enclosure 3. Results indicate this design provides comparable protection to the existing basin against wave energy.

4. The Jacksonville District concurs with your cost estimate for demolition, construction of new buildings, and site work, recognizing that it does not include costs for basin construction, other waterfront structures, or the acquisition, remediation, restoration, or preparation of land. Please confirm that USCG costs provided for reference a. will not change as a result of the proposed shifting of the basin 80 feet to the west as shown in Figure C of Enclosure 2 and that you agree with this proposed shifting.

CESAJ-PD-PN
SUBJECT: Port Everglades Feasibility Study- USCG Station Ft. Lauderdale Relocation Plan

5. We request your response by 30 Jun 10. If you should need additional information please contact Mr. Tim Murphy, Project Manager, at 904-232-1671. Also, CG CEU Miami (s) LCDR M.E. Kicklighter's assistance has proved very helpful during our planning process.

REBECCA S. GRIFFITH, Ph.D, PMP
Chief, Planning Division

Enclosures

U.S. Department of Homeland Security
United States Coast Guard

Commanding Officer
U.S. Coast Guard
Civil Engineering Unit Miami

15608 SW 117th Avenue
Miami, FL 33177-1630
Staff Symbol: c
Phone: (305) 278-6770
Fax: (305) 278-6704
Email: Joel.D.Dolbeck@uscg.mil

11000

MEMORANDUM

AUG 4 2009

From: J. D. DOLBECK, CAPT
CG CEU Miami

Reply to Attn of: CG CEU Miami (s)
LCDR M. E. Kicklighter
(305) 278-6764

To: Department of the Army, Jacksonville District Corps of Engineers
Attn: Chief, Planning Division

Subj: PORT EVERGLADES CHANNEL WIDENING PROJECT

Ref: (a) Your letter of May 23, 2008

1. As requested in reference (a) and as a result of our follow-on meetings, I have thoroughly reviewed your plans to reconstruct the boat basin and relocate facilities at Coast Guard Station Fort Lauderdale and found them non-viable.

2. We have documented our detailed concerns with the proposed plan as submitted and identified alternative options that we would be willing to consider. This information is summarized in the enclosed planning document, along with our Basic Facility Requirements (BFR) and cost estimate. Please note that our cost estimate is for the recommended preferred alternative which includes demolition, construction of new buildings, and site work. It does not include the cost of the basin construction, other waterfront structures, or the acquisition, remediation, restoration, or preparation of land.

3. My staff and I are committed to working with the Army Corps of Engineers in the development of this project. We appreciate your cooperation and patience in obtaining our input. If you have any questions or need additional information please contact LCDR Mike Kicklighter, at (305) 278-6764.

#

Enclosure

Copy: CGD SEVEN (dm, dr)
CG SECTOR Miami
CG STA Fort Lauderdale
CG ANT Fort Lauderdale
CGC GANNET (WPB 87334)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

MAY 23 2008

REPLY TO
ATTENTION OF

Planning Division
Plan Formulation Branch

Mr. Orlando Arana, P.E., CEM, CIE
U. S. Coast Guard Civil Engineering Unit
15608 SW 117th Avenue
Miami, Florida 33177-1630

Dear Mr. Arana:

In 2004, the U.S. Army Corps of Engineers (Corps), Jacksonville District Port Everglades Team had a verbal discussion with your agency to discuss relocation costs of U.S. Coast Guard features as a result of the Port Everglades navigation proposed channel widening project. Due to the lapse in time, our team has escalated the given costs from 2004 to 2008, shown in Table 1, with the total escalated new costs shown in the column titled "Total Contract 2008". A more detailed breakdown of costs is shown in Table 2. These costs would apply to any project alternatives which include the South Access Channel (Alternatives 2B, 5C, and 6B). A selected plan has not been determined at this point.

We have also included Figures 1 and 2 to illustrate the locations of items shown in Table 1. Figure 1 shows a close up view of the basin of features to be removed (Bulkheads, Docks, Buildings and Travel Boat Lift). The light blue dashed line shows the project cut and why these items will need to be relocated. Figure 2 shows the proposed new location of removed items. Proposed relocated bulkheads are shown in the solid blue line, while docks, buildings and the travel boat lift are shown in items 1-5. Note that Figure 2 is a conceptual design for the purposes of the Feasibility Study. The Corps understands that the U.S. Coast Guard will retain authority to design the relocated basin to suit operation needs.

We request your review of the enclosed costs in Tables 1 and 2 and we invite discussion of any questions or corrections you may have so that we may obtain the most accurate estimate for relocation costs. Please provide your response by June 30, 2008.

If you have any questions or need clarification on the above matter, contact Mr. Dick Powell at 904-232-1694.

Sincerely,

for

Rebecca S. Griffith, Ph.D, PMP
Chief, Planning Division

Enclosures

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
4400 PGA Boulevard, Suite 500
Palm Beach Gardens, FL 33410

REPLY TO
ATTENTION OF

MAR 0 2 2006

Palm Beach Gardens Regulatory Office
SAJ-2002-72(IP-LAO)

Broward County Parks and Recreation Division
Attn: Pat Young Administrative Manager
950 NW 38th Street
Oakland Park, FL 33309

Dear Mr. Young:

The U.S. Army Corps of Engineers (Corps) is pleased to enclose the Department of the Army permit, which should be available at the construction site. Work may begin immediately but the Corps must be notified of:

a. The date of commencement of the work,

b. The dates of work suspensions and resumptions of work, if suspended over a week, and

c. The date of final completion.

This information should be mailed to the Enforcement Section of the Regulatory Division of the Jacksonville District at Post Office Box 4970, Jacksonville, Florida 32232-0019. The Enforcement Section is also responsible for inspections to determine whether Permittees have strictly adhered to permit conditions.

IT IS NOT LAWFUL TO DEVIATE FROM
THE APPROVED PLANS ENCLOSED.

Sincerely,

Lawrence C. Evans
Chief, Regulatory Division

Enclosures

Copies Furnished:

Miller Legg & Associates, Inc. - Mark Brandenburg
CESAJ-RD-PE

BROWARD COUNTY
FLORIDA

PARKS AND RECREATION DIVISION
950 N.W. 38TH Street • Oakland Park, Florida 33309-5982 • 954-357-8100 • TTY 954-537-2844 • FAX 954-537-2849
Winner of the National Gold Medal Award for Excellence in Park and Recreation Management
Accredited by the Commission for Accreditation of Parks and Recreation Agencies (CAPRA)

May 28, 2002

Dylan Larson, P.W.S.
Miller, Legg & Associates, Inc.
1800 N. Douglas Road, Suite 200
Pembroke Pines, FL 33024-3200

Re: Master Mitigation for West Lake Park
RLI #021899-RB
BCPRD #425-00A, MLA #937503

Dear Mr. Larson:

The purpose of this letter is to acknowledge responsibility for mitigation construction, five year maintenance and monitoring, and perpetual management of the overall mitigation efforts underway at West Lake Park.

As previously discussed with you, the published Request for Letters of Interest and our subsequent Agreement with Miller, Legg & Associates, Inc. both state that the consultant shall be responsible for construction administration and overseeing the monitoring and maintenance for the required warranty period. Therefore, Miller, Legg & Associates, Inc. will be responsible for these activities acting as agent for Broward County. Broward County Parks and Recreation Division will be responsible for overseeing your project activities and for the perpetual management after the warranty period expires.

If you have any questions, please contact me at (954) 357-8181.

Sincerely,

Pat Young
Administrative Manager

PY:pay

US Army Corps of Engineers
File # SAJ-2002-72(IP-LAO)
ATTACHMENT 4

a:\5 yr monitor.wpd

Broward County Board of County Commissioners
Josephus Eggelletton, Jr. • Ben Graber • Sue Gunzburger • Kristin D. Jacobs • Jane Liebermann • Lori Neece Parrish • John E. Rodstrom, Jr. • James A. Scott • Diana Wasserman-Rubin
www.broward.org/parks

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
3301 Gun Club Road, West Palm Beach, Florida 33406 • (561) 686-8800 • FL WATS 1-800-432-2045 • TDD (561) 697-2574
Mailing Address: P.O. Box 24680, West Palm Beach, FL 33416-4680 • www.sfwmd.gov

CON 24

Permit No. 06-04016-P
Application No. 011226-21

April 22, 2004

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE STE 421
FT LAUDERDALE, FL 33301

Dear Permittee:

Enclosed is your Permit as authorized by the Governing Board of the South Florida Water Management District at its meeting on April 14, 2004.

Please note that there are pre-construction documentation requirements which must be met prior to commencement of any construction. Failure to comply with these requirements may result in formal enforcement action to force cessation of construction activities pending permit compliance.

Special Conditions to your Permit require reports to be filed with this District. Please read these Conditions and use the enclosed form(s), as applicable, for your submittal of these required reports.

Should you have any questions concerning these requirements, please feel free to contact this office.

Sincerely,

Elizabeth Veguilla

Elizabeth Veguilla
Deputy Clerk
Environmental Resource Regulation Department

Enclosures

GOVERNING BOARD

Nicolás J. Gutierrez, Jr., Esq., Chair
Pamela Brooks-Thomas, Vice-Chair
Irela M. Bagué
Michael Collins
Hugh M. English
Lennart E. Lindahl, P.E.
Kevin McCarty
Harkley R. Thornton
Trudi K. Williams, P.E.

EXECUTIVE OFFICE

Henry Dean, Executive Director

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
ENVIRONMENTAL RESOURCE PERMIT NO. 06-04016-P
DATE ISSUED: APRIL 14, 2004

FORM #0145
Rev. 03/95

PERMITTEE: STATE OF FLORIDA
(WEST LAKE PARK)
DIVISION OF STATE LANDS,3900 COMMONWEALTH BOULEVARD
TALLAHASSEE , FL 32399

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
(WEST LAKE PARK)
115 SOUTH ANDREWS AVE,STE 421
FT LAUDERDALE , FL 33301

PROJECT DESCRIPTION: AUTHORIZATION FOR CONSTRUCTION AND OPERATION OF A MITIGATION PROJECT WITHIN THE 1522.2 ACRE WEST LAKE PARK TO PROVIDE COMPENSATION FOR FUTURE WETLAND IMPACTS THAT MAY BE ASSOCIATED WITH FUTURE BROWARD COUNTY PROJECTS

PROJECT LOCATION: BROWARD COUNTY ,

SECTION 35,36 TWP 50S RGE 42E
SECTION 1,2,11 TWP 51S RGE 42E

PERMIT DURATION: See Special Condition No:1. See attached Rule 40E-4.321, Florida Administrative Code.

This Permit is issued pursuant to Application No. 011226-21 , dated December 13, 2001. Permittee agrees to hold and save the South Florida Water Management District and its successors harmless from any and all damages, claims or liabilities which may arise by reason of the construction, operation, maintenance or use of activities authorized by this Permit. This Permit is issued under the provisions of Chapter 373 , Part IV Florida Statutes (F.S.), and the Operating Agreement Concerning Regulation Under Part IV, Chapter 373 F.S., between South Florida Water Management District and the Department of Environmental Protection. Issuance of this Permit constitutes certification of compliance with state water quality standards where neccessary pursuant to Section 401, Public Law 92-500, 33 USC Section 1341 , unless this Permit is issued pursuant to the net improvement provisions of Subsections 373.414(1)(b), F.S., or as otherwise stated herein.

This Permit may be transferred pursuant to the appropriate provisions of Chapter 373, F.S, and Sections 40E-1.6107(1) and (2), and 40E-4.351(1), (2), and (4), Florida Administrative Code (F.A.C.). This Permit may be revoked, suspended, or modified at any time pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.351(1), (2), and (4), F.A.C.

This Permit shall be subject to the General Conditions set forth in Rule 40E-4.381, F.A.C., unless waived or modified by the Governing Board. The Application, and the Environmental Resource Permit Staff Review Summary of the Application, including all conditions, and all plans and specifications incorporated by reference, are a part of this Permit. All activities authorized by this Permit shall be implemented as set forth in the plans, specifications, and performance criteria as set forth and incorporated in the Environmental Resource Permit Staff Review Summary. Within 30 days after completion of construction of the permitted activity, the Permittee shall submit a written statement of completion and certification by a registered professional engineer or other appropriate individual, pursuant to the appropriate provisions of Chapter 373, F.S. and Sections 40E-4.361 and 40E-4.381, F.A.C.

In the event the property is sold or otherwise conveyed, the Permittee will remain liable for compliance with this Permit until transfer is approved by the District pursuant to Rule 40E-1.6107, F.A.C.

SPECIAL AND GENERAL CONDITIONS ARE AS FOLLOWS:

SEE PAGES 2 - 7 OF 10 (41 SPECIAL CONDITIONS).
SEE PAGES 8 - 10 OF 10 (19 GENERAL CONDITIONS).

FILED WITH THE CLERK OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

ON April 22, 2004

BY Graciela Veguilla
DEPUTY CLERK

SOUTH FLORIDA WATER MANAGEMENT DISTRICT, BY ITS GOVERNING BOARD

BY
ASSISTANT SECRETARY

BOARD OF SOUTH FLORIDA WATER MANAGEMENT DISTRICT
STATE OF FLORIDA
SEAL
Established 1949

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

DEC 02 2010

Honorable Debbie Wasserman Schultz
United States House of Representatives
118 Cannon House Office Building
Washington, D.C. 20515

Dear Congresswoman Wasserman Schultz:

This is in response to your letter dated November 8, 2010, cosigned with Congressman Klein, asking that Federal funds be considered for construction of a seawall for the Oceanographic Center at Nova Southeastern University (Nova) near Port Everglades, Florida.

Your letter indicated that the seawall likely will be authorized and eligible for Federal funding by 2012, and asked that funding options be identified that would be available prior to the 2012 authorization. The seawall is estimated to cost $7 million, and your letter asked that it be considered as a small project that perhaps would be eligible for discretionary funding. My response to your suggestions is provided below.

Over the past several years, the Army Corps of Engineers has been conducting a feasibility study of potential improvements to the Port Everglades Harbor Federal navigation project, which is adjacent to Nova's property. The authorized purpose of the study is to evaluate widening and deepening of the Federal channel for use by deep draft vessels. The study still is underway and will not be completed until November 2012. The study has not been approved, nor has construction of navigation improvements been authorized by Congress. Without congressional authorization, Federal funds cannot be spent to construct any of the navigation improvements contemplated under this study. Furthermore, because the proposed seawall is not for the purpose of or necessary for commercial navigation, it is not part of or related to either the existing Federal project or the study of potential improvements to the navigation project. Therefore, Federal funds cannot be spent to construct the seawall as part of the navigation project, unless specifically authorized and appropriated by Congress.

I also have considered the possibility of providing Federal funds under the discretionary authority under which the Army, acting through the Corps of Engineers, is authorized to plan, design and construct certain types of water resources improvements without additional project specific authorization from Congress. This is commonly referred to as the Continuing Authorities Program. Of the ten discretionary authorities available to the Army under this program, there are two that address shoreline erosion and one that pertains to navigation improvements, as explained below.

Section 14 of the Flood Control Act of 1946, as amended, authorizes Federal participation to implement projects to protect public facilities and facilities owned by non-profit organizations from streambank and shoreline erosion. The facilities must provide public services that are open to all on equal terms. Because Nova is a private university, the seawall is not an eligible facility under the Section 14 authority.

Printed on Recycled Paper

Section 103 of the River and Harbor Act of 1962, as amended, authorizes Federal participation in the cost of protecting multiple public and private properties and facilities and single non-Federal public properties and facilities against damages caused by storm driven waves and currents. The primary purpose of Nova's seawall is to provide a vertical surface for mooring its research vessels as opposed to protecting the shoreline from erosion. Consequently, the seawall is not eligible under the Section 103 authority.

Section 107 of the River and Harbor Act of 1960, as amended, authorizes small projects that serve the general public interest and must be accessible and available to all on equal terms. Improvements are not made under this authority to provide navigation access to privately owned facilities that are not open to the general public on equal terms. Also, by law, Section 107 projects must be economically justified.

The other seven continuing authorities address mitigation of shore damages caused by Federal navigation projects, placement of dredged material on beaches, beneficial uses of dredged material, flood damage reduction, aquatic ecosystem restoration, removal of obstructions to reduce flood damages, and project modifications for improving the environment. None of these authorities are applicable to Nova's seawall.

In summary, there is no authority to use Federal funds to construct the seawall. However, on November 29, 2010, the Corps issued a permit to Nova for various improvements to its facilities, including repair and replacement of its existing seawall and construction of a new seawall. This is the extent of the Army's involvement with Nova's seawall. I regret that I cannot provide a more positive response. I am sending an identical letter to Congressman Klein.

Very truly yours,

Jo-Ellen Darcy

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

APPENDIX E

DREDGED MATERIAL MANAGEMENT PLAN (DMMP)

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

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1. Project Name and Description

1a. Name: Port Everglades

1b. CWIS #: 010207

1c. Project Description:

The Federal navigation project is in Port Everglades Harbor, a major seaport located on the southeast coast of Florida in Broward County. The entrance of the Port is approximately 17 nautical miles north of Miami Harbor, 31 nautical miles south of the Port of Palm Beach, and 196 nautical miles south of Jacksonville Harbor, all located in Florida.

The authorized project for Port Everglades is presented in **Figure 1** and the proposed Navigational improvement is shown in **Figure 2**. The harbor project provides for the following existing features identified by section with dimensions shown in Table 1:

Outer Entrance Channel (OEC) - The outermost approach channel extends approximately 5,000 feet from the outer sea buoy to the seaward end of the harbor jetties with a 500-foot width over a project depth of 45 feet.

Inner Entrance Channel (IEC) - A rectangular approach channel inside Port Everglades harbor at 450 feet in width, with a project depth of 42 feet extending approximately 2,340 feet from the landward end of the OEC to the main turning basin.

Main Turning Basin (MTB) – A 95-acre turning basin area adjacent to the entrance channels, with a project depth of 42 feet, an east to west dimension of about 1,200 feet, and a north to south dimension of about 2,450 feet . Dimensions vary along the perimeter of the MTB with 2,600 feet along the west side, 800 feet along the north side, and 1,100 feet along the south side.

North Turning Basin (NTB or Northport) – The NTB covers about 19 acres immediately to the north of the MTB and has a project depth of 31 feet. The turning basin extends about 1200 feet to the north with a depth of 31 feet and ease-west dimension tapering from 800 to 500 feet.

South Turning Basin (STB or Midport) – A 20-acre turning basin area located south of the main turning basin containing berths 16 through 22 with varing project depths of 31-37 feet. The turning basin to the south has a depth of 31 feet and measuring about 1,000 feet north-south and 1100 feet east-west with a channel inside along the westerly edge varying in depth from 37 to 36 feet and narrowing in width from 300 feet to 150 feet over a distance of about 1,000 feet.

Southport Access Channel (SAC) – North South channel extending 8,500 ft south from the MTB area with a 400-foot width over a project depth of 42 feet. The SAC has a 150 degree bend at the north end known as "the knuckle".

Turning Notch (TN) – The TN has a width of about 750 feet and length of 1000 feet

over a project depth of 42 feet. The container terminal facilities located south of the TN are known as Southport.

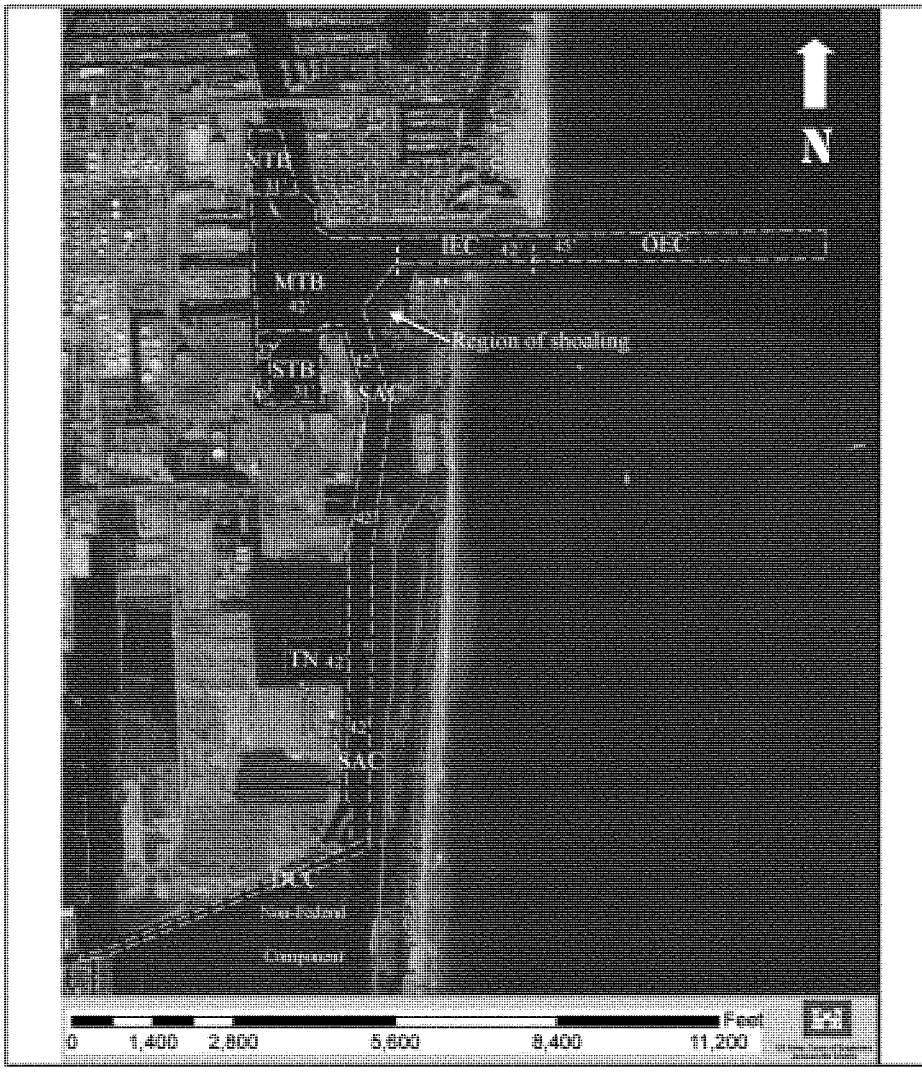

Figure 1: Existing Federal Channel Components

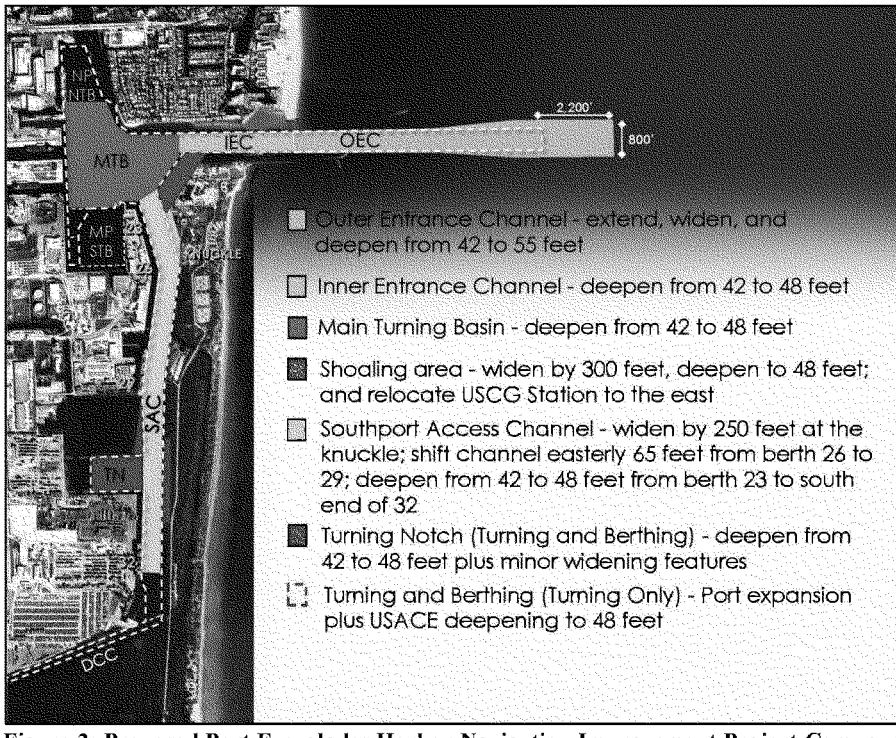

Figure 2: Proposed Port Everglades Harbor Navigation Improvement Project Components

1d. Current Project as Being Maintained:

The Federal project exists as authorized and shown by the dashed lines in **Figure 1** and with the authorized dimensions described in **Table 1**. Maintenance of the authorized Federal channel depths and dimensions has continued as identifed in **Table 1**.

Table 1: Project Status

Reach or Segment	Nominal Depth (feet)[1]		Nominal Channel Width (feet)		Max Sailing Draft[2] (feet)	Project Sponsor (Y/N)
	(as auth.)	(as maint.)	(as auth.)	(as maint.)		
Outer Entrance Channel (OEC)	45	45	500	500	42	Y
Inner Entrance Channel (IEC)	42	42	450	450	40	Y
Main Turning Basin (MTB)	42	42	2400(N-S)	2400(N-S)	40	Y
North Turning Basin (NTB)	31	31	1200(N-S)	1200(N-S)	29	Y
South Turning Basin (STB)	31,36,37	31,36,37	1000(N-S)	1000(N-S)	29,34.35	Y
Turning Notch (TN)	42	42	750 (N-S)	750 (N-S)	40	Y
Southport Access Channel (SAC)	42	42	400	400	40	Y
Source: Waterborne Commerce of the United Sates (CY2008)						
Name: Broward County Port Everglades Department						
Address: 1850 Eller Drive						
City: Fort Lauderdale		State: Florida		Zip: 33316		
Point of Contact: Mr. David Anderton				Email: DANDERTON@broward.org		

NOTE: [1] Does not include overdepth

[2] For vessels currently using the harbor with no use of tides. Mean tidal variation is less than 2 feet MLLW in the entrance and less than 2 feet in the bay (Engineering Appendix, P. A-16)

1e. Sponsor:

Broward County Port Everglades Department
1850 Eller Drive
Fort Lauderdale, Florida, 33316
Point of Contact: (954) 523-3404

1f. Name and Status of Cooperation Agreement:

The most recent Project Cooperation Agreement is between the United States of America and the Port Everglades Authority for modification authorized in 1974. In 2004, a Reimbursement Agreement between the Department of the Army and Broward County was signed stating that work on the Southport Access Channel and Turning Notch performed by non-Federal interests is consistent with Federal navigation interest.

2. Authority

Tables 2 and **3** provide the Congressional authorizing documents for the existing Port Everglades general navigation features.

Table 2: Previous Reports and Authorizing Documents

Study Type[1]	Report Date	Results	Congressional Documents				Authorizing Act
			Type	No.	Cong.	Session	
PE	1928	U	-	-	-	-	-
PE	1929	U	-	-	-	-	-
SR	1930	F	H	357	71	2	R&H 1930
PE	1932	F	-	-	-	-	-
SR	1933	U	-	-	-	-	-
SR	1935	F	H	25	74	1	30-Aug-25
SR	1937	F	H	545	75	3	20-Jun-38
SR	1944	F	H	768	78	2	24-Jul-46
SR	1946	U	-	-	-	-	-
SR	1958	F	H	346	85	2	3-Jul-58
SR	1971	F	H	144	93	1	9 and 31 May 1974
RR	1987	F	-	-	-	-	-
FR	1991	F	H	126	103	1	WRDA 1992, Title I Sec 101(9)
LRR[2]	1998	U	-	-	-	-	WRDA 2000 Sec 515

[1] PE = Preliminary Assessment, SR = Survey Report, FR = Feasibility Report, LRR = Limited Re-Evaluation Report

[2] Reimbursement of $15,003,000 was authorized by Congress

The reports outlined in Table 2 are described in the 1991 Feasibility Report and 1998 Limited Reevaluation Report.

Table 3: Authorizing Acts

Act	Document, Congress/Session	Work Authorized
R&H Act 1930	HD 357, 71/2	Federal maintenance of entrance channel, turning basin, and jetties constructed by local interests.
R&H Act 1935	HR Committee of R&H Doc. 25, 74/1	Construction and maintenance of an enlarged entrance channel, and a 1,200 ft square turning basin to a depth of 35 feet.
R&H Act 1938	HD 545, 75/3	Construction and maintenance of a 350 ft wide trapezoidal area on the north side of the main turning basin.
R&H Act 1946	HD 768, 78/2	Construction and maintenance of a 200 ft northerly and 500 ft southerly extensions to the main turning basin.
R&H Act 1958	HD 346, 85/2	Construction and maintenance of outer entrance channel deepening to 40 ft, inner entrance channel deepening to 37 feet, expanding the main turning basin to the north and south.
PL 89-298 Section 201, 1974	HD 93-144	Deepen outer entrance channel to 45 feet at a width of 500 feet, inner entrance channel to 42 feet at a width of 450 feet, main turning basin to 42 feet, channel opposite Pier 7 to 36 feet, maintain channel opposite Berth 18 to 36 feet
WRDA 1992	HD 103-126, 103/1	Federal maintenance of locally constructed Southport Access Channel dredging to 42 feet, and locally constructed turning notch to a depth of 42 feet.

3. Economic Assessment

Port Everglades infrastructure is divided into three Port terminal areas, each with individual characteristics and use: Northport, Midport, and Southport. 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. The Northport area has oil product storage tanks, cement silos, railroad spur access, road access, and airport access nearby. There is also two daily cruise vessels that berth in this area.

Port Everglades' Midport, like Northport, is a multi-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: 2 rail-mounted Panamax gantry cranes, a refrigerated wharehouse, 77 acres of open yard area for containers and neobulk storage, and 9 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. Midport and Southport contain Foreign Trade Zone (FTZ) #25. Established in 1976, it includes five warehouses with a total of 388,600 square feet.

Port Everglades handles a wide variety of cargo and vessel types. Port Everglades is one of the world's largest cruise ports and is one of the southeastern US's major cargo ports. The Port's total cruise passengers and waterborne commerce by type are shown in **Table 4.**

Table 4: Port Everglades Cruise Passengers and Total Tonnage by Type (FY2012)

Total Cruise Passengers	**3,757,320**
Single-day	68,298
Multi-day	3,689,022
Total Containerized Cargo Tonnage	**5,944,513**
TEUs Loaded	655,046
TEUs Total	923,600
Total Petroleum Tonnage	**14,830,384**
Total Bulk Tonnage	**973,191**
Bulk Cement	613,051
Other Dry Bulk	346,976
Liquid Bulk (non-petroleum)	13,164
Total Break Bulk Tonnage	**120,812**
Steel/Coil/Rebar	53,055
Other Break Bulk	67,757
Total Vehicles and Yachts	**166,237**
Total Waterborne Commerce Tonnage	**22,116,275**

Source: Port Everglades Commerce Report FY2012
Notes: Short tons. Cruise Passengers are counted at embarkation and debarkation.

For containerized cargo, Port Everglades handles the largest share (28%) of South and Central American-Caribbean regional[1] cargo (558,032 loaded TEUs in FY2012) as compared to all other southeastern US ports, including Jacksonville, Palm Beach, Miami, Savannah, and Charleston. However, the Port's total containerized cargo throughput is similar to that of both Jacksonville and Miami.

Port Everglades is an important stimulus to the economic growth and progress of the Fort Lauderdale and South Florida area. Job-related industries, transportation of finished products, and cruise-oriented activities have contributed significantly in the expansion of economic activity. As the Port's role as a key gateway to the world has developed, so has its significance as a major economic engine for the County, regional and state economies.

Transportation networks, connecting Port Everglades to Florida and the remainder of the region, are extensive. 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 excellent access to Florida's East Coast Railway links. The Fort Lauderdale International Airport handles a majority of cruise passengers using the port.

[1] South and Central American-Caribbean regional cargo refers to international trade with nation in the Caribbean, Central America, east coast of South America, north coast of South America, and the west coast of South America

According the Waterborne Commerce Statistics Center, over 22 million tons of waterborne cargo passed through Port Everglades in 2012. Major commodities moving through the port in 2012 included: petroleum products, manufactured goods, food and farm products, and manufactured machinery. As shown in **Figure 3**, liquid bulk represents 67% of the total tonnage while containerized cargo includes about 27%.

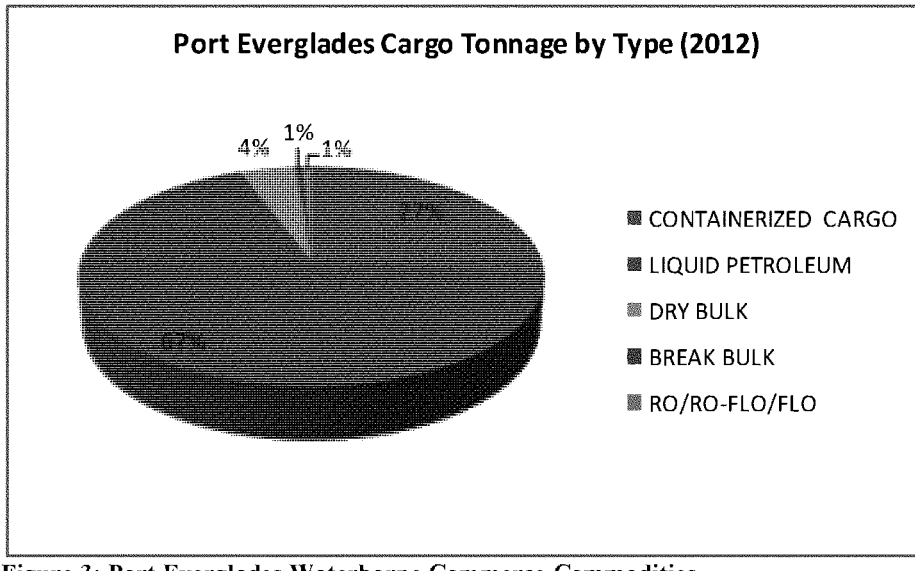

Figure 3: Port Everglades Waterborne Commerce Commodities

4. Shoaling and Maintenance

Shoaling

Littoral processes at Port Everglades are influenced heavily by the presence of man-made structures in the vicinity of the port's entrance channel. A shoal to the north of the inlet, the inlet's jetties, and the navigation channel itself lead to the occurrence of accretion and erosion at the adjacent shorelines.

The navigation channel and south jetty act jointly as a sediment sink for sediment that reaches the inlet. Based on surveys of channel dredging, it is estimated that approximately 21,700 cubic yards of sand enters the inlet each year (Olsen Associates Inc., 2007, Engineering Appendix A). This material migrates westerly along the northern seawall and deposits on the side slopes of the channel, at the western end of the wall adjacent to the Main Turning Basin, and in the Main Turning Basin.

The net southerly longshore sediment transport rate is 54,900 cubic yards per year, of which 37,700 cubic yards accumulate along the north beach and 17,200 cubic yards deposit in the inlet. The annual erosion rate of 48,500 cubic yards at John U. Lloyd includes an additional 4,500 cubic yards entering the inlet and 7,500 cubic yards being lost in the cross-shore. The resultant net transport rate to the south is 36,500 cubic yards.

History of Maintenance

Port Everglades was authorized as a Federal navigation project in 1930. There has been a total of eleven Federally sponsored maintenance dredging projects aimed at removing accumulated sediments within the entrance channel and turning basin since then. **Table 5** shows the historical dredging and disposal up until 1978 as documented in the 1990 Feasibility Report, with more recent data from the Port Authority and the Jacksonville District added. Between 1934 and 2005 Federal channel maintenance included a total volume of 1,538,500 cubic yards dredged from the OEC, IEC, MTB, NTB, and STB. The average shoaling rate for this time period is approximately 21,700 cy per year (Engineering Appendix Section 2.5 and 4.5.2).

Table 5: Historic Maintenance Dredging for Port Everglades

Date	Volume (cy)	Location	Method	Disposal
1934	139,900	Entrance Channel and Turning Basin	Hopper Dredge	Ocean
1935	97,400	Entrance Channel and Turning Basin		Ocean
	73,100	Turning Basin	Pipeline Dredge	Upland
1939	48,300	Entrance Channel and Turning Basin		Upland
1948	93,900	South side of Turning Basin		Upland
	206,300	Entrance Channel and North side of Turning Basin	Hopper Dredge	Ocean
1950	47,300	North side of Turning Basin	Pipeline Dredge	Upland
1953	97,300	Entrance Channel	Hopper Dredge	Ocean
	179,800	Turning Basin	Pipeline Dredge	Upland
1954	101,200	Turning Basin		Upland
1960	38,700	Entrance Channel	Hopper Dredge	Ocean
	179,800	Turning Basin	Pipeline Dredge	Upland
1961-62	9,600	Turning Basin		Upland
	12,200	Turning Basin		Ocean
	22,500	Entrance Channel		Ocean/Beach
1978	144,500	Turning Basin	Hopper Dredge	Ocean
2005	46,700	Turning Basin		Ocean

Most Recent and Anticipated Maintenance

The most recent maintenance event took place in 2013. A total of 418,674 cubic yards was dredged with 96,126 cy beach placement and 322,548 cy to the ODMDS. **Table 6** provides the estimated volumes by component. Future maintenance of the channel and basin including the new work construction areas are expected in years 2027, 2037, 2047, and 2057. Table A-22 in Engineering Appendix A and **Table 6** below provide the breakdown. Future maintenance material is expected to be placed in the Port Everglades Ocean Dredged Material Disposal Site (ODMDS). Programmed dredging including the construction of the proposed navigation improvements is presented in **Table 8**.

Future Federal maintenance of Port Everglades Harbor was estimated using the history of Federal maintenance dredging previously discussed in this document. Shoaled material per square foot of the channel is approximately 0.003 cubic yards. The extension of the OEC will increase the channel by approximately 2,033,000 square feet, increasing the estimated annual shoaling rate for the increased project footprint by 5,740 cy/yr to total rate of 27,440 cy/yr.

The Port has reported that approximately 30,000 cubic yards has been maintenance dredged from berthing areas in the last 15 years. This translates to a yearly berthing area maintenance dredge rate of 2,000 cy/yr. Maintaining berthing areas to project depths is the responsibility of the Broward County Port Authority.

The most recent hydrographic survey for Port Everglades yielded a total of 265,366 cubic yards projected quantity for future maintenance dredging of the harbor to design depth, **Table 7**. The survey indicates shoal areas along the perimeter of the inner entrance channel, main turning basin area, and along the east portions of the Federal Southport Access Channel.

Table 6: Current Maintenance Volumes

Component	Volume (cy)
OEC (45')	46,633
IEC (42')	42,204
MTB (42')	41,799
Widener	---
SAC (42')	0
TN (42')	91,972
SAC and TN (42')	41,758
TOTALS	265,366

Table 7: Anticipated Dredging Volumes

Project Component	Estimated Future Shoaling Rate (cy/yr)	Estimated Future Maintenance Quantity (cy)			
		2027	2037	2047	2057
Federal Channels	27,440	274,000	274,000	274,000	274,000
Port Berthing Areas	2,000	20,000	20,000	20,000	20,000

Note: From EN Appendix Table A-22

Table 8: Proposed Construction Phasing

Location	Depth	Federal Quantity[1] (cy)	Berth Quantity (cy)	Site	Start Year	Constract No.
ODMDS Designation	-	-	-	-	Year 1	1
Plans & Specifications	-	-	-	-	Year 2	1
Outer Entrance Channel	55	1,057,062	0	ODMDS	Year 3	1
Inner Entrance Channel	48	307,693	0	ODMDS	Year 4	1
Widener	48	996,245	0	ODMDS	Year 5	1
Main Turning Basin	48	700,734	146,286	ODMDS	Year 6	1
Southport Access Channel	48	1,571,500	40,004	ODMDS	Year 7	1
Turning Notch	48	608,528	42,497	ODMDS	Year 8	1

1. Quantities include maintenance material and required and allowable overdepth

5. Material Type

Geotechnical core borings and investigations determined that materials at Port Everglades were composed predominately of sand, "soft" rock (rock not requiring blasting for excavation), and "hard" rock (rock requiring blasting). **Table 9** gives estimated percentages of materials based on project component.

Table 9: Distribution of Materials by Percentage

Location	Percentage of Sand (%)	Percentage of Soft Rock (%)	Percentage of Hard Rock (%)
Outer Entrance Channel	70.0	20.0	10.0
Inner Entrance Channel	40.0	55.0	5.0
Main Turning Basin	40.0	20.0	40.0
North Turning Basin	40.0	10.0	50.0
South Turning Basin	40.0	10.0	50.0
Widener	50.0	50.0	0.0
Southport Access Channel	50.0	50.0	0.0
Turning Notch	50.0	50.0	0.0
Dania Cutoff Canal	50.0	40.0	10.0

A geotechnical analysis for beach quality sand potential at the Widener area was performed. The purpose of the analysis was to evaluate all available information gathered to date to determine and quantify the suitability of the excavated material for beach quality materials. Based on the analysis, the information shows without processing, the excavated material would produce marginal quality beach fill. Processing would consist of screening out any gravel (+1 inch) and removing all silts and peat deposits, resulting in slightly gravelly-fine to coarse-grained sand. Thirty five percent of the as-excavated material would require processing. This material contains 5-percent gravel larger than 1-inch in size, 15-percent gravel up to 1-inch in size, and 15-percent fines (#200-sieve).

6. Material Disposal Options

Three disposal methods were initially considered for Port Everglades material: beach disposal, offshore disposal, and upland disposal.

Beach disposal consists of using excavated materials as beach fill. As part of the regional sediment management investigation, use of beach quality sand would be placed on John U. Lloyd State Park located immediately south of the entrance channel as directed by previous Environmental Assessments for both Port Everglades Harbor and a onetime Port Everglades Entrance Channel. While the majority of excavated materials at Port Everglades will be sand sized, these materials will contain gravel components, pockets of silt, and limited deposits of peat. In addition, excavation of hard massive rock areas will result in a mixture of sandy gravelly materials, cobbles, and boulders depending on the method of excavation employed. Separation of materials "by layer" during the dredging process is not feasible due to the mixed quality of sand w/gravel and silts as well as the presences of multiple lens of harder materials. This makes it unfeasible to do nearshore placement. Nearshore placement is also not an option due to the nearshore hardbottoms that are present and are designated critical habitat for threatened coral species. Nearshore placement would involve the burial of that habitat. In addition, a sand bypassing operation currently in development by the County at this location is expected to restrict beach quality sand from entering the channel that otherwise might have been available.

Offshore disposal consists of excavating materials using a clamshell dredge, placing it on barges, and towing the barges to a designated offshore dredged material disposal site (ODMDS). Ocean disposal is a viable option for dredged material in the Port Everglades (PE) area. The existing PE ODMDS is intended for disposal of dredged material from the Port Everglades Harbor and vicinity.

In 2005 an ODMDS site was designated 4 miles northeast of Port Everglades. Based on numerical modeling prior to designation, disposal capacity is limited to 500,000 cubic yards per event. As the volume of material for this project is expected to exceed this cap, the USACE Jacksonville District and EPA Region 4 have identified the need to expand the existing ODMDS and this effort to expand and redefine the capacity is underway. Formal designation of the expanded disposal site is expected to be complete before the final Feasibility Study is completed.

Processing of materials would have to be done after excavation and would require a staging/production area within reasonable transport/pumping distance of the project area. The Fort Lauderdale area is extensively developed and no staging/production area could be located. Therefore, due to the inability to process the material, either in situ (via dredging process) or upland, in order to extract the quality of beach fill required for permitting, this alternative was screened out during the Feasibility phase screening process.

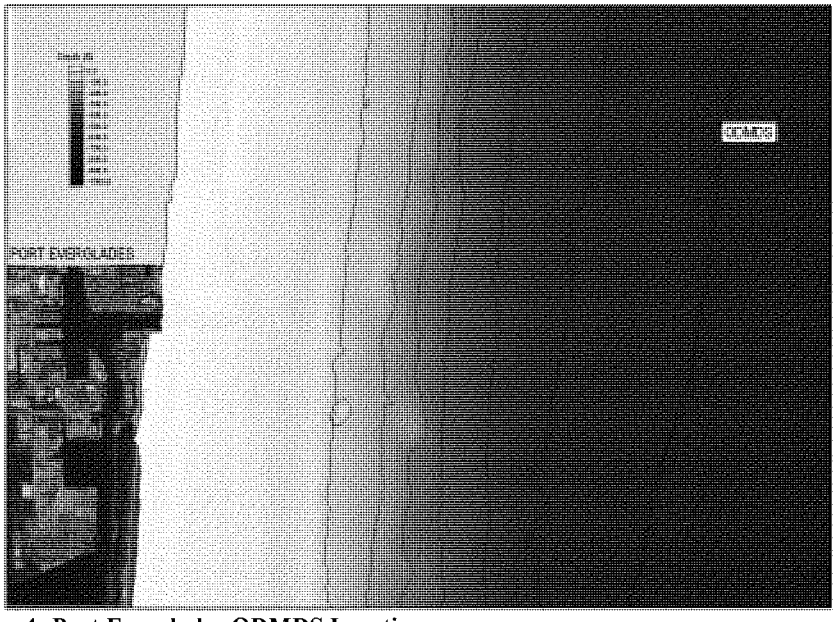

Figure 4: Port Everglades ODMDS Location

Upland disposal is a third option. This option consists of excavating materials using a cutter suction dredge and pumping them through a pipeline to a diked upland disposal site. Two upland sites were originally identified, just north of the Dania Cutoff Canal. Site 1 (**Figure 5**) was a single use site located at the southwest corner of Port property. During the early stages of the study, Site 1 measured 62 acres offering approximately 1 million cubic yards of storage, but later evolved into 107 acres with a capacity of 3.2 million cubic yards. Site 2 (**Figure 6**) was a 64 acre site located on Airport property expected to provide a capacity of approximately 1.6 million cubic yards. Although originally designated as a multiple use site, plans to expand the Airport's runway system made it necessary to designate Site 2 as a single use site.

Figure 5: Disposal Site "Site 1" (2 Alternatives) Located at Port Everglades

Figure 6: Disposal Site "Site 2" Located at Fort Lauderdale Airport

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 disposal sites. Therefore, Site 1 and Site 2 disposal areas have been removed from further consideration.

In order to pump dredged material to an upland site and dewater disposal material, any disposal site would need proximity to the Port. However, Fort Lauderdale, Florida, and the region around the Port specifically, are extremely developed and open space is rare. Originally two potential disposal sites were identified, a 64 acre site located on Ft Lauderdale Airport property and a 72 acre site located on Port property. These were the only two locations of viable size, within acceptable proximity to the project site that were located. Both sites were studied and phasing plans for multiple disposal events were developed. However, during the course of the study the Airport began implementing plans for runway expansion. Due to conflicts with their construction/development plans, the use of the Airport disposal site was rescinded. Similarly, during the same time frame, portions of the Port disposal site were developed or reserved for future development. The resulting acreage and configuration of the remaining land was not suitable for the construction of a disposal facility. As determined earlier in the study, no additional available open land of suitable acreage was identified within reasonable proximity to the project.

7. Dredged Material Disposal Site Capacity and Usage

Port Everglades Harbor ODMDS Background and Disposal History:

A Disposal Area Study (DAS) was completed for the Port Everglades Harbor Project in 1994 (CESAJ, 1994). The purpose of the DAS was to determine the availability and feasibility of using upland sites in comparison to use of an Offshore Dredged Material Disposal Site (ODMDS). The DAS investigated 153 potential upland sites within a 10 mile radius and found 22 of those sites were suitable for disposal. The study concluded that the Port Everglades Harbor ODMDS site was the most economically viable site.

Beneficial use placement has taken place in association with construction or maintenance dredging of the Federal channels of the Port Everglades Harbor Project. In 1961-62 maintenance dredge material was placed on the beach adjacent to John U. Lloyd SRA. An Environmental Assessment was completed and a Finding of No Significant Impact on January 5, 2004 for Broward County to dredge beach quality sand from the Inner Entrance Channel and place the sand on John U. Lloyd SRA. In addition, a draft Environmental Assessment is currently in revision for a long-term disposal plan for beach quality maintenance dredge material to be placed on Broward County beaches.

An additional beneficial use of dredged material from the port involves placement of large blasted rock material into reef creation sites located north of the outer channel to serve as substrate for artificial reef creation.

As part of the Port Everglades Dredging Feasibility Study, various options were identified for managing dredged material, including upland storage/disposal at two Confined Disposal Facilities (CDF) or offshore disposal at an ODMDS. The lack of a suitable upland site near the For Lauderdale Airport for the projected volume of dredged material has resulted in the need to pursue offshore disposal.

It is intended that the Port Everglades Harbor ODMDS will be used for disposal of dredged material (both maintenance and construction or new work material) from the Port Everglades Harbor and vicinity. The primary user of the ODMDS will be the U.S. Army Corps of Engineers for maintenance of the Port Everglades Harbor Federal Project.

Historically, the interim offshore disposal site located approximately 1.6 nautical miles from shore was used for ocean disposal of dredged material from Port Everglades Harbor. Approximately 219,000 cubic yards of dredged material was disposed of at the interim site since 1976 with the last disposal of 16,400 cubic yards occurring in 1982 (WES, 1999). The Jacksonville District Corps of Engineers has projected annual average disposal rates of 30,000 cubic yards from Port Everglades Harbor, however, annual disposal events are unlikely. Maintenance dredging project sizes have ranged from 26,000 cubic yards to 144,000 cubic yards including portions used for beneficial uses (Brodehl, 2003). Maintenance disposal volumes at the ODMDS will likely be less than 294,000 CY every ten years. The new work from the proposed harbor expansion will produce approximately 5.5 MCY of material.

Existing Port Everglades Harbor ODMDS Description (Port Everglades Harbor ODMDS, 2004 SMMP):

The Port Everglades Harbor ODMDS was designated in 2005 as a 1 nmi by 1 nmi square area centered at the coordinates 26° 07.00'N latitude and 80° 01.50'W longitude (NAD83) or state plane coordinates 649292.4 N and 976098.2 E (NAD83). The corner coordinates are as follows:

Table 10: Existing ODMDS Coordinates

	Geographic (NAD83)		State Plane (FL East 0901 FT NAD83)	
NW Corner	26°07.50' N	80°02.00' W	652301.1 N	973341.1 E
NE Corner	26°07.50' N	80°01.00' W	652342.1 N	978810.0 E
SW Corner	26°06.50' N	80°02.00' W	646242.9 N	973386.1 E
SE Corner	26°06.50' N	80°01.00' W	646283.9 N	978855.7 E

[1]Data from 2004 Port Everglades SMMP

The existing Port Everglades Harbor ODMDS is located approximately 4 nmi east-northeast of the PE Harbor. This site is located on the upper continental slope on the western edge of the Florida Current and consists of primarily soft-bottom habitat in water depths of 195 to 215 meters (640 to 705 feet). See **Figure 7.**

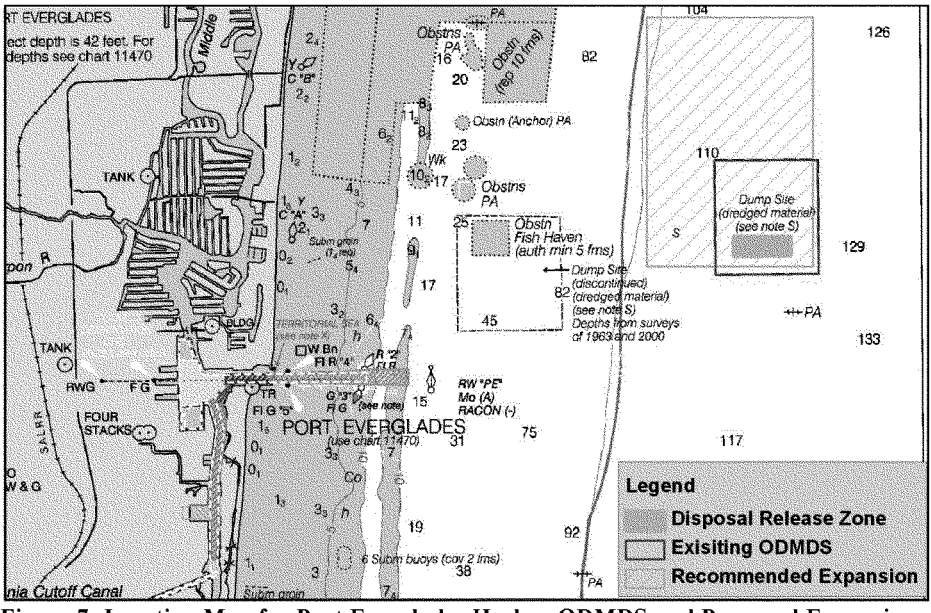

Figure 7: Location Map for Port Everglades Harbor ODMDS and Proposed Expansion

Port Everglades Harbor ODMDS Expansion:

The Jacksonville District has determined that an expansion of the Port Everglades Harbor ODMDS is needed to support the potential construction dredging at Port Everglades Harbor. The expansion need was based on the results of the Long Term Fate Module (LTFATE) and Multi-dump Module (MDFATE) of the Automated Dredging and Disposal Alternatives Modeling System (ADDAMS Model). The model evaluated dredged material placement at the ODMDS based on the quantities projected by the current Recommended Plan, 6.6 million cubic yards; area currents; and adjacent site bathymetry. An Environmental Assessment (EA) document and associated surveys are currently underway in support of the ODMDS expansion, (**Figure 7**).

The coordinates of the proposed expansion area are as follows:

Table 11: Proposed ODMDS Coordinates

	Geographic (NAD83)		State Plane FL East 0901 FT NAD83	
NW Corner	26°08.750'N	80°02.650'W	659889N	969745E
NE Corner	26°08.750'N	80°01.033'W	659889N	978555E
SW Corner	26°06.583'N	80°02.667'W	646669N	978555E
SE Corner	26°06.567'N	80°01.050'W	646669N	969745E

All project dredging in the deep harbor area has been in navigable waters of the United States.

Table 12: Disposal Site Data

Disposal Site(s) (Identifier)	Site Type[1]	Disposal Site Capacity		Beneficial Uses (CY per year		Other Users[2]	Disposal Site Monitor Sponsor (Y/N)
		Original (1000s CY)	Percent Filled	Existing	Anticipated		
ODMDS	2	500 per event	N/A	N/A	N/A	B	Y
Beach	4	200 per event	depends on nourishment cycle	Beach considered beneficial use	Beach considered beneficial use	B	Y
Disposal 1	6	3200	Unconstructed	N/A	N/A	TBD	TBD
Disposal 2	6	1600	Unconstructed	N/A	N/A	TBD	TBD
Name: Broward County Department of Port Everglades							
Address: 1850 Eller Drive							
City: Fort Lauderdale	State: Florida			Zip: 33316			
Point of Contact: Mr. David Anderton				Email: DANDERTON@broward.org			

NOTES:

[1] Disposal Sites:

1- Open water, unrestrained
2- Designated open water
3- Near shore (surf zone)
4- Onshore (beach nourishment)
5- Near shore confined (in-water CDF)
6- Upland confined (onshore CDF)
7- Upland unconfined

[2] Non-Corps Users

A- None, Corps exclusive use
B- Authorized (other parties allowed to use, with or without Corps consent)
C- Allocated (space available for project relate non-Corps dredging at no cost)
D- Permitted (space avilable for non-Corps dredging in the area at cost)
E- Restricted (non-Corps use controlled by another party, Corps has full use)
F- Royalty (site controlled by another party, Corps uses at cost)

8. Reef Mitigation

The hardbottom habitats offshore of southeast Florida form three tracts parallel to shore, running north to south, and also comprise a nearshore hardbottom area adjacent to shore. Specifically, the three offshore tracts are referred to as "fossil" reefs because the substructure of these hardbottoms was created thousands of years ago. However, the "reef" crusts are an invaluable resource in that living corals still thrive in association with macroalgae, sponges, and numerous species of macroinvertebrates and fishes. The depths at the peaks of the submerged reefs range from 8 to 12 meters.

In addition to performing ecosystem services for hundreds of species of fauna and flora, southeast Florida reefs serve important functions for endangered and threatened species. Sea turtles are known to use reefs for grazing and for cover when migrating between inshore and offshore habitats and for individuals migrating north and south along the coast. *Acropora* species (stag- and elk-horn corals), which are listed as "threatened," are known from the area (much of which comprises designated critical habitat), but were not observed in the project footprint (DC&A 2009). Other species of special status, including marine mammals, also depend on reef resources.

Finally, south Florida reefs, including those near Port Everglades, support both recreational and commercial fisheries (including for shrimp and lobster) and are a major feature of south Florida tourism. Reefs also serve to protect the shore from tropical storm waves.

Impacts to reefs and hardbottom habitat will be compensated through installation of artificial reef habitats in Broward County.

{Reference: Dial Cordy and Associates Inc.; Incremental Cost Analysis for Compensatory Mitigation, Port Everglades Feasibility Study}

Several alternatives for artificial reef construction have been discussed. One alternative consists of mining the rock during the channel expansion and moving it to a mitigation area north of the channel. Displaced corals would then be transplanted to the relocated rock. A second alternative would be to harvest a land based source of limestone that would be cut to specifications and relocated to the designated mitigation area north of the channel. The same displaced corals would be transplanted to the relocated limestone. Creation of artificial reef is required as part of the project mitigation, but whether dredged material can be beneficially used will depend on the contractor's dredging methods.

9. Environmental Compliance

ODMDS Designation Process:

The Marine Protection, Research, and Sanctuaries Act of 1972 (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 (MPRSA Sections 102 and 103).

Section 102 of the MPRSA authorizes EPA to designate sites or times at which dumping may occur and to establish criteria for reviewing and evaluating permit applications, including those for dredged material. It also authorizes EPA, in conjunction with USACE, to develop site management plans for dredged material disposal sites.

Under Section 102 of the MPRSA, EPA is authorized to designate sites and time periods for dumping. EPA site designations are published in the Federal Register at 40 CFR Part 228 and require the development of a voluntary NEPA document. Site designations include a description of the site, the type of material for which the site is designated, and any restrictions on site use established by EPA. 40 CFR 228.4 (e) requires that Ocean Dredged Material Disposal Site (ODMDS) designations be based on environmental studies of each site. 40 CFR 228.13 provides guidance on baseline studies. A history of related documents is included below in **Table 13**.

The designation process is currently underway between the agencies and is scheduled for completion in 2015 so that the ODMDS may be used for the Port Everglades Harbor construction dredging starting in 2015.

The main environmental concerns regarding disposal of dredged material at the Port Everglades Harbor ODMDS are: (1) disposal of sediments that may cause significant mortality or bioaccumulation of contaminants within the disposal site or adjacent to the site boundaries, and (2) adverse ecological changes to the ODMDS and the surrounding sea floor. The first concern is addressed through the permitting/evaluation process in which the sediments are evaluated. The second concern is addressed through monitoring of the ODMDS. Changes in the benthic community inside the ODMDS are expected because different grain size characteristics in the dredged material may promote colonization of the site by different benthic species. If dredged material is detected outside of the ODMDS, benthic community changes adjacent to the site may be evaluated to determine whether these changes are acceptable. Additionally, at the Port Everglades Harbor ODMDS there are concerns about potential impacts to nearshore living coral and coralline algal reef systems along the coastline to the west of the site.

Table 13: ODMDS Studies

Survey Title	Conducted by	Date	Purpose	Conclusion
Benthic Macroinfaunal Analysis of the Port Everglades and Palm Beach, Florida ODMDS Surveys	Batelle for EPA	1984	Characterization (sediment analysis, benthic biota) Survey	Characterization of benthos for February & November 1984
Field Studies in Nearshore Areas at Port Everglades, Palm Beach County, and Brevard County, Florida	Continental Shelf Associates for EPA	1985	Benthic characterization of one square mile candidate site (4 mile candidate site) through sidescan and bathymetry.	No high relief ledges, rock outcrops or steep slopes detected. Occasional rubble or cobbles and some low relief rock outcrop
Video, Still Camera, and Side-Scan Sonar Survey of the Seafloor Within and Downcurrent of a Tentative Alternative ODMDS off Port Everglades, Florida.	Continental Shelf Associates for EPA	1986	Look for presence of natural resources (critical habitats) and presence of man made obstructions on the bottom and. down current of site.	Data showed a predominately fine-to-coarse sediment covered bottom with scattered rocks, areas of rock rubble and sand ripples.
Sediment & Water Quality of Candidate Ocean Dredged Material Disposal Sites for Port Everglades and Palm Beach, Florida	U.S. EPA Region 4	1999	Characterization (water column profiles, water quality, sediment characteristics, benthic biota) survey	Conditions at the site are relatively pristine. Water column is clear with low suspended sediment concentrations (2-20mg/l). Sediments consists of mostly fine sand (70%) and have low level of contaminants.
Sidescan Survey of Candidate Ocean Dredged Material Disposal Sites for Port Everglades and Palm Beach, Florida	U.S. EPA Region 4	1999	Look for presence of natural resources (critical habitats) and presence of man made obstructions on the bottom.	The side-scan sonar data indicated a fine sandy bottom with scattered rouble zones throughout the site and areas 2 miles to the north and 2 miles south of the site. No areas of rock outcrops or potential wrecks were identified through the side-scan record within the site or north or south of the site.

10. Conclusions

Preliminary assessment of the deep harbor serving the port indicates that the disposal of shoal material has no major problems for the foreseeable dredging cycle. Future maintenance dredging will utilize the designated ODMDS. EPA designation of an expanded ODMDS has proceeded on schedule with no identified problems. The designation process currently underway between the agencies indicates completion before the end of 2015. The ODMDS may be used for Port Everglades Harbor new construction dredging (approximately 5.5MCY).

The economic viability of Port Everglades Harbor is not in question at the present time. Over the years the amount of containerized cargo tonnage in the deep draft harbor has increased from approximately 1.5 million short tons to over 5 million short tons. Port related industries have significant investments in terminals and infrastructure to handle the tonnage volume. Available information indicates Port Everglades represents an economically viable project, justified for future maintenance, and not limited by environmental compliance over the next twenty years.

Should EPA not designate a disposal site with capacity for proposed material from the Port Everglades Harbor deepening under Section 102 of the Marine, Research, Protection, and Sanctuaries Act (MPRSA), Section 103(b) of MPRSA authorizes USACE, with USEPA concurrence, to select a site for one time disposal of dredged material in ocean waters when the use of a site designated by USEPA is not feasible. The necessary documentation was written by SAJ, and is sufficiently complete for this time in the project implementation schedule. This one-time use would be a permit for the entire construction event (which will produce about 5.5 MCY); the site's capacity is 6.6 MCY. After this use, USACE and EPA have the option to permit it beyond that time frame under Section 103. All maintenance material will be placed in the existing ODMDS site, which has more than enough capacity. The existing site has an event limit of 500,000 CY; Port Everglades only has about 30,000 CY of shoaling a year. Historically, the Federal channel has been dredged every ten years, which is a total of about 300,000 CY per event. The no action alternative in the Environmental Assessment (EA) for the expansion of the Port Everglades ODMDS would entail continued use of the existing ODMDS for operations and maintenance dredging; and/or the emergency one time designation of a site by the Corps of Engineers under Section 103(b) of MPRSA for the dredged material generated by the proposed port expansion. The cost involved with this contingency plan would be approximately $100,000 (only labor funds for designation).

11. Recommendations

The Port Everglades Federal Navigation project warrants continued maintenance on the basis of project usage and indicators of economic productivity, sufficient disposal capacity availability, and maintenance activities in compliance with applicable environmental laws and regulations for the next 20 years. Therefore, no additional dredged material management plan (DMMP) is necessary beyond this assessment.

APPENDIX F

COST ESTIMATES AND COST AND SCHEDULE RISK ANALYSIS

FINAL
FEASIBILITY REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
PORT EVERGLADES HARBOR NAVIGATION STUDY
BROWARD COUNTY, FLORIDA

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G. COST ESTIMATE AND RISK ANALYSIS

G1. GENERAL INFORMATION

Corps of Engineers cost estimates for planning purposes are prepared in accordance with the following guidance:

- Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil Works, 30 September 2008
- Engineer Regulation (ER) 1110-1-1300, Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302, Civil Works Cost Engineering, 15 September 2008
- ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999
- ER 1105-2-100, Planning Guidance Notebook, 22 April 2000, as amended
- Engineer Manual (EM) 1110-2-1304 (Tables Revised 31 March 2012), Civil Works Construction Cost Index System, 31 March 2000
- CECW-CP Memorandum for Distribution, Subject: Initiatives to Improve the Accuracy of Total Project Costs in Civil Works Feasibility Studies Requiring Congressional Authorization, 19 September 2007
- CECW-CE Memorandum for Distribution, Subject: Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs, 3 July 2007
- Cost and Schedule Risk Analysis Process, March 2008

The goal of the cost estimates for the Port Everglades Harbor, Florida Feasibility Study is to present a Total Project Cost (Construction and Non-Construction costs) for the National Economic Development (NED) plan and the Locally Preferred Plan (LPP) at the current price level to be used for project justification/authorization. In addition, the costing efforts are intended to produce a final product (cost estimate) that is reliable and accurate, and that supports the definition of the Government's and the Non-Federal sponsor's obligations.

The cost estimating effort for the study also yielded a series of alternative plan formulation cost estimates for decision making. The cost estimates supporting the NED plan and the LPP are prepared in MCACES/MII format to the CWWBS sub-feature level. This estimate is supported by the preferred labor, equipment, materials and crew/production breakdown. A Cost and Schedule Risk Analysis (CSRA) is included that addresses project uncertainties and sets contingencies for each plan's cost items.

G.1.1 Recommended Alternative Plans

The final NED plan and LPP resulted directly from the plan formulation described above. The Economics Appendix fully describes the plan selection. The scopes of work for the NED plan LPP are found in the Engineering Appendix. The MCACES/MII cost estimate is based on that scope and is formatted in the CWWBS. The notes provided in the body of the estimate detail the estimate parameters and assumptions. These include pricing at the Fiscal Year 2015 price level (1 October 2014-30 September 2015).

The construction costs fall under the following feature codes:

- 02 Relocations
- 06 Fish and Wildlife Facilities
- 12 Navigation Ports and Harbors

The non-construction costs fall under the following feature codes:

- 01 Lands and Damages
- 30 Planning, Engineering and Design
- 31 Construction Management

G.1.2 Construction Cost

Construction costs were developed in MCACES/MII and include all major project components categorized under the appropriate CWWBS to the sub-feature level. The Total Project Costs on each plan contain contingencies that were determined as a result of the risk analysis. Additional information follows on the risk analysis.

In addition to the typical construction costs, this project also includes a Relocations cost for the relocation of aids to navigation, as well as non-construction Fish and Wildlife Facilities costs for the establishment of nutrient reduction measures, eco-restoration areas, and post construction monitoring.

G.1.3 Non-construction Cost

Non-construction costs typically include Lands and Damages (Real Estate), Planning Engineering & Design (PED) and Construction Management Costs (Supervision & Administration, S&A). PED costs for the preparation of contract plans and specifications (P&S) and Construction Management costs for the supervision and administration of the contract including Project Management and Contract Admin costs were provided by the PDT. Lands and Damages costs are provided by Real Estate and are described in the Real Estate Appendix

The main report details both cost allocation and cost apportionment for the Federal Government and the Non-Federal Sponsor. Also included in the main report are the Non-Federal Sponsor's obligations (items of local cooperation).

G.1.4 Plan Formulation Cost Estimates

For the plan formulation cost estimates, unit prices for dredging related work were developed in the Corps of Engineers Dredge Estimating Program (CEDEP) and then entered into MCACES/MII. Unit prices for the remaining major or variable construction elements were developed in MCACES/MII based on input from the PDT. Design details, information and assumptions are provided in the Engineering Appendix. Plan formulation alternatives and cost estimates did not include advanced maintenance or any associated advanced maintenance features.

Refer to Economics Section in the main report for final plan formulation cost tables.

G.1.5 Construction Schedule

A construction schedule was prepared utilizing input from the PDT and reflects all project construction components. The schedule considers not only durations of individual components of construction, but also the timing of construction contracts based on funding. The construction schedule was combined with the project schedule to create an overall schedule that was used for the generation of the Total Project Cost. The construction schedule will change as the project moves through the various project lifecycle phases. The overall project schedule is provided in this report.

G2. PLAN FORMULATION COST ESTIMATES

Refer to the Economics Section in the Main Report.

G3. NED & LPP COST ESTIMATE

The cost estimates were prepared for the Total Project costs, not just the initial construction.

G4. SCHEDULE

Refer to the Schedule in this report.

47' PROJECT

ID		Task Name	Duration	Start	Finish
1		**STUDY PHASE**	**714 days**	**Thu 4/25/13**	**Thu 4/9/16**
2		Complete econ modeling, NED determination, BCR analysis (DQC)	27 days	Thu 4/25/13	Wed 5/22/13
3		TSP MS Read Ahead Materials at SAD/HQ & Legal Review	29 days	Thu 4/25/13	Fri 5/3/13
4		TSP MS Meeting and Approval	0 days	Fri 5/31/13	Fri 5/31/13
5		Complete Econ Appx, Revised Feas Rpt, DQC and Legal Review	14 days	Fri 5/31/13	Fri 6/14/13
6		DEIS submitted to EPA	13 days	Fri 6/14/13	Thu 6/27/13
7		EPA Publishes Notice of Availability in Fed Register	0 days	Fri 6/28/13	Fri 6/28/13
8		Public Review (45FR)	46 days	Fri 6/28/13	Tue 8/27/13
9		Public/Focus group meeting	2 days	Tue 7/23/13	Thu 7/25/13
10		ATR Review	26 days	Wed 8/16/13	Wed 7/17/13
11		IEPR Review (including final report approximately)	89 days	Wed 8/16/13	Mon 9/16/13
12		HC Study	77 days	Fri 5/17/13	Fri 9/27/13
13		SAD/HQ Review	42 days	Fri 8/23/13	Fri 8/9/13
14		CZMA consistency determination (MS)	350 days	Fri 8/23/13	Fri 6/13/14
15		Address public, ATR, IEPR, SAD/HQ, CZMA comments, Coal certification	97 days	Fri 7/5/13	Tue 9/10/13
16		Mitigation impact analysis and plan information	66 days	Fri 8/30/13	Tue 12/3/13
17		NMFS prepare Biological Opinion	85 days	Wed 12/4/13	Fri 3/7/14
18		NMFS distribution letter for Biop, costs and recommendations	52 days	Mon 3/10/14	Thu 5/1/14
19		HQ plan policy determination	39 days	Tue 5/13/14	Thu 7/3/14
20		Prepare REVISED Draft Feas and EIS	401 days	Thu 3/10/14	Fri 9/12/14
21		REVISED Draft report DQC/Legal Reviews	60 days	Tue 9/9/14	Fri 9/12/14
22		REVISED Draft Feas and EIS, Cost Cert, ATR, IEPR, SAD GAC, HQ policy compliance	21 days	Mon 9/15/14	Mon 10/6/14
23		***ATR certification/IEPR final report***	0 days	Mon 10/6/14	***Mon 10/6/14***
24		Final Draft Feas and EIS	5 days	Mon 10/6/14	Sat 10/11/14
25		Final Draft report DQC/Legal Reviews	5 days	Sun 10/12/14	Fri 10/17/14
26		Report Reproduction & Assembly	5 days	Tue 10/21/14	Sun 10/26/14
27		District transmits signed report to SAD	5 days	Mon 10/27/14	Sat 11/1/14
28		Division Engineer transmittal memo (MS)	5 days	Sun 11/2/14	Fri 11/7/14
29		***HQ Final Review/Chief's Report Development/CWRB Prep***	36 days	Mon 11/10/14	***Tue 12/16/14***
30		CWRB/DCG/ CEO decision to release final report (MS)	0 days	Wed 12/17/14	Wed 12/17/14
31		SAA Review, Interested Party, & EIS filing letters signed and sent to District	12 days	Thu 12/18/14	Thu 1/1/15
32		District sends letters/memo to Stakeholders & files EIS	7 days	Fri 1/2/15	Fri 1/9/15
33		Notice of availability appears in Federal Register	0 days	Fri 1/16/15	Fri 1/16/15
34		Final NEPA, SEA Review Period (30 days)	30 days	Fri 1/16/15	Sun 2/15/15
35		District provides draft responses to Significant NEPA, SEA review comments	14 days	Mon 2/16/15	Mon 3/2/15
36		Final NEPA, SEA response letters mailed (SAD/HQ)	7 days	Tue 3/3/15	Tue 3/10/15
37		Documentation of Review Package	82 days	Wed 12/17/14	Mon 3/9/15
38		Routing Final Report at HQ	14 days	Tue 3/10/15	Tue 3/24/15
39		Review by Office of the Chief	14 days	Wed 3/25/15	Wed 4/8/15
40		Signature of Chief's Report	0 days	Thu 4/9/16	Thu 4/9/16
41					
42		**PED PHASE**	**906 days**	**Thu 4/9/16**	**Sat 9/30/17**
43		Design Agreement (DA) Initiated (Once Division Engineer's Transmittal Letter)	0 days	Thu 4/9/16	Thu 4/9/16
44		DA to Local Sponsor (LS)	1 day	Thu 4/9/16	Fri 4/10/16
45		DA Local Sponsor (LS) Comments Received	30 days	Fri 4/10/16	Sun 5/9/16
46		DA submitted to SAD	3 days	Sun 5/9/16	Wed 5/11/16
47		DA Approved	30 days	Wed 5/11/16	Fri 6/10/16
48		DA Executed by LS	30 days	Fri 6/10/16	Sun 7/10/16
49		DA Executed USACE	30 days	Sun 7/10/16	Tue 8/11/16
50		Receive Sponsor Funding & FEDERAL FUNDING	14 days	Thu 8/11/16	Thu 10/27/16
51		PED Complete PED Investigations (After Sponsor Contribution)	210 days	Thu 10/27/16	Thu 6/29/17
52		PED Complete WQC	120 days	Mon 2/27/16	Tue 6/28/16
53		PED Complete PED	491 days	Tue 6/27/16	Sat 9/30/17
54					
55		**CONSTRUCTION PHASE START**	**309 days**	**Thu 4/9/16**	**Fri 2/12/16**
56		Project Cooperation Agreement (PCA) Initiated (Once Authorized) WQC	1 day	Thu 4/9/16	Fri 4/10/16
57		PCA transmitted to Local Sponsor (LS)	2 days	Fri 4/10/16	Sun 4/12/16
58		PCA LS Comments Received	30 days	Sun 4/12/16	Sat 7/11/16
59		PCA submitted to HQ (Once WQC received)	21 days	Sat 7/11/16	Sat 8/1/16
60		PCA Approved by ASA(CW)	90 days	Sat 8/1/16	Fri 10/30/16
61		PCA Executed by LS	60 days	Fri 10/30/16	Tue 12/29/16
62		PCA Executed by USACE	14 days	Tue 12/29/16	Tue 1/12/16
63		Receive Sponsor Contributions	30 days	Tue 1/12/16	Thu 2/11/16
64		Advertise (Contingent upon funding)	1 day	Thu 2/11/16	Fri 2/12/16
65					
66		**CONSTRUCTION PHASE - 47' PROJECT**	**1539 days**	**Sat 9/30/17**	**Sun 9/27/22**
67		Open Bids	30 days	Sat 9/30/17	Mon 10/30/17
68		Award	30 days	Mon 10/30/17	Wed 11/29/17
69		NTP	30 days	Wed 11/29/17	Fri 12/29/17
70		Mobilization	30 days	Fri 12/29/17	Sun 1/28/18
71		Rock Blasting	105 days	Sun 3/28/18	Thu 8/4/18
72		OBC Dredging	265 days	Mon 2/13/18	Tue 12/4/18
73		IBC Dredging	18 days	Tue 12/4/18	Wed 12/26/18
74		WLIE Dredging	280 days	Wed 2/27/19	Wed 11/27/19
75		MSB Dredging	219 days	Wed 11/27/19	Fri 7/3/20
76		SAC Dredging	438 days	Fri 7/3/20	Wed 8/18/21
77		Tilt Dredging	176 days	Wed 8/18/21	Sat 3/12/22
78		Demobilization	15 days	Sat 3/12/22	Sun 3/27/22

Project: Project Schedule REV 1
Date: Tue 9/20/16

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestones | Deadline

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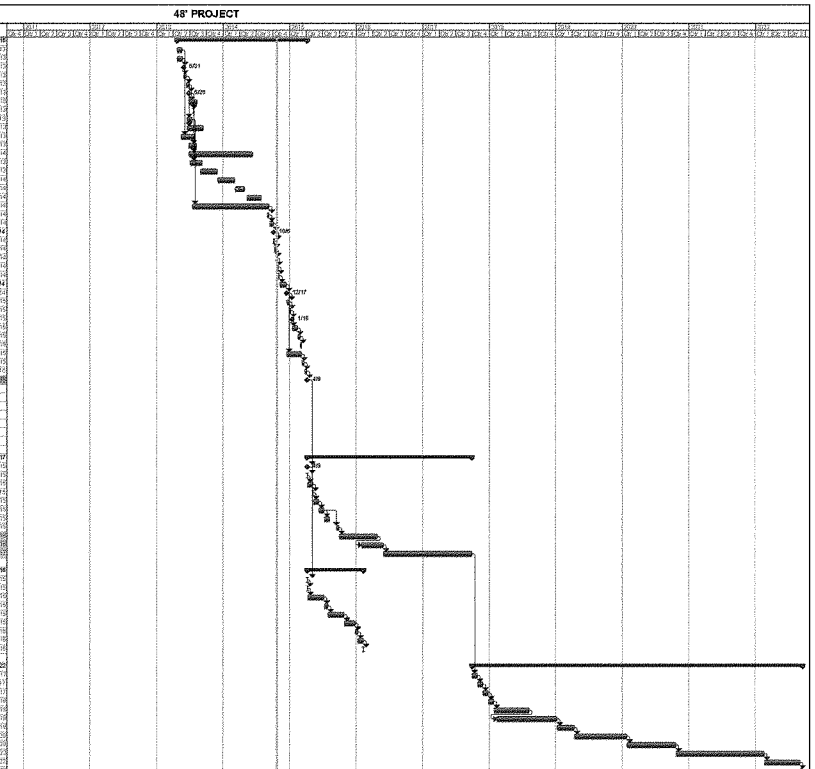
48" PROJECT

ID	Task Name	Duration	Start	Finish
1	**STUDY PHASE**	**714 days**	**Thu 4/25/13**	**Thu 4/8/16**
2	Complete scoping, NEPA determination, BCR analysis (DGC's)	27 days	Thu 4/25/13	Wed 5/29/13
3	TSP MS Prelg Revised Materials at SAD/HQ Legal Review	29 days	Thu 4/25/13	Fri 5/24/13
4	TSP MS Meeting and Approval	6 days	Fri 5/31/13	Fri 6/28/13
5	Complete Econ Appr, revised Fines Rpt, DGC and Legal Review	14 days	Fri 5/31/13	Fri 6/14/13
6	DEIS submittal to EPA	13 days	Fri 5/31/13	Thu 6/27/13
7	EPA Publishes Notice of Availability in Fed Register	5 days	Fri 6/28/13	Fri 7/5/13
8	Public Review (NEPA)	46 days	Fri 6/28/13	Tue 8/27/13
9	Public Focus group meeting	2 days	Tue 7/23/13	Thu 7/25/13
10	ATR Review	28 days	Wed 8/14/13	Wed 7/11/13
11	SDPR Review (including final report due to Hecker)	69 days	Wed 8/14/13	Mon 8/19/13
12	VE study	77 days	Fri 5/31/13	Fri 9/27/13
13	SAD/HQ Review	42 days	Fri 8/28/13	Fri 8/8/13
14	CZMA consistency determination (MS)	358 days	Fri 8/28/13	Fri 6/12/14
15	Address public, ATR, SDPR, SAD/HQ, CZMA comments, Cost certification	87 days	Fri 7/5/13	Tue 9/10/13
16	Mitigation impact analysis and plan reformulation	65 days	Fri 8/9/13	Tue 12/3/13
17	HRS prepare Biological Opinion	93 days	Wed 12/4/13	Fri 5/1/14
18	HRS clarification letter re: BiOp, costs and econ analysis	52 days	Mon 3/10/14	Thu 5/1/14
19	NED plan safety determination	79 days	Tue 8/13/14	Thu 7/23/14
20	Prepare REVISED Draft Feas and EIS	431 days	Thu 7/18/13	Fri 8/12/14
21	REVISED Draft report DGC/Legal Reviews	10 days	Tue 9/2/14	Fri 9/12/14
22	REVISED Draft Feas and EIS, Cost Cert, ATR, SDPR, SAD OK, HQ policy compliance	21 days	Mon 9/15/14	Mon 10/6/14
23	***ATR certification/EPA final report***	0 days	Mon 10/6/14	***Mon 10/6/14***
24	Final Draft Feas and EIS	5 days	Mon 10/6/14	Fri 10/11/14
25	Final Draft report DGC/Legal Reviews	5 days	Sun 10/12/14	Fri 10/17/14
26	Report Reproduction & Assembly	5 days	Tue 10/21/14	Mon 10/20/14
27	District Scientific signed report to SAD	8 days	Mon 10/27/14	Sat 11/1/14
28	Division Engineer transmittal memo (MS)	5 days	Sun 11/2/14	Fri 11/7/14
29	***HQ Final Review/Chief's Report Development/CWRB Prep***	36 days	Mon 11/10/14	***Tue 12/16/14***
30	CWRBDX/CEO accept to release final report (MS)	5 days	Wed 12/17/14	Wed 12/17/14
31	SBA Review, Intervided Parks, S.205 Reg letters signed sent to District	14 days	Thu 12/18/14	Thu 1/1/15
32	District errata/information to Scientificnics & Nat ESS	7 days	Fri 1/2/15	Fri 1/9/15
33	Notice of availability signed in Federal Register	5 days	Fri 1/16/15	Fri 1/16/15
34	Final NEPA, SBA Review Period (90 days)	90 days	Fri 1/16/15	Sun 2/15/15
35	District provides draft response to significant NEPA, SBA review comments	14 days	Mon 2/16/15	Mon 3/2/15
36	Final NEPA, SBA response transmitted (SAD/HQ)	7 days	Tue 3/3/15	Tue 3/10/15
37	Documentation of Review/Findings	50 days	Wed 12/17/14	Mon 1/26/15
38	Routing Final Report at HQ	14 days	Tue 2/10/15	Tue 2/24/15
39	Review by Office of the Chief	14 days	Wed 2/25/15	Wed 4/8/15
40	**Complete Study Phase**	**0 days**	**Thu 4/8/15**	**Thu 4/8/15**
41				
42				
43				
44				
45				
46				
47				
48				
49	**PED PHASE**	**965 days**	**Thu 4/9/15**	**Sat 6/30/17**
50	Design Agreement (DA) initiated (Chief Division Engineer's Transmittal Letter)	6 days	Thu 4/9/15	Thu 4/9/15
51	DA to Local Sponsor (LS)	1 day	Thu 4/9/15	Fri 4/10/15
52	DA Local Sponsor (LS) comments received	35 days	Fri 4/10/15	Sun 5/10/15
53	DA submitted to SAD	2 days	Sun 5/10/15	Wed 5/13/15
54	DA approved	30 days	Wed 5/13/15	Fri 6/12/15
55	DA Executed by LS	30 days	Fri 6/12/15	Sun 7/12/15
56	DA Executed USACE	30 days	Sun 7/12/15	Tue 8/11/15
57	Receive Sponsor Funding & FEE/REAL PLANNING	14 days	Thu 8/13/15	Thu 10/1/15
58	PED Complete PMP development after Sponsor Commitment	315 days	Thu 10/1/15	Thu 9/28/16
59	PED Complete MSC	120 days	Mon 3/7/16	Sat 9/24/16
60	PED Complete PPA	497 days	Tue 8/31/16	Sun 6/30/17
61				
62	**CONSTRUCTION PHASE START**	**309 days**	**Thu 4/8/16**	**Fri 2/12/18**
63	Project Cooperation Agreement (PCA) initiated (Chief Authorized/VADC)	1 day	Thu 4/8/16	Fri 4/9/16
64	PCA transmitted to Local Sponsor (LS)	2 days	Fri 4/15/16	Sun 4/17/16
65	PCA LS comments received	90 days	Sun 4/17/16	Sat 7/16/16
66	PCA submitted to HQ/one MSC reviewed	21 days	Sat 7/16/16	Sat 8/13/16
67	PCA Approved by ASA(CW)	90 days	Sat 8/13/16	Fri 11/28/16
68	PCA Executed by LS	90 days	Fri 11/28/16	Tue 12/26/16
69	PCA Executed by USACE	14 days	Tue 12/26/16	Tue 1/10/16
70	Receive Sponsor Contributions	90 days	Tue 1/10/16	Thu 3/11/16
71	Advertise (Contingent upon funding)	1 day	Thu 3/11/16	Fri 3/12/16
72				
73	**CONSTRUCTION PHASE - 48" PROJECT**	**1016 days**	**Sat 9/30/17**	**Tue 6/26/22**
74	Open Bids	28 days	Sat 9/30/17	Mon 10/30/17
75	Award	30 days	Mon 10/30/17	Wed 11/29/17
76	NTP	10 days	Wed 11/29/17	Fri 12/29/17
77	Mobilization	90 days	Fri 12/29/17	Sun 3/29/18
78	P200 Dredging	180 days	Sun 1/28/18	Thu 8/9/18
79	CB01 Dredging	152 days	Mon 3/12/18	Thu 8/9/18
80	BC Dredging	56 days	Thu 8/10/18	Mon 8/10/18
81	WOE Dredging	268 days	Mon 4/16/18	Tue 1/28/19
82	MTB Dredging	216 days	Tue 1/29/19	Sat 10/24/20
83	SAC Dredging	486 days	Sat 10/24/20	Mon 2/21/22
84	TK Dredging	186 days	Mon 2/21/22	Mon 8/5/22
85	Demobilization	15 days	Mon 8/5/22	Tue 8/22/22



Project: Project Schedule REV 1
Date: Tue 3/31/14

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

G5. RISK AND UNCERTAINTY ANALYSIS

A Cost and Schedule Risk Analysis was conducted according to the procedures outlined in the manual entitled; "Cost and Schedule Risk Analysis Process" dated March 2008.

G.5.1 Risk Analysis Methods

The entire PDT participated in cost and schedule risk analysis brainstorming sessions to identify risks associated with the recommended plan. The risks were listed in the risk register and evaluated by the PDT. Assumptions were made as to the likelihood and impact of each risk item, as well as the probability of occurrence and magnitude of the impact if it were to occur. Adjustments were made to the analysis accordingly and the final contingency was established. The contingency was applied to each plan estimate in order to obtain the Total Project Cost.

G.5.2 Risk Analysis Results

Refer to the CSRA Report provided in this report.

US Army Corps of Engineers®

COST AND SCHEDULE RISK ANALYSIS
PORT EVERGLADES HARBOR
NATIONAL ECONOMIC DEVELOPMENT PLAN
BROWARD COUNTY, FLORIDA

Prepared for:

U.S. Army Corps of Engineers,
Jacksonville District

Prepared by:

U.S. Army Corps of Engineers,
Jacksonville District and

Civil Works Cost Engineering and ATR Mandatory Center of Expertise with Technical Expertise, Walla Walla

October 8, 2014

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Executive Summary

The purpose of this report is to document the results of the cost and schedule risk analysis (CSRA) performed for the Port Everglades Harbor feasibility study project. This report presents a recommendation for the total project cost and schedule contingencies based on CSRA results.

The scope of this CSRA report is to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level using risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. This report presents the contingency results for both cost and schedule risks for both construction features and non-construction features. The CSRA does not include consideration for lifecycle costs.

Port Everglades Harbor is a major seaport located on the southeast coast of Florida. 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 facility, the Nova Southeastern University Oceanographic Center, a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park and its adjacent beaches. South of the Dania Cutoff Canal 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.

The Port Everglades Harbor Feasibility Study was initiated in 2001 with the non- federal sponsor, Broward County. The primary purpose of conducting the feasibility study is to investigate improvements to the Federal navigation project at Port Everglades. The existing Federal Channel project depth of 42-feet does not provide adequate, safe depth for large tankers and container ships currently visiting the harbor. The next generation of container ships and oil tankers requires significantly more channel depth to operate efficiently. The National Economic Development (NED) plan, depth where the net benefits are the highest, has been identified to be 47 feet. The non-federal sponsor requested a Locally Preferred Plan (LPP) of 48 feet. There are positive net benefits at this depth. The Tentatively Selected Plan (TSP) is the LPP of 48 feet.

Summary of Findings

Table ES-1 provides the cost contingencies for NED plan calculated at selected confidence level intervals. Contingency was quantified as approximately $74.1 million at the 80 percent confidence level, which is about 26.3% of the base cost estimate of approximately $281.9 million. These results reflect contingencies based on both the cost and schedule risk analyses.

Table ES- 1 - NED Plan CSRA

Confidence Level (%)	Base Cost Estimate[1] + Contingency	Contingency ($)	Contingency (%)
5	$285,566,000	$3,655,000	1.3%
50	$328,883,000	$46,972,000	16.7%
80	**$356,009,000**	**$74,098,000**	**26.3%**
90	$371,323,000	$89,412,000	31.7%

Notes:

1. The NED Plan base cost estimate is $281,910,803.

The primary threats to the NED Plan cost estimate identified by the CSRA process are listed below. These threats include both direct cost impacts and the cost impacts of schedule delays.

Industry Availability/Bidding Climate: The relatively large contract size may limit field of interested bidders and increase the uncertainty of future costs. Joint ventures may be necessary due to the size of the contract. Schedule for this project could overlap with competing dredging projects which are preparing for New Panamax class ships.

Bonding Capacity: Competition may be limited due to bonding capacity issues. Joint ventures (JV's) will likely be necessary due to the size of the anticipated contract. Several market participants have existing JV agreements. Bonding capacity is also impacted by the number of dredging projects being performed in the same time frame.

Results of PED Studies Impact Costs: Further studies will be performed during the Planning Engineering and Design (PED) phase. The results of these studies could impact the cost estimate. Future geotechnical and environmental surveys have the greatest potential for impacts. New sea grass and coral surveys will be completed.

Feasibility Level Designs: Current design level is appropriate for feasibility level; however, designs will be refined during the PED phase. Refinement is likely to impact costs.

Table ES-2 provides the cost contingencies for LPP plan calculated at selected confidence level intervals. Contingency was quantified as approximately $78.0 million at the 80 percent confidence level, which is about 26.3% of the base cost estimate of approximately

$296.2 million. These results reflect contingencies based on both the cost and schedule risk analyses.

Table ES- 2 - LPP Plan CSRA

Confidence Level (%)	Base Cost Estimate[1] + Contingency	Contingency ($)	Contingency (%)
5	$302,214,000	$6,050,000	2.0%
50	$346,794,000	$50,630,000	17.1%
80	**$374,180,000**	**$78,016,000**	**26.3%**
90	$389,689,000	$93,525,000	31.6%

Notes:
1. The LPP Plan base cost estimate is $296,164,431.

The primary threats to the LPP Plan cost estimate identified by the CSRA process are listed below. These threats include both direct cost impacts and the cost impacts of schedule delays.

Industry Availability/Bidding Climate: The relatively large contract size may limit field of interested bidders and increase the uncertainty of future costs. Joint ventures may be necessary due to the size of the contract. Schedule for this project could overlap with competing dredging projects which are preparing for New Panamax class ships.

Bonding Capacity: Competition may be limited due to bonding capacity issues. Joint ventures (JV's) will likely be necessary due to the size of the anticipated contract. Several market participants have existing JV agreements. Bonding capacity is also impacted by the number of dredging projects being performed in the same time frame.

Results of PED Studies Impact Costs: Further studies will be performed during the Planning Engineering and Design (PED) phase. The results of these studies could impact the cost estimate. Future geotechnical and environmental surveys have the greatest potential for impacts. New sea grass and coral surveys will be completed.

Feasibility Level Designs: Current design level is appropriate for feasibility level; however, designs will be refined during the PED phase. Refinement is likely to impact costs.

Table ES-3, on the following page, provides a comparison of recommended contingency values for the major elements of the cost estimates for each plan. The contingency values presented in Table ES-3 are calculated at the 80 percent confidence level. The contingency values are not rounded and were calculated based on statistical analysis of the CSRA Monte Carlo simulation.

Recommendations

The project delivery team (PDT) should include the recommended contingency levels in the total project cost estimate for the Port Everglades Harbor project.

Project leadership should use of the outputs created during the CSRA effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

Project leadership should review risk items identified in the NED plan and LPP risk registers and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

Table ES- 3 - Recommended Contingency for WBS Features

Feature	Base Cost Estimate, Excluding Contingency ($)	Recommended Contingency ($)	Base Cost Estimate + Contingency ($)
NED Plan - 47'			
Wildlife Facilities & Sanctuary (Mitigation & Monitoring)	$40,316,657	$10,603,281	$50,919,938
Navigation Ports & Harbors (Dredging)	$230,318,620	$60,573,797	$290,892,417
Relocations (Aids to Navigation)	$147,703	$38,846	$186,549
Planning Engineering and Design	$4,453,000	$1,171,139	$5,624,139
Construction Management	$6,674,823	$1,755,478	$8,430,301
LPP - 48'			
Wildlife Facilities & Sanctuary (Mitigation & Monitoring)	$40,316,657	$10,603,281	$50,919,938
Navigation Ports & Harbors (Dredging)	$230,318,620	$60,573,797	$290,892,417
Relocations (Aids to Navigation)	$147,703	$38,846	$186,549
Planning Engineering and Design	$4,453,000	$1,171,139	$5,624,139
Construction Management	$6,674,823	$1,755,478	$8,430,301

1. Recommended contingency is based on the 80-percent confidence level CSRA.

1. Introduction

a) In July of 2013, Legis Consultancy, Inc. ("Legis") entered into an agreement with the United States Army Corps of Engineers (USACE) Jacksonville District to provide support for preparation of the Final Report Cost Appendix for the Port Everglades Harbor feasibility study project. This report documented the Cost and Schedule Risk Analysis (CSRA) prepared as an element of the Cost Appendix.

   The Legis CSRA support team included the following individuals:
   Gordon L. Ballentine, CFA; David R. Smart, JD, CCA, PMP; and Michael C. Ray, PE, CCE, PSP, PMP

b) In 2014 the project scope changed to include 'Coral Propagation'. This was done to satisfy the environmental requirements of the National Marine Fisheries Service (NMFS) necessary for issuance of a favorable Biological Opinion to support permit issuance.

2. Purpose

This purpose of this report is to document the results of the CSRA performed for the Port Everglades Harbor feasibility study project. This report presents a recommendation for the total project cost and schedule contingencies based on CSRA results.

3. Background

Port Everglades Harbor is a major seaport located on the southeast coast of Florida. 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 facility, the Nova Southeastern University Oceanographic Center, a U.S. Coast Guard (USCG) facility, and John U. Lloyd Beach State Park and its adjacent beaches. South of the Dania Cutoff Canal 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.

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ships and oil tankers requires significantly more channel depth to operate efficiently. The National Economic Development (NED) plan, depth where the net benefits are the highest, has been identified to be 47 feet. The non-federal sponsor requested a Locally Preferred Plan (LPP) of 48 feet. There are positive net benefits at this depth. The Tentatively Selected Plan (TSP) is the LPP of 48 feet.

4. Report Scope

The scope of this CSRA report is to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level using risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. This report presents the contingency results for both cost and schedule risks for both construction features and non-construction features. The CSRA does not include consideration for lifecycle costs.

4.1 Project Scope

The Port Everglades Harbor project technical scope, cost estimates and schedules were developed and presented by the Jacksonville District. Consequently, these documents serve as the basis for the CSRA. The cost estimate and schedule for the NED and LPP plans are provided in summary format as Appendix A.

CSRA development included extensive involvement of the Project Delivery Team (PDT) for risk identification and the development of the risk register for the NED plan. The analysis process evaluated the Micro Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Oracle Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) Construction Cost Estimating Guide for Civil Works, dated September 30, 2008.

4.2 USACE Risk Analysis Process

The risk analysis process for this study follows USACE Headquarters guidance as well as guidance provided by the USACE Cost Engineering MCX/TCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Oracle Crystal Ball software application. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingency reflective of various levels of confidence to successfully accomplish the project work within that established contingency amount. Furthermore, the process includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to support decision making and risk management as the project progresses to completion. To fully recognize its benefits, CSRA should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to substantially meet the guidance and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the Cost Engineering MCX/TCX.
- Memorandum from Major General Don T. Riley (US Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.
- Engineering Regulation ER 1110-2-1150 dated August 31, 1999.
- Engineering Regulation ER 1110-2-1302 dated September 15, 2008.
- Engineering Technical Letter ETL 1110-2-573 dated September 30, 2008.

5. Methodology/Process

The risk analysis process used for the CSRA determined the probability of various cost outcomes and quantified the required contingency needed in the project cost estimate to achieve any desired level of cost confidence. A parallel process was also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests may result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept, the more contingency should be applied. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering MCX/TCX guidance for CSRAs generally recommends budgeting based on the 80-percent confidence level for contingency calculation. An 80-percent confidence level results in greater contingency as compared to a 50-percent confidence level. The use of the 50-percent confidence level is a risk neutral approach, so use of the 80-percent

confidence level as a decision criteria is a risk averse approach (levels less than 50 percent would be risk seeking).

The risk analysis process uses *Monte Carlo* simulation to determine confidence levels and contingency. *Monte Carlo* simulation is a technique that computes or iterates the project cost or project schedule many times using input values selected at random from probability distributions of possible costs or durations, to calculate a distribution of possible project costs or durations. Consistent with Cost Engineering MCX/TCX guidance, the *Monte Carlo* simulation is facilitated computationally using the Oracle Crystal Ball software application which is an add-in to Microsoft Excel.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 7.

5.1 Identify and Qualitatively Analyze Project Risks

A project risk is an uncertain event or condition that, if it occurs, has an uncertain positive or negative effect on a project's objectives. This definition includes two key dimensions of risk: uncertainty and effect on a project's objectives (*i.e.*, cost and schedule objectives in the case of CSRA). When assessing the importance of a project risk, these two dimensions are both considered. The uncertainty dimension is described using the terms "likelihood" or "probability" and the effect is called "impact".

Members of the Port Everglades Harbor PDT identified and qualitatively analyzed risks during a facilitated risk identification and qualitative analysis meeting. The original risk identification and qualitative analysis effort was conducted 22 August 2013 in Jacksonville, Florida. Legis support team members participated in the risk meeting. A follow-up meeting was held on 3 September 2014 in which the PDT reconsidered all elements of the previous risk register, considered the conditions that had changed in the last year, and assessed the risk associated with the added project component of 'Coral Propagation'.

Both meetings focused on refinement of risks previously identified, as well as the identification and qualitative analysis of risks not previously identified. The risk meeting included capable and qualified representatives from multiple project disciplines and functions, including:

- Project Management
- Contracting
- Real Estate
- Engineering and Design
- Cost Engineering
- Construction
- Environmental
- Sponsor
- Risk Analysis

Risks identified by the PDT were categorized as to the likelihood of occurrence and the impact to the project if realized using the categories identified in Table 1.

Table 1- Risk Categories Used by the PDT

Likelihood of Occurrence Category
Very Unlikely
Unlikely
Likely
Very Likely
Impact Category
Negligible
Marginal
Significant
Critical
Crisis

After categorizing project risks in regard to likelihood of occurrence and impact, a risk matrix was used to prioritize individual risks for inclusion in quantitative analysis. The risk matrix is presented as Figure 1. Consistent with Cost Engineering MCX/TCX guidance for CSRA, only the moderate and high level risks are included in quantitative analysis. Low-level risks are not included, but remain within the risk register to document PDT discussions as well as support follow-on risk studies.

Figure 1- Risk Matrix Used by the PDT

Risk Matrix					
		Impact or Consequence of Occurrence			
		Negligible	Marginal	Significant	Critical	Crisis
Likelihood of Occurrence	Certain	Moderate	Moderate	High	High	High
	Very Likely	Low	Moderate	High	High	High
	Likely	Low	Moderate	High	High	High
	Unlikely	Low	Low	Moderate	Moderate	High
	Very Unlikely	Low	Low	Low	Low	Moderate

5.2 Quantitative Analysis of Project Risks

The quantitative impacts of project risks on cost and schedule objectives were analyzed using a combination of professional judgment, empirical data and analytical techniques. Similar to the identification and qualitative analysis process, quantitative analysis involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines.

5.3 Analysis of Contingency

Contingency was analyzed using the Oracle Crystal Ball software application. *Monte Carlo* analysis was performed by applying the project risks (quantified as probability density functions) to the appropriate Work Breakdown Structure (WBS) elements identified in the risk register. Contingency was calculated by applying only the moderate and high level risks identified through qualitative risk analysis. Low-level risks were not considered, but remain within the risk register to document PDT discussions as well as support follow-on risk studies.

For the NED plan cost estimate, cost risk contingency was calculated as the difference between the cost forecast at various confidence level intervals and the base cost estimate (excluding escalation). For the NED plan schedule, schedule contingency was calculated as the difference between the duration forecast at various confidence level intervals and the base schedule duration. The duration contingency was then used to calculate the cost impact of schedule delays (*i.e.*, escalation risk) that are included in the presentation of total cost contingency in Section 7.4.

6. Key Assumptions and Limitations

Key assumptions and limitations are those that are most likely to significantly affect the determinations of contingency presented in the CSRA. The key assumptions and limitations are important to help ensure that project leadership and other decision makers understand the steps, logic, and decisions made in the risk analysis, as well as any resultant implications on the use of outcomes and results.

Section 6.1 identifies key assumptions and limitations for the CSRA development process. Section 6.2 identifies key assumptions and limitations of the project cost estimate and schedule within the context of CSRA development.

6.1 CSRA Process

The following list identifies the key risk analysis assumptions and limitations within the context of the Port Everglades Harbor CSRA. For each item, the context is first provided and then followed by the key assumption or limitation.

1. Unknown Decisions or Decision Makers: The CSRA was prepared using a framework to identify cost and schedule risks with a resulting recommendation for contingencies at the 80 percent confidence level. The framework may generate results that are appropriate for use by a wide variety of decision makers or stakeholders; however, the assumed use CSRA result is to provide a contingency recommendation. Other uses by unknown decision makers may not be appropriate.

2. Dynamic Risks: Project risks are dynamic, not static, and should be evaluated regularly through all phases of the project. The CSRA is based on the identification and assessment of risks as of the date of this report. Reduced utility of current CSRA results should be assumed if the likelihood and impact of risks change over time.

3. Causal Relationships: With the exception of risks identified as correlated in the risk register, it is assumed that the impacts of risks are independent and that the realization of one risk does not cause the realization of another. Significant variance of the risk model results from actual project costs and schedules may be experienced if significant causal relationships exist between risks assumed to be independent.

4. Conservation of Market Pricing Risk: The CSRA assumes that market pricing risks are not created or destroyed but can only be transferred or shared at a price as a result of various contract acquisition strategies. As an example, it is assumed that a contractor will add a level of contingency to a fixed price bid, relative to a cost reimbursable bid, that is reflective of the risk transferred contractually from the Government to the contractor. Other aspects of contract acquisition strategies not related to market pricing, such as the management cost of modifications or claims, are not included in this assumption. Any contract acquisition strategy that actually transfers market pricing risk to a contractor at no cost to the Government is not reflected in the CSRA.

5. Unknown Unknown and Unknowable Risks: The CSRA process focuses on Known Known and Known Unknown risks and is not intended to quantify the impacts of Unknown Unknown or Unknowable risks. Significant variance of the risk analysis results from actual project costs may be experienced if Unknown Unknown or Unknowable risks are experienced. The following definitions of these project risk categories may be useful for understanding this limitation:

- A risk is a Known Known if it can be identified and there is no uncertainty in regard to its likelihood and impact.
- A risk is a Known Unknown if it can be identified but there is uncertainty in regard to its likelihood, impact or both.
- A risk is an Unknown Unknown if it can be identified; there is uncertainty in regard to its likelihood, impact or both; but the project team did not conceive of the risk during the risk identification process.
- A risk is Unknowable if the existence of the risk is not predictable.

6. Variance-Based Sensitivity Analysis: The Oracle Crystal Ball software uses a statistical measure (contribution to variance) that approximates the importance of each risk contributing to variability of cost outcomes during *Monte Carlo* simulation. In variance-based sensitivity analysis, expectation values have to be evaluated to generate a global sensitivity measure. Because expectation values are means (probability-weighted averages), using the importance measures to calculate the contingency associated with a risk at any given confidence level would generally not be meaningful. Variance-based sensitivity analysis may provide misleading results for correlated risks.

6.2 Cost Estimate and Schedule

The following list identifies key assumptions and limitations of the project cost estimate and schedule within the context of CSRA development.

1. Acquisition Strategy: The cost estimate is based on a single, five-year prime contract with a large business dredging contractor. It is anticipated that the prime contractor will subcontract non-dredging work including bulkhead construction, mitigation construction work and environmental monitoring. The single, five-year contract assumption may be impacted by funding stream limitations. Unanticipated funding stream impacts may result in contractor claims, multiple contracts or multiple mobilizations.

2. Funding: Future Federal funding levels are uncertain. Incremental funding is anticipated. Funding levels less than required to support the project schedule may result in additional years of work.

3. Level of Design Development: Current design level is appropriate for feasibility level; however, designs will be refined during the PED phase. Refinement is likely to impact costs and may impact schedule assumptions.

4. Escalation: No escalation is applied in the MII cost estimate. Contractors are likely to include contingency in their bids to cover potential cost escalation and escalation risk over the five year contract period.

5. Environmental Concerns and Permitting: Specific environmental impacts and appropriate mitigation will be more precisely identified during the PED phase. Turbidity monitoring and Endangered Species Observer costs are currently included in the estimate. Permits may be untimely. Legal challenges may occur during National Environmental Policy Act (NEPA) coordination and permit authorizations. Administrative challenge to Water Quality Certification (WQC) certification/permit is likely.

6. Real Estate: No real estate acquisition planned.

7. Equipment and Labor Availability/Bidding Climate: Cost estimate assumptions for equipment and labor availability are typical for construction dredging projects. The relatively large contract size/duration may limit the field of capable bidders and increase the uncertainty of future costs. Joint ventures may be necessary due to the size of the contract. Schedule for this project could overlap with competing dredging projects which are preparing for New Panamax class ships.

7. Results

The results of the CSRA for the Port Everglades Harbor deepening are provided in the following sections. The CSRA process involves developing a risk register and then performing independent cost estimate and schedule risk analyses which are combined to capture the cost impact of schedule delays. The risk register is described in Section 7.1; cost estimate risk analysis is described in Section 7.2; schedule risk analysis are described in Section 7.3; and combined cost and schedule risk analysis is described in Section 7.4. In addition to cost estimate and schedule risk analysis results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

7.1 Risk Registers

A risk register is a tool commonly used in project risk management. The risk register developed for the NED plan and LPP are included as Appendix B. The risk registers presented in Appendix B are the result of a two-step development process. The initial step was development of the initial risk registers by the PDT during the Identify and Qualitatively Analyze Project Risks process described in Section 5.1. The second step of risk register development was the refinement of the initial risk registers based on the results of the Quantitative Analysis of Project Risks process described in Section 5.2. The refined risk registers presented in Appendix B are considered final for the CSRA and should serve as the basis of future project risk management activities. Table 2 provides a summary of the risk register for the NED plan.

Table 2- Risk Register Summary

Risk Register Summary	NED	LPP
Total Number of Individual Risks	48	48
Number of Moderate and High Level Cost Risks	20	20
Number of Moderate and High Level Schedule Risks	8	8

7.2 Cost Risk Analysis

The results of the cost risk analysis for the NED plan and LPP are provided in the following subsections. Note that the combined cost and schedule risk analyses are provided in Section 7.4. The cost risk analyses provided in this section do not include the cost impact of schedule delays.

In addition to risk analysis results, a sensitivity analysis is provided for each plan's cost and schedule risk analysis. Sensitivity analysis is important because it serves to rank the relative importance of each risk in regard to its contribution to project contingency. Key cost and schedule risk drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of project risks and their potential impacts throughout the project lifecycle.

The risks considered as key or primary cost drivers are ranked in order of importance in sensitivity analysis bar charts. A longer bar in the sensitivity analysis chart represents a greater potential impact to total project cost.

7.2.1 NED Cost Risk Analysis

Table 3 provides the cost contingencies for the NED plan calculated at various confidence level intervals. Cost contingency was quantified as approximately $67.1 million at the 80 percent confidence level, which is about 23.8% of the base cost estimate of approximately $281.9 million.

Table 3- NED Cost Risk Analysis

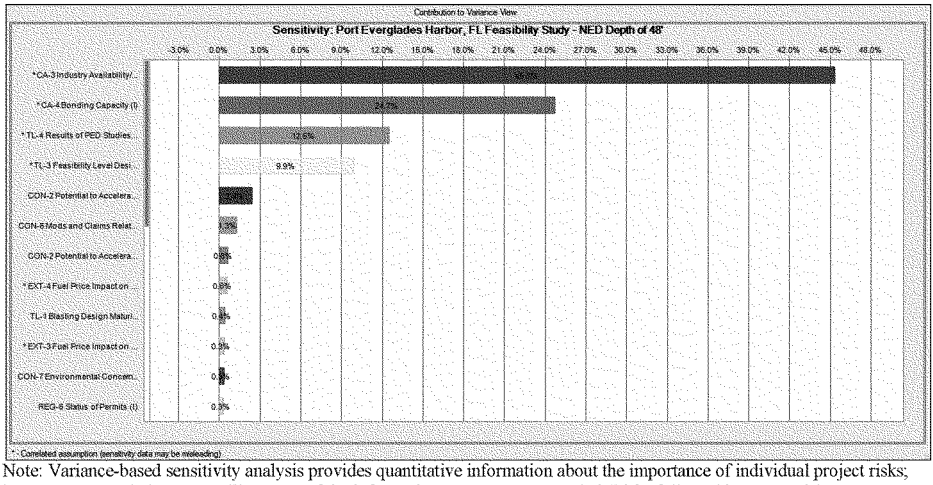
Confidence Level (%)	Base Cost Estimate[1] + Contingency	Contingency[2] ($)	Contingency (%)
0	$258,223,810	($23,686,993)	-8.4%
5	$281,201,871	($708,932)	-0.3%
10	$289,894,490	$7,983,687	2.8%
15	$295,699,046	$13,788,243	4.9%
20	$301,171,431	$19,260,628	6.8%
25	$305,498,960	$23,588,157	8.4%
30	$308,591,829	$26,681,026	9.5%
35	$313,329,588	$31,418,784	11.1%
40	$316,529,970	$34,619,166	12.3%
45	$319,444,396	$37,533,593	13.3%
50	$322,886,207	$40,975,404	14.5%
55	$326,439,274	$44,528,471	15.8%
60	$330,184,377	$48,273,574	17.1%
65	$333,292,919	$51,382,116	18.2%
70	$337,948,831	$56,038,027	19.9%
75	$342,018,118	$60,107,315	21.3%
80	**$349,056,473**	**$67,145,670**	**23.8%**
85	$355,633,664	$73,722,861	26.2%
90	$363,815,524	$81,904,720	29.1%
95	$379,486,715	$97,575,911	34.6%
100	$443,237,613	$161,326,810	57.2%

Notes: 1. The NED Plan base cost estimate is $ $281,910,803.

2. Negative contingencies indicate cost or schedule outcomes that are less than the base (deterministic) cost estimate or schedule.

Figure 2 presents a sensitivity analysis that includes the moderate and high level cost risks identified in the risk register for the NED Plan.

Figure 2- NED Plan Cost Risk Sensitivity Analysis



Note: Variance-based sensitivity analysis provides quantitative information about the importance of individual project risks; however, extrapolations or ancillary uses of the information are not recommended. Risks followed by an asterisk are correlated with one or more other project risks.
All risks contributing at least 0.1% of variance are included in the figure.

The primary threats to the NED Plan cost estimate identified through sensitivity analysis are as follows:

Industry Availability/Bidding Climate: The relatively large contract size may limit field of interested bidders and increase the uncertainty of future costs. Joint ventures may be necessary due to the size of the contract. Schedule for this project could overlap with competing dredging projects which are preparing for New Panamax class ships.

Bonding Capacity: Competition may be limited due to bonding capacity issues. Joint ventures (JV's) will likely be necessary due to the size of the anticipated contract. Several market participants have existing JV agreements. Bonding capacity is also impacted by the number of dredging projects being performed in the same time frame.

Results of PED Studies Impact Costs: Further studies will be performed during the Planning Engineering and Design (PED) phase. The results of these studies could impact the cost estimate. Future geotechnical and environmental surveys have the greatest potential for impacts. New sea grass and coral surveys will be completed.

7.2.2 LPP Cost Risk Analysis

Table 4 provides the cost contingencies for the LPP calculated at various confidence level intervals. Cost contingency was quantified as approximately $70.7 million at the 80 percent confidence level, which is about 23.9% of the base cost estimate of approximately $296.1 million.

Table 4- LPP Cost Risk Analysis

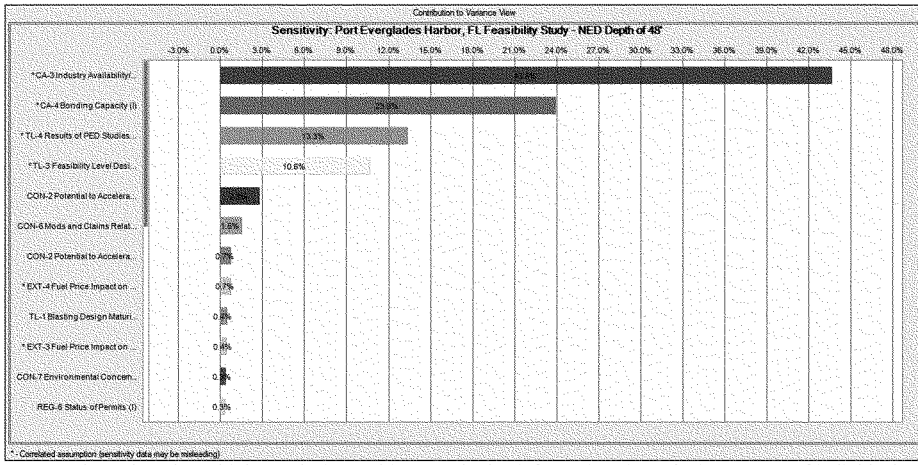
Confidence Level (%)	Base Cost Estimate[1] + Contingency	Contingency[2] ($)	Contingency (%)
0	$273,550,682	($22,613,749)	-7.6%
5	$297,628,747	$1,464,315	0.5%
10	$306,105,232	$9,940,801	3.4%
15	$312,594,777	$16,430,345	5.5%
20	$317,813,582	$21,649,151	7.3%
25	$322,163,457	$25,999,025	8.8%
30	$326,019,433	$29,855,002	10.1%
35	$330,310,024	$34,145,593	11.5%
40	$334,060,536	$37,896,105	12.8%
45	$336,869,530	$40,705,098	13.7%
50	$340,493,258	$44,328,827	15.0%
55	$344,434,379	$48,269,948	16.3%
60	$347,981,795	$51,817,364	17.5%
65	$351,048,457	$54,884,026	18.5%
70	$355,391,418	$59,226,986	20.0%
75	$359,709,690	$63,545,258	21.5%
80	**$366,876,027**	**$70,711,596**	**23.9%**
85	$373,112,050	$76,947,619	26.0%
90	$381,802,399	$85,637,968	28.9%
95	$397,207,784	$101,043,353	34.1%
100	$462,528,162	$166,363,730	56.2%

Notes: 1. The NED Plan base cost estimate is $296,164,431.

2. Negative contingencies indicate cost or schedule outcomes that are less than the base (deterministic) cost estimate or schedule.

Figure 3 presents a sensitivity analysis that includes the moderate and high level cost risks identified in the risk register for the LPP.

Figure 3- LPP Cost Risk Sensitivity Analysis



Note: Variance-based sensitivity analysis provides quantitative information about the importance of individual project risks; however, extrapolations or ancillary uses of the information are not recommended. Risks followed by an asterisk are correlated with one or more other project risks. All risks contributing at least 0.1% of variance are included in the figure.

The primary threats to the LPP cost estimate identified through sensitivity analysis are as follows:

Industry Availability/Bidding Climate: The relatively large contract size may limit field of interested bidders and increase the uncertainty of future costs. Joint ventures may be necessary due to the size of the contract. Schedule for this project could overlap with competing dredging projects which are preparing for New Panamax class ships.

Bonding Capacity: Competition may be limited due to bonding capacity issues. Joint ventures (JV's) will likely be necessary due to the size of the anticipated contract. Several market participants have existing JV agreements. Bonding capacity is also impacted by the number of dredging projects being performed in the same time frame.

Results of PED Studies Impact Costs: Further studies will be performed during the Planning Engineering and Design (PED) phase. The results of these studies could impact the cost estimate. Future geotechnical and environmental surveys have the greatest potential for impacts. New sea grass and coral surveys will be completed.

7.3 Schedule Risk Analysis

The results of the schedule risk analysis for the NED plan and LPP are provided in the following subsections. In addition to risk analysis results, a sensitivity analysis is provided for each plan.

7.3.1 NED Plan Schedule Risk Analysis

Table 5 provides the schedule duration contingencies for the NED plan calculated at various confidence level intervals. Schedule duration contingency was quantified as about 32.1 months at the 80 percent confidence level (about 38.2% of the baseline schedule duration of approximately 84 months).

Table 5- NED Plan Schedule Risk Analysis

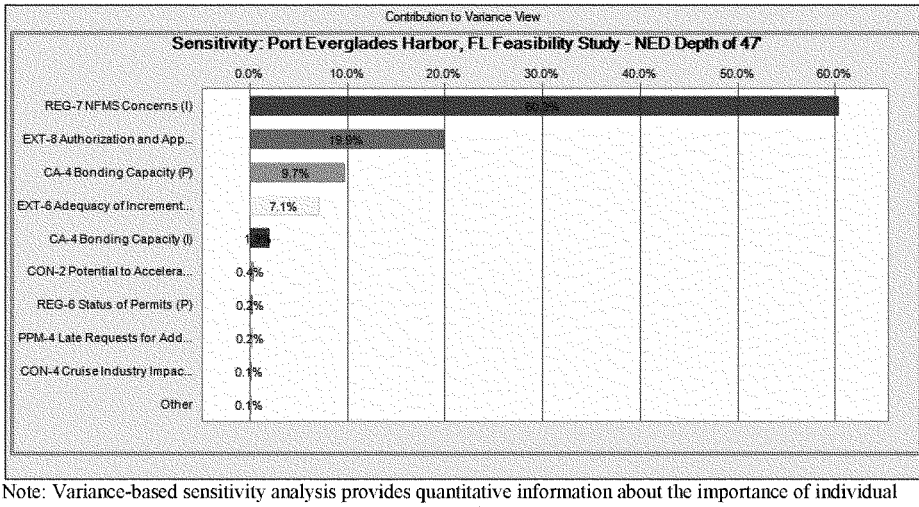
Confidence Level (%)	Duration[1] + Contingency (months)	Contingency (months)	Contingency (%
0	100.3	16.3	19.4%
5	104.2	20.2	24.1%
10	105.7	21.7	25.8%
15	106.8	22.8	27.1%
20	107.5	23.5	28.0%
25	108.3	24.3	28.9%
30	109.0	25.0	29.8%
35	109.7	25.7	30.7%
40	110.4	26.4	31.5%
45	111.1	27.1	32.2%
50	111.7	27.7	33.0%
55	112.3	28.3	33.7%
60	112.9	28.9	34.4%
65	113.6	29.6	35.2%
70	114.3	30.3	36.0%
75	115.1	31.1	37.0%
80	**116.1**	**32.1**	**38.2%**
85	117.1	33.1	39.5%
90	118.6	34.6	41.2%
95	120.1	36.1	43.0%
100	124.6	40.6	48.3%

Note:

1. The base NED Plan schedule duration is approximately 84 months.

Figure 4 presents a sensitivity analysis that includes the moderate and high level schedule risks identified in the risk register for the NED plan.

Figure 4- NED Plan Schedule Risk Sensitivity Analysis



Note: Variance-based sensitivity analysis provides quantitative information about the importance of individual project risks; however, extrapolations or ancillary uses of the information are not recommended.

The primary threats to the NED Plan schedule identified through sensitivity analysis are as follows:

NFMS Concerns: The state and federal regulatory agencies have given the EIS favorable reviews with the exception of NMFS. Possibility exists that NMFS will elevate their concerns.

Authorization and Appropriation: Future Federal funding levels are uncertain. Incremental funding is anticipated. Funding levels less than required to support the project schedule may result in additional years of work.

Bonding Capacity: Competition may be limited due to bonding capacity issues.

Adequacy of Incremental Funding: Actual project funding may not be sufficient to achieve schedule.

7.3.2 LPP Plan Schedule Risk Analysis

Table 6 provides the schedule duration contingencies for the NED plan calculated at various confidence level intervals. Schedule duration contingency was quantified as about 32.1 months at the 80 percent confidence level (about 38.2% of the baseline schedule duration of approximately 84 months).

Table 6- LPP Plan Schedule Risk Analysis

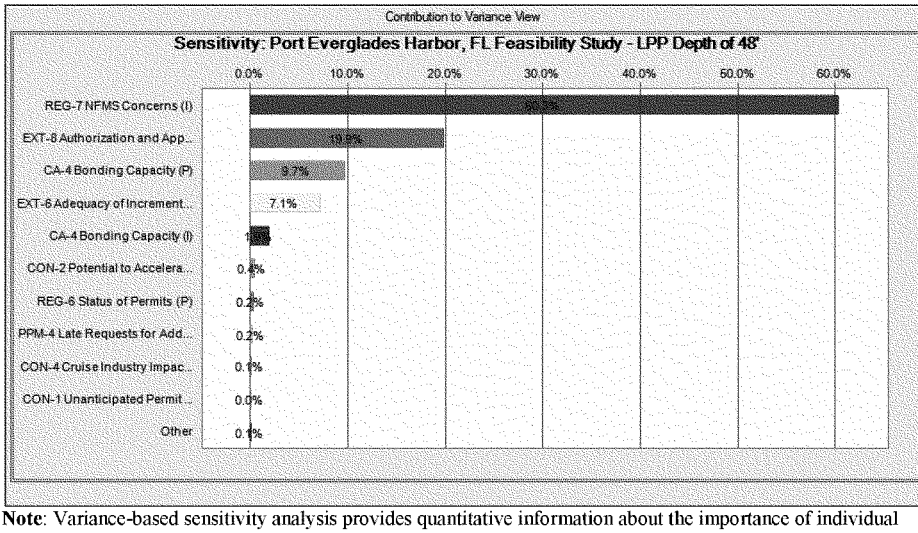
Confidence Level (%)	Duration[1] + Contingency (months)	Contingency (months)	Contingency (%)
0	100.3	16.3	19.4%
5	104.2	20.2	24.1%
10	105.7	21.7	25.8%
15	106.8	22.8	27.1%
20	107.5	23.5	28.0%
25	108.3	24.3	28.9%
30	109.0	25.0	29.8%
35	109.7	25.7	30.7%
40	110.4	26.4	31.5%
45	111.1	27.1	32.2%
50	111.7	27.7	33.0%
55	112.3	28.3	33.7%
60	112.9	28.9	34.4%
65	113.6	29.6	35.2%
70	114.3	30.3	36.0%
75	115.1	31.1	37.0%
80	**116.1**	**32.1**	**38.2%**
85	117.1	33.1	39.5%
90	118.6	34.6	41.2%
95	120.1	36.1	43.0%
100	124.6	40.6	48.3%

Note:

1. The base LPP Plan schedule duration is approximately 84 months.

Figure 5 presents a sensitivity analysis that includes the moderate and high level schedule risks identified in the risk register for the LPP plan.

Figure 5- LPP Plan Schedule Risk Sensitivity Analysis



Note: Variance-based sensitivity analysis provides quantitative information about the importance of individual project risks; however, extrapolations or ancillary uses of the information are not recommended.

The primary threats to the NED Plan schedule identified through sensitivity analysis are as follows:

NFMS Concerns: The state and federal regulatory agencies have given the EIS favorable reviews with the exception of NMFS. Possibility exists that NMFS will elevate their concerns.

Authorization and Appropriation: Future Federal funding levels are uncertain. Incremental funding is anticipated. Funding levels less than required to support the project schedule may result in additional years of work.

Bonding Capacity: Competition may be limited due to bonding capacity issues.

Adequacy of Incremental Funding: Actual project funding may not be sufficient to achieve schedule.

7.4 Combined Cost and Schedule Risk Analysis

The results of the combined cost and schedule risk analysis for the NED plan and LPP are provided in the following subsections. The results provided in this section include the cost impact of schedule delays (*i.e.*, escalation risk).

7.4.1 NED Plan CSRA

Table 7 provides the cost contingencies for the NED plan calculated at various confidence level intervals. Contingency was quantified as approximately $74.1 million at the 80 percent confidence level, which is about 26.3% of the base cost estimate of approximately $281.9 million. The values presented in Table 7 are presented in graphic format in Figure 6.

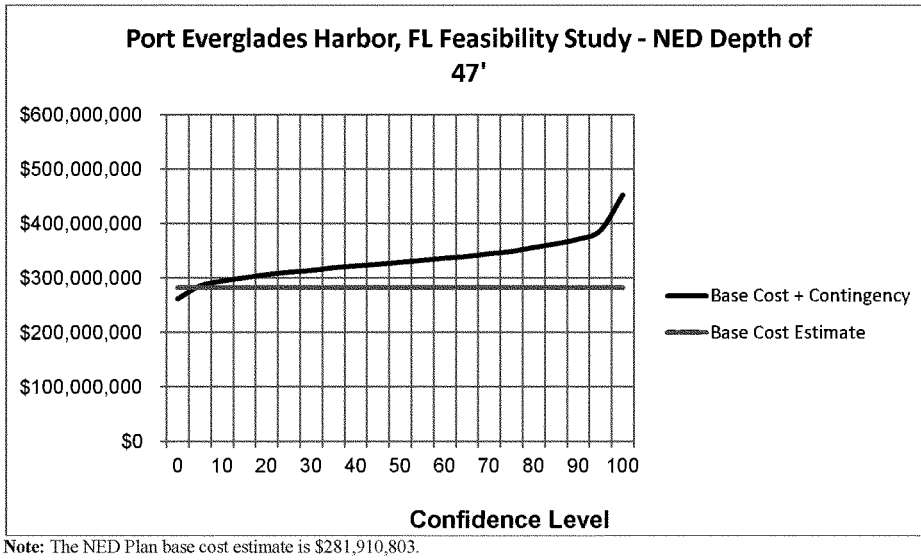
Table 7- NED Plan CSRA

Confidence Level (%)	Base Cost Estimate[1] + Contingency	Contingency[2] ($)	Contingency (%)
0	$261,740,000	($20,171,000)	-7.2%
5	$285,566,000	$3,655,000	1.3%
10	$294,569,000	$12,658,000	4.5%
15	$300,613,000	$18,702,000	6.6%
20	$306,256,000	$24,345,000	8.6%
25	$310,744,000	$28,833,000	10.2%
30	$313,997,000	$32,086,000	11.4%
35	$318,895,000	$36,984,000	13.1%
40	$322,246,000	$40,335,000	14.3%
45	$325,301,000	$43,390,000	15.4%
50	$328,883,000	$46,972,000	16.7%
55	$332,567,000	$50,656,000	18.0%
60	$336,443,000	$54,532,000	19.3%
65	$339,702,000	$57,791,000	20.5%
70	$344,499,000	$62,588,000	22.2%
75	$348,749,000	$66,838,000	23.7%
80	**$356,009,000**	**$74,098,000**	**26.3%**
85	$362,818,000	$80,907,000	28.7%
90	$371,323,000	$89,412,000	31.7%
95	$387,327,000	$105,416,000	37.4%
100	$452,059,000	$170,148,000	60.4%

Notes:

1. The NED Plan base cost estimate is $281,910,803.
2. Negative contingencies indicate cost or schedule outcomes that are less than the base (deterministic) cost estimate or schedule.

Figure 6- NED Plan CSRA



Note: The NED Plan base cost estimate is $281,910,803.

7.4.2 LPP CSRA

Table 8 provides the cost contingencies for the LPP calculated at various confidence level intervals. Contingency was quantified as approximately $78.0 million at the 80 percent confidence level, which is about 26.3% of the base cost estimate of approximately $296.3 million. The values presented in Table 8 are presented in graphic format in Figure 7.

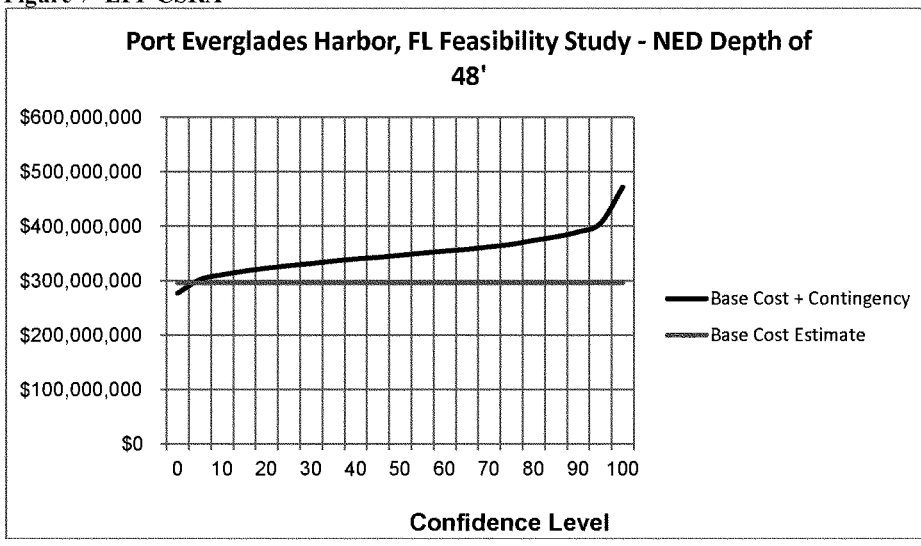
Table 8- LPP CSRA

Confidence Level (%)	Base Cost Estimate[1] + Contingency	Contingency[2] ($)	Contingency (%)
0	$277,245,000	($18,919,000)	-6.4%
5	$302,214,000	$6,050,000	2.0%
10	$311,016,000	$14,852,000	5.0%
15	$317,758,000	$21,594,000	7.3%
20	$323,155,000	$26,991,000	9.1%
25	$327,673,000	$31,509,000	10.6%
30	$331,698,000	$35,534,000	12.0%
35	$336,157,000	$39,993,000	13.5%
40	$340,066,000	$43,902,000	14.8%
45	$343,022,000	$46,858,000	15.8%
50	$346,794,000	$50,630,000	17.1%
55	$350,872,000	$54,708,000	18.5%
60	$354,557,000	$58,393,000	19.7%
65	$357,782,000	$61,618,000	20.8%
70	$362,273,000	$66,109,000	22.3%
75	$366,781,000	$70,617,000	23.8%
80	**$374,180,000**	**$78,016,000**	**26.3%**
85	$380,660,000	$84,496,000	28.5%
90	$389,689,000	$93,525,000	31.6%
95	$405,445,000	$109,281,000	36.9%
100	$471,796,000	$175,632,000	59.3%

Notes:

1. The LPP base cost estimate is $296,264,431.
2. Negative contingencies indicate cost or schedule outcomes that are less than the base (deterministic) cost estimate or schedule.

Figure 7- LPP CSRA



Note: The LPP base cost estimate is $296,264,431.

APPENDIX A
Cost Estimates and Schedules

Port Everglades Harbor, FL Feasibility Study - NED Depth of 47'	$291,810,000.00
Construction Costs	$207,906,436.17
Navigation Ports & Harbors	$207,906,436.17
Outer Entrance Channel - 54'	$40,856,934.94
Inner Entrance Channel - 47'	$8,109,512.10
Main Turning Basins - 47'	$40,303,265.60
Widener - 47'	$21,788,565.52
Southport Access Channel - 47'	$108,690,511.64
Turning Notch - 47'	$33,236,333.09
Non-Construction Costs	$24,826,827.30
Acquisition	$0.00
Cadastral, Utilities, & Structure	$0.00
Utilities	$0.00
FPL Utility Relocation Cost (Southport Access Channel)	$0.00
Fish and Wildlife Facilities	$12,897,054.20
Wildlife Facilities & Sanctuary	$12,897,054.20
Habitat and Feeding Facilities	$12,897,054.20
Post Construction Mitigation Monitoring and Coral Propagation	$12,897,054.20
Planning, Engineering and Design	$4,453,000.00
PED	$4,453,000.00
Cost Estimates	$4,453,000.00
Planning, Engineering & Design Cost Estimate	$4,453,000.00
Construction Management	$8,874,823.00
Construction Contracts	$8,874,823.00
Construction Contracts	$8,874,823.00
Construction Management	$8,874,823.00

47' PROJECT

ID		Task Name	Duration	Start	Finish
1		**STUDY PHASE**	**714 days**	**Thu 4/26/13**	**Thu 4/8/16**
2		Complete scoping modeling, NED determination, BCR analysis (DQC's)	21 days	Thu 4/26/13	Wed 5/22/13
3		TSP MS Read Ahead Materials to SAD/HQ & Legal Reviewer	20 days	Thu 4/25/13	Fri 5/24/13
4		TSP MS Meeting and Approval	0 days	Fri 5/31/13	Fri 5/31/13
5		Complete Econ Appr, revised Feas Rpt, DQC and Legal Review	14 days	Fri 5/31/13	Fri 6/14/13
6		DEIS submittal to EPA	13 days	Fri 6/14/13	Thu 6/27/13
7		EPA Publishes Notice of Availability in Fed Register	0 days	Fri 6/28/13	Fri 6/28/13
8		Public Review (NEPA)	46 days	Fri 6/28/13	Tue 8/13/13
9		Public/Focus group meeting	2 days	Tue 7/23/13	Thu 7/25/13
10		ATR Review	30 days	Wed 6/19/13	Wed 7/17/13
11		IEPR Review (including final report panel review)	86 days	Wed 6/19/13	Mon 9/16/13
12		VE Study	21 days	Fri 6/21/13	Fri 7/19/13
13		SAD/HQ Review	40 days	Fri 6/28/13	Fri 8/9/13
14		CZMA consistency determination (MS)	300 days	Fri 6/28/13	Fri 8/12/14
15		Address public, ATR, IEPR, SAD/HQ, CZMA comments, Cost certification	67 days	Fri 7/5/13	Tue 9/10/13
16		Mitigation impact analysis and plan information	95 days	Fri 8/30/13	Tue 1/28/14
17		MFS prepare designer/owner	58 days	Wed 12/4/13	Thu 3/27/14
18		MFS clarification interim: BCR, costs and scope updates	52 days	Mon 3/10/14	Thu 5/1/14
19		NED plan policy determination	79 days	Tue 5/13/14	Thu 7/5/14
20		Prepare REVISED Draft Feas and EIS	421 days	Thu 7/18/13	Fri 3/13/14
21		REVISED Draft report DQC/Legal Reviews	30 days	Tue 9/3/14	Fri 9/12/14
22		REVISED Draft Feas and EIS, Cost Cert, ATR, IEPR, SAD QA, HQ policy compliance	21 days	Mon 9/15/14	Mon 10/6/14
23		***ATR certification/IEPR final report***	0 days	Mon 10/6/14	**Mon 10/6/14**
24		Final Draft Feas and EIS	5 days	Mon 10/6/14	Sat 10/11/14
25		Final Draft report DQC/Legal Reviews	5 days	Sun 10/12/14	Fri 10/17/14
26		Report Reproduction & Assembly	5 days	Tue 10/21/14	Sun 10/26/14
27		District transmits signed report to SAD	5 days	Mon 10/27/14	Sat 11/1/14
28		Division Engineer transmittal memo (MS)	5 days	Sun 11/2/14	Fri 11/7/14
29		***HQ Final Review/Chief's Report Development/CWRB Prep***	36 days	Mon 11/10/14	**Tue 12/16/14**
30		CWRB/CG-CEO decision to develop final report (MS)	0 days	Wed 12/17/14	Wed 12/17/14
31		SLA Review, Interested Party, & EIS filing letters signed and sent to District	14 days	Thu 12/18/14	Thu 1/1/15
32		District sends letters/reports to Stakeagencies & filed EIS	7 days	Fri 1/2/15	Fri 1/9/15
33		Notice of availability appears in Federal Register	0 days	Fri 1/16/15	Fri 1/16/15
34		Final NEPA, SEA Review Period (30 days)	30 days	Fri 1/16/15	Sun 2/15/15
35		District provides draft responses to significant NEPA, SEA review comments	14 days	Mon 2/16/15	Mon 3/2/15
36		Final NEPA, SEA response letters mailed (SAD/HQ)	7 days	Tue 3/3/15	Tue 3/10/15
37		Documentation of Review Findings	62 days	Wed 12/17/14	Mon 3/9/15
38		Routing Final Report at HQ	14 days	Tue 3/10/15	Tue 3/24/15
39		Review by Office of the Chief	14 days	Wed 3/25/15	Wed 4/8/15
40		***Signed to Congressional (MS)***	0 days	Thu 4/9/15	Thu 4/9/15
41					
42		**PED PHASE**	**905 days**	**Thu 4/9/15**	**Sat 9/30/17**
43		Design Agreement (DA) Initiated (Once Division Engineer's Transmittal Letter)	0 days	Thu 4/9/15	Thu 4/9/15
44		DA to Local Sponsor (LS)	1 day	Thu 4/9/15	Fri 4/10/15
45		DA Local Sponsor (LS) Concurrence Received	30 days	Fri 4/10/15	Sun 5/10/15
46		DA submitted to SAD	3 days	Sun 5/10/15	Wed 5/13/15
47		DA Approved	30 days	Wed 5/13/15	Fri 6/12/15
48		DA Executed by LS	30 days	Fri 6/12/15	Sun 7/12/15
49		DA Executed USACE	30 days	Sun 7/12/15	Tue 8/11/15
50		Receive Superior Funding & FEDERAL FUNDING	14 days	Thu 8/11/15	Thu 10/1/15
51		PED Complete PED Investigation (After Sponsor Contribution)	210 days	Thu 10/1/15	Thu 4/28/16
52		PED Complete WQC	120 days	Mon 2/1/16	Tue 5/31/16
53		PED Complete PPA	185 days	Tue 3/15/16	Sat 9/30/17
54					
55		**CONSTRUCTION PHASE START**	**309 days**	**Thu 4/9/15**	**Fri 2/12/16**
56		Project Cooperation Agreement (PCA) Initiated (Once Authorized & WQC)	1 day	Thu 4/9/15	Fri 4/10/15
57		PCA transmitted to Local Sponsor (LS)	2 days	Fri 4/10/15	Sun 4/12/15
58		PCA LS Concurrence Received	90 days	Sun 4/12/15	Sat 7/11/15
59		PCA submitted to HQ (once WQC received)	21 days	Sat 7/11/15	Sat 8/1/15
60		PCA Approved by ASA(CW)	90 days	Sat 8/1/15	Fri 10/30/15
61		PCA Executed by LS	90 days	Fri 10/30/15	Tue 12/29/15
62		PCA Executed by USACE	14 days	Tue 12/29/15	Tue 1/12/16
63		Receive Sponsor Contribution	30 days	Tue 1/12/16	Thu 2/11/16
64		Advertise (Contingent upon funding)	1 day	Thu 2/11/16	Fri 2/12/16
65					
66		**CONSTRUCTION PHASE - 47' PROJECT**	**1639 days**	**Sat 9/30/17**	**Sun 9/27/22**
67		Open Bids	30 days	Sat 9/30/17	Mon 10/30/17
68		Award	30 days	Mon 10/30/17	Wed 11/29/17
69		NTP	30 days	Wed 11/29/17	Fri 12/29/17
70		Mobilization	30 days	Fri 12/29/17	Sun 1/28/18
71		Work Blasting	100 days	Sun 1/28/18	Thu 5/9/18
72		OBC Dredging	268 days	Mon 2/12/18	Tue 12/4/18
73		IBC Dredging	78 days	Tue 12/4/18	Wed 2/20/19
74		WOE Dredging	280 days	Wed 2/20/19	Wed 11/27/19
75		MBF Dredging	219 days	Wed 11/27/19	Fri 7/3/20
76		SBC Dredging	439 days	Fri 7/3/20	Wed 8/15/21
77		TR Dredging	176 days	Wed 8/15/21	Sat 3/12/22
78		Demobilization	15 days	Sat 3/12/22	Sun 3/27/22

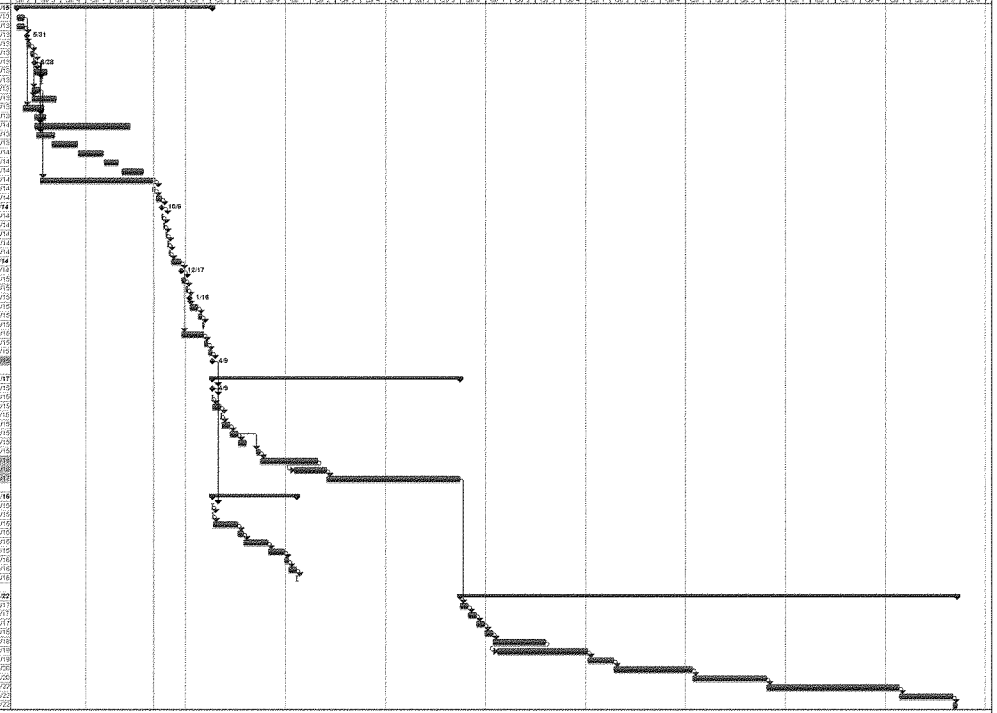
Project: Project Schedule REV 1
Date: Tue 9/30/14

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Port Everglades Harbor, FL Feasibility Study - LPP Depth of 48'	**$296,194,431.35**
Construction Costs	**$271,308,863.04**
Navigation Paths & Harbors	**$271,308,863.04**
Outer Entrance Channel - 55'	$46,836,488.46
Inner Entrance Channel - 45'	$7,335,599.23
Main Turning Basins - 45'	$48,167,077.61
Widener - 45'	$22,292,556.21
Southport Access Channel - 45'	$112,442,676.52
Turning Notch - 45'	$24,324,360.46
Non Construction Costs	**$24,779,963.04**
Operations	**$0.00**
Operation, Utilities, & Structure	**$0.00**
Utilities	**$0.00**
FPL Utility Relocation Cost (Southport Access Channel)	$0.00
Fish and Wildlife Facilities	**$13,647,540.84**
Wildlife Facilities & Secondary	**$13,647,540.84**
Habitat and Feeding Facilities	**$13,647,540.84**
Post Construction Mitigation Monitoring and Coral Propagation	$13,647,540.84
Planning, Engineering and Design	**$4,453,000.00**
PED	**$4,453,000.00**
Cost Estimates	**$4,453,000.00**
Planning, Engineering & Design Cost Estimate	$4,453,000.00
Construction Management	**$6,674,023.00**
Construction Contracts	**$6,674,023.00**
Construction Contracts	**$6,674,023.00**
Construction Management	$6,674,023.00

48' PROJECT

ID		Task Name	Duration	Start	Finish
1		**STUDY PHASE**	**714 days**	**Thu 4/25/13**	**Thu 4/5/16**
2	24	Complete econ modeling, NED determination, BCR analysis (DDC'd	27 days	Thu 4/25/13	Wed 5/29/13
3	24	TSP MS Read Ahead Materials at SAD/HQ & Legal Review	29 days	Thu 4/25/13	Fri 5/24/13
4		TSP MS Meeting and Approval	0 days	Fri 5/31/13	Fri 5/31/13
5		Complete Econ Appr, revised Feas Rpt, DDC and Legal Review	14 days	Fri 5/31/13	Fri 6/14/13
6		DEIS submitted to EPA	10 days	Fri 8/14/13	Thu 8/27/13
7		EPA Publishes notice of Availability in Fed Register	0 days	Fri 8/28/13	Fri 8/28/13
8		Public Review (NEPA)	40 days	Fri 8/28/13	Tue 9/17/13
9		Public/Focus group meeting	2 days	Tue 7/23/13	Thu 7/25/13
10		ATR Review	20 days	Wed 8/19/13	Wed 7/17/13
11		IEPR Review (including final report back/redraw)	90 days	Wed 8/19/13	Mon 9/16/13
12		VE Study	21 days	Fri 8/17/13	Fri 8/23/13
13		SAD/HQ Review	42 days	Fri 6/28/13	Fri 8/4/13
14		CZMA Concurrency determination (MS)	350 days	Fri 6/28/13	Fri 6/13/14
15		Address public, ATR, IEPR, SAD/HQ, CZMA comments, Cost certification	67 days	Fri 7/5/13	Tue 9/10/13
16	14	Mitigation impact analysis and plan reformulation	35 days	Fri 9/20/13	Tue 12/3/13
17	14	NMFS prepare Biological Opinion	90 days	Wed 10/4/13	Fri 3/7/14
18	14	NMFS construction letter re: BCR, costs and econ updates	32 days	Mon 3/10/14	Thu 5/1/14
19	14	NED plan policy determination	70 days	Tue 5/13/14	Thu 7/31/14
20		Prepare REVISED Draft Feas and EIS	421 days	Thu 7/10/13	Fri 9/12/14
21		REVISED draft report DDC/Legal Reviews	10 days	Tue 9/2/14	Fri 9/12/14
22	24	REVISED Draft Feas and EIS, Cost Cert, ATR, IEPR, SAD/OACHQ policy compliance	21 days	Mon 9/15/14	Mon 10/6/14
23		***ATR certification/IEPR final report***	0 days	Mon 10/6/14	***Mon 10/6/14***
24		Final Draft Feas and EIS	5 days	Mon 10/6/14	Sat 10/11/14
25		Final Draft report DDC/Legal Review	3 days	Sun 10/12/14	Fri 10/17/14
26		Report Reproduction & Assembly	5 days	Tue 10/21/14	Sun 10/26/14
27		District transmits signed report to SAD	5 days	Mon 10/27/14	Sat 11/1/14
28		Division Engineer transmits memo (MS)	5 days	Sun 11/2/14	Fri 11/7/14
29		***HQ Final Review/Chief's Report Development/CWRB Prep***	35 days	Mon 11/10/14	***Tue 12/16/14***
30		CWRB/DCG-CEO decision to release final report (MS)	3 days	Wed 12/17/14	Wed 12/17/14
31		SBA Review, Interested Party, & EIS Eng letters signed and sent to District	14 days	Thu 12/18/14	Thu 1/1/15
32		District sends letters/reports to State/agencies & final EIS	7 days	Fri 12/26	Fri 1/9/15
33		Notice of availability appears in Federal Register	0 days	Fri 1/16/15	Fri 1/16/15
34		Final NEPA, SBA Review Period (30 days)	30 days	Fri 1/16/15	Sun 2/15/15
35		District provides draft responses to significant NEPA, SBA review comments	14 days	Mon 2/16/15	Mon 3/2/15
36		Final NEPA, SBA responses letters sent (SAD/HQ)	7 days	Tue 3/3/15	Tue 3/10/15
37		Documentation of Review Findings	82 days	Wed 12/17/14	Mon 3/9/15
38		Revising Final Report at HQ	14 days	Tue 3/10/15	Tue 3/24/15
39		Review by Office of the Chief	14 days	Wed 3/25/15	Wed 4/8/15
40		Signature on Chief's Report (MS)	0 days	Thu 4/9/15	Thu 4/9/15
41					
42		**PED PHASE**	**905 days**	**Thu 4/9/15**	**Sat 9/30/17**
43		Design Agreement (DA) initiated (Once Division Engineer's Transmittal Letter)	0 days	Thu 4/9/15	Thu 4/9/15
44		DA to Local Sponsor (LS)	1 day	Thu 4/9/15	Fri 4/10/15
45		DA Local Sponsor (LS) Concurrence Received	30 days	Fri 4/10/15	Sun 5/10/15
46		DA submitted to SAD	3 days	Sun 5/10/15	Wed 5/13/15
47		DA Approved	30 days	Wed 5/13/15	Fri 6/12/15
48		DA Executed by LS	30 days	Fri 6/12/15	Sun 7/12/15
49		DA Executed USACE	30 days	Sun 7/12/15	Tue 8/11/15
50	49	Receive Sponsor Funding & FEDERAL FUNDING	14 days	Thu 8/13/15	Thu 10/1/15
51		PED complete P&S investigations (after Sponsor Contributions)	120 days	Thu 10/1/15	Thu 4/28/16
52		PED complete WGC	30 days	Mon 2/1/16	Sat 3/2/16
53		PED complete P&S	481 days	Tue 12/1/16	Sat 3/30/17
54					
55		**CONSTRUCTION PHASE START**	**309 days**	**Thu 4/9/15**	**Fri 2/12/16**
56		Project Cooperation Agreement (PCA) initiated (Once Authorized& WGC)	1 day	Thu 4/9/15	Fri 4/10/15
57		PCA transmitted to Local Sponsor (LS)	2 days	Fri 4/10/15	Sun 4/12/15
58		PCA LS Concurrence Received	90 days	Sun 4/12/15	Sat 7/11/15
59		PCA submitted to HQ (once WGC received)	21 days	Sat 7/11/15	Sat 8/1/15
60		PCA approved by ASA(CW)	60 days	Sat 8/1/15	Fri 10/30/15
61		PCA Executed by LS	60 days	Fri 10/30/15	Tue 12/29/15
62		PCA Executed by USACE	14 days	Tue 12/29/15	Tue 1/12/16
63		Receive Sponsor Contributions	30 days	Tue 1/12/16	Thu 2/11/16
64		Advertise (Contingent upon funding)	1 day	Thu 2/11/16	Fri 2/12/16
65					
66		**CONSTRUCTION PHASE 48' PROJECT**	**1816 days**	**Sat 9/30/17**	**Tue 8/30/22**
67		Open Bids	30 days	Sat 9/30/17	Mon 10/30/17
68		Award	30 days	Mon 10/30/17	Wed 11/29/17
69		NTP	30 days	Wed 11/29/17	Fri 12/29/17
70		Mobilization	30 days	Fri 12/29/17	Sun 1/28/18
71		Rock Blasting	193 days	Sun 1/28/18	Thu 8/9/18
72		OEC Dredging	322 days	Mon 3/12/18	Thu 1/10/19
73		IEC Dredging	30 days	Thu 1/10/19	Mon 2/11/19
74		WIDE Dredging	359 days	Mon 4/15/19	Tue 1/29/20
75		MTB Dredging	270 days	Tue 1/29/20	Sat 10/24/20
76		SAC Dredging	495 days	Sat 10/24/20	Mon 3/21/22
77		TN Dredging	196 days	Mon 3/21/22	Mon 9/8/22
78		Demobilization	15 days	Mon 9/5/22	Tue 9/20/22



Project: Project Schedule REV 1
Date: Fri 8/5/14

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Port Everglades Harbor, FL Feasibility Study -NED Depth of 47'

Brief Scope Presentation: The project consists of construction dredging, bulkhead improvements and mitigation costs for the 48' LPP depth which is the Locally Preferred Plan. Dredging will occur in the Outer Entrance Channel, Inner Entrance Channel, Main Turning Basin (MTB), Widener, South Port Access Channel, Turning Notch, and Berths located south of the MTB along the Intercoastal Waterway, Broward County, Florida. The project depth costs include a one foot required and one foot allowable overdepth.

							Project Cost			Project Schedule		
Risk No.	**RBS Level III**	**Feature of Work**	**Risk/Opportunity Event**	**PDT Event Concerns**	**PDT Discussions**	**Responsibility/POC**	**Likelihood**	**Impact**	**Risk Level**	**Likelihood**	**Impact**	**Risk Level**
PPM-1	Project & Program Management	Total Project	Inadequate PDT Staffing Levels	There is a dedicated USACE staff in place for completing the Chief's Report by May 2015. No concerns at this time regarding staffing for PED activities.	Not a concern for FY15. Some concern in out years, subject to future funding levels.	PM	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-2	Project & Program Management	Total Project	Delayed Project Decisions	Compressed schedule for Chief's Report requires timely decisions.	Risk is partially mitigated by conducting in-progress reviews. None of a potential schedule impact than cost. Examples of potential delayed decisions include the PPA. Impact is somewhat dependent on the specific decision that is delayed.	PM/Sponsor	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-3	Project & Program Management	Total Project	Contractor Delays	Some concern regarding environmental sub-contractors ability to perform within this time frame	EIS is primarily done by a contractor	PM	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-4	Project & Program Management	Total Project	Late Requests for Additional Analysis	Unanticipated requests for additional analysis could delay the Chief's Report	Chief's Report on expedited schedule is fully funded as of now. Additional requests create risk to schedule. IEPR reviewer doesn't agree with the methodology used to predict O&M quantities. May be required to do further analysis (not likely flow risk), but would require 6-month to modeling.	PM	Unlikely	Marginal	LOW	Unlikely	Critical	MODERATE
PPM-5	Project & Program Management	Total Project	Competition for Resources within the District	Higher priority projects could divert resources away from this project.	***Project is one of District and Division priorities.*** Schedule is accelerated already due to priority. There is always a risk of losing key staff to other projects (hurricane response, etc.) Risk applies to both PED and construction phases.	PM	Very Unlikely	Marginal	LOW	Very Unlikely	Critical	LOW
CA-1	Contract Acquisition	All Construction	Funding Stream Impacts to Contract Acquisition	Funding stream may require base bid and options or separate contracts.	Acquisition plan under development during feasibility phase. Construction schedule reflects current acquisition assumptions. Schedule is based on realistic funding stream assumptions. Phasing or combining contract clause would be potential issues if used. ASA approval required for continuing contract clause use. Acquisition plan will go to Deputy Secretary for Acquisition for approval. Unanticipated funding stream impacts may result in contractor claims, multiple contracts or multiple mobilizations.	Contracting	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
CA-2	Contract Acquisition	Drilling & Blasting	Mods and Claims Related to Rock Quantities	There is uncertainty in the estimated quantity of rock material.	Additional geotechnical investigation will be performed in PED to further define rock quantities and characteristics. Complexity of project suggest moderate level of mods and claims (less than a typical civil works project). For a claim, the contractor would need to show that core logs were not representative in terms of volume. Mods could arise from hardness of rock issues.	Engineering	Unlikely	Significant	MODERATE	Unlikely	Negligible	LOW
CA-3	Contract Acquisition	Dredging	Industry Availability/Bidding Climate	Limited competition due to large contract value.	There is only one dredging company that likely could handle the work alone. 3-4 companies could JV and bid. Number of proposals will likely be 3-4. Industry day will be held to provide maximum exposure to potential bidders to encourage competition. Anticipating one prime contractor for construction (however, USCG station ***reconfiguration*** may be under separate contract). Could be base + options, combining contracting clause, etc. Acquisition strategy not completely defined. Impact based on future market conditions. Future market conditions are difficult to forecast.	Contracting	Likely	Critical	HIGH	Likely	Negligible	LOW
CA-4	Contract Acquisition	Dredging	Bonding Capacity	Competition may be limited due to bonding capacity issues.	Joint ventures (JV's) will likely be necessary due to the size of the anticipated contract. Several market participants have existing JV agreements. Bonding capacity is also impacted by the number of dredging projects being performed in the same time frame.	Contracting	Likely	Marginal	MODERATE	Likely	Critical	HIGH
CA-5	Contract Acquisition	Environmental Mitigation	Separate Contract for Mitigation	A separate environmental mitigation contractor may result in coordination issues with the dredging contractor. Performance of two separate contractors may not be aligned.	A separate mitigation subcontractor under the dredging prime is preferred at this time to facilitate construction scheduling. Coral relocation will be performed before construction. Risk is placed on prime contractor (not the independent mitigation contractor). ***Coral propagation to be separate contract.***	Contracting	Very Unlikely	Negligible	LOW	Very Unlikely	Marginal	LOW
CA-6	Contract Acquisition	Associated General Items	Prime Contractor Markups for AGI's	Risk is that a single prime contractor adds significant markups to subcontractors resulting in unfavorable pricing.	By keeping all work under a single prime contractor there would be a sole source of responsibility for coordinating the different work elements and avoid scheduling and resource issues. However, use a separate contractor in certain instances may reduce costs. Impact is potential cost savings, but there is a potential for schedule risk due to smaller contractor performance and additional recovery cost. USCG station ***reconfiguration*** could be a separate design build contract.	Contracting	Likely	Marginal	MODERATE	Likely	Negligible	LOW
CA-7	Contract Acquisition	Mechanical Dredging	Mods and Claims Related to Dredge Material Quantities	There is uncertainty in the estimated quantity of material to be dredged.	Additional physical surveys will be performed during the PED phase to increase confidence in the dredge material quantities. Another source of mods is typically upland disposal for dredge materials. This project is ocean disposal only.	Engineering	Very Unlikely	Significant	LOW	Very Unlikely	Negligible	LOW
TL-1	Technical	Drilling & Blasting	Blasting Design Maturity	Uncertainty related to physical surveys and rock properties.	Next set of surveys will include bathymetric surveys, resistivity surveys, and coring to greater depths. Historical cores do not go as deep as necessary. Some change is likely. Impact can be positive or negative based on refined understanding of physical conditions. May have opportunities to dredge instead of blast.	Engineering	Likely	Significant	HIGH	Likely	Negligible	LOW
TL-2	Technical	Aids to Navigation	USCG Coordination	Uncertainty regarding USCG ability to deliver ATON's on schedule and budget.	Past experience with the USCG demonstrate a high degree of reliability. Long term coordination with USCG for this project. No range markers anticipated.	Engineering	Likely	Negligible	LOW	Likely	Negligible	LOW

Risk No.	RBS Level III	Feature of Work	Risk/Opportunity Event	PDT Event Concerns	PDT Discussions	Responsibility/POC	Project Cost Likelihood	Project Cost Impact	Project Cost Risk Level	Project Schedule Likelihood	Project Schedule Impact	Project Schedule Risk Level
TL-3	Technical	All Construction	Feasibility Level Designs	Current design level is appropriate for feasibility level; however, designs will be refined during the PED phase. Refinement is likely to impact costs.	Current conceptual design and cost estimates are considered conservative and will be refined during the PED phase. ***PED may result in cost savings.***	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	Low
TL-4	Technical	All Construction	Results of PED Studies Impact Costs	Further studies will be performed during the PED phase. The results of these studies could impact the cost estimate.	The level of study completion is appropriate for Feasibility phase. Future geotechnical and environmental surveys have the greatest potential for impacts. New seagrass and coral surveys will be completed ***during PED***	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	Low
TL-5	Technical	Associated General Items	Environmentally Friendly Bulkheads (EFBs)	EFB design is new application for USACE projects.	While EFB design/use is new for USACE, EFBs are used by industry and is not a new application in general. Environmental groups are providing inputs to engineering.	Engineering	Unlikely	Marginal	Low	Unlikely	Negligible	Low
LD-1	Lands and Damages	Associated General Items	Real Estate Plan	Inaccurate real estate plan assumptions could impact project cost or schedule.	No real estate acquisition planned. USCG will give **a permit to *reconfigure***. All estate is not required. USCG is not giving up land.	Real Estate	Very Unlikely	Significant	Low	Very Unlikely	Significant	Low
LD-2	Lands and Damages	Associated General Items	Westlake Park Mitigation Area	Westlake Park will include construction as part of mitigation. Real estate is already been acquired by state for a conservation area. State has leased land to County. County will provide a right of entry to USACE. State cannot sell property to USACE by state law.	Not an easement. Only a permission is required. Intent is for the Port to perform mitigation before Federal construction project begins. Mitigation work will be contracted by Broward County. Counts as part of the Port's cost share. ***VT may question innovative approach.***	Real Estate	Very Unlikely	Significant	Low	Very Unlikely	Significant	Low
REG-1	Regulatory and Environmental	Environmental Mitigation	Mitigation Design Maturity	Scope is well defined; however, new baseline surveys for seagrass, corals, and mangrove will be required in PED. Conservative values based on historical records have been used for planning purposes.	Response surveys will be updated and refinements will be made in PED. Potential for larger areas than estimated. Stakeholders may ask for increased seagrass mitigation. This risk is separate from engineering issues such as rock quantities. Likelihood is unlikely because of conservation of estimate and high degree of confidence in environmental design.	Environmental	Unlikely	Marginal	Low	Unlikely	Negligible	Low
REG-2	Regulatory and Environmental	Mechanical Dredging	Disposal Area Uncertainty	EPA could reject CDMDS as a disposal area.	EPA has never denied a USACE request for disposal area approval. There are no known issue that would result in denial. EPA process includes rule making for the disposal site so there is some uncertainty. Majority of material will be rock rather than sediments that have a greater potential for issues.	Engineering	Very Unlikely	Marginal	Low	Very Unlikely	Significant	Low
REG-3	Regulatory and Environmental	Mechanical Dredging	Hazardous Waste Concerns	No hazardous waste concerns identified during feasibility phase; however, if Section 103 testing identifies that a portion of dredge material unsuitable for ODMDS disposal, the Port has expressed ability to provide upland disposal capacity.	Disposal material will primarily be rock. Federal channels rarely have contamination issues. Berthing areas may have issues from operations. Risk is meeting Federal standards and standards for placing material in ocean disposal site. EIS decides that no alternatives have hazardous waste issues. If an issue arises, sponsor would be responsible for cost, impact to Federal project would be schedule. Berths are historically responsibility of Port.	Environmental	Very Unlikely	Negligible	Low	Very Unlikely	Significant	Low
REG-4	Regulatory and Environmental	Environmental Mitigation	Adaptive Management Features	Adaptive management is very likely to be used.	Cost estimate and schedule include adaptive management. Adaptive management could be augmented based on on-going negotiations. Additional costs may be moved to adaptive management in current plan. Cost impact could be zero or increase (no opportunity for cost savings).	Environmental	Likely	Significant		Likely	Negligible	Low
REG-5	Regulatory and Environmental	Total Project	Cultural Resources, Endangered Species and Wetlands Identification	Unknown cultural resources, endangered species or wetlands could be identified in the PED phase.	No cultural resources have been identified. Wetlands are well known. All species have been identified, including proposed listing species. Construction schedule reflects restriction on blasting during winter and use of clam shell dredging.	Environmental	Very Unlikely	Marginal	Low	Very Unlikely	Critical	Low
REG-6	Regulatory and Environmental	Total Project	Status of Permits	Permits will be obtained during PED phase.	Permits may be untimely. There could be administrative appeal on a Florida ECP permit. Impact viewed as a percentage of mitigation cost. Current estimate is about $42 million for mitigation. PDT believes a 29% potential cost impact is possible. Recent changes in Florida has time schedule impacts.	Environmental	Likely	Significant		Likely	Marginal	MODERATE
REG-7	Regulatory and Environmental	NFMS Concerns	NFMS Concerns	The state and federal regulatory agencies have given the EIS favorable reviews with the exception of NMFS. Possibility exists that NMFS will elevate their concerns.	Project has a 17-year history and some regulatory opinions may be entrenched. NMFS agenda may not be aligned with USACE mission. NMFS delays related to staffing issues are historically common. USACE may need to modify plan based on NMFS review concerns. Potential issues may be elevated within streamlined timeframes. Resolution is uncertain and may delay Chief's Report. Extensive consultation with NMFS in the 2nd quarter of FY14 resulted in a scope and quantity sufficient to allow issuance of a Favorable Biological Opinion. Credit were solicited by NFMS from several vendors (and provided to USACE) to assure adequate funding.	Environmental	Likely	Significant		Likely	Significant	
CON-1	Construction	All Construction	Unanticipated Permit or Environmental Work Windows	Unanticipated permit or environmental work windows.	No blasting during winter. Certain dredging equipment use is seasonal. Cost estimate and schedule reflect restrictions already. Unanticipated restrictions are very unlikely, but the impact could be crisis level if this risk occurs.	Contractors	Unlikely	Marginal	Low	Unlikely	Negligible	Low

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Risk No.	RBS Level III	Feature of Work	Risk/Opportunity Event	PDT Event Concerns	PDT Discussions	Responsibility/POC	Project Cost Likelihood	Project Cost Impact	Project Cost Risk Level	Project Schedule Likelihood	Project Schedule Impact	Project Schedule Risk Level
CON-2	Construction	All Construction	Potential to Accelerate Construction Schedule	Sponsor prefers a faster schedule.	If a faster schedule is adopted, more than one contract may be needed. There are only 2-3 contractors that are anticipated to be proficient in the project work. Estimate is based on excavator. A few individual contractors have up to three rock-capable dredges and could complete the work. Some schedule acceleration is possible using a single contractor. Significant acceleration would require a second contractor. Two contractors each have two cutter suction dredges that could be used with little blasting. Two dredges is probably the maximum possible due to level of port activity (would require 3 years). Accelerating the project may also impact level of competition. 3 years is the minimum (one contractor with two dredges); 4 years is available with one contractor; 5 years will be least expensive and create the best bidding environment. Cost relative/schedule opportunity. Cost impact is second rock and lower efficiency operations.	Construction	Unlikely	Significant	MODERATE	Unlikely	Crisis	
CON-3	Construction	Mechanical Dredging	Cross Current Impact on Productivity	Dredge will need to be removed from the channel when ships enter due to the cross current.	Schedule assumes that dredge will be removed from the channel.	Construction	Unlikely	Negligible	Low	Unlikely	Negligible	Low
CON-4	Construction	Drilling & Blasting	Cruise Industry Impacts to Blasting	Cruise ships not likely to enter port if explosives are set.	Could be a delay after explosives are loaded due to immediate presence. Technical issues can add delays while holes are loaded. Potential loss of cruise ship revenue for sponsor may result in requirements to change construction techniques or scheduling.	Construction	Unlikely	Marginal	Low	Unlikely	Significant	MODERATE
CON-5	Construction	Associated General Items	Relocation Issues	Relocations issues that result in higher costs or schedule delays.	USCG station ***reconfiguration*** is a navigation feature (not a relocation) and **could** be completed before construction begins. One FPL electrical cable (in south channel) will be removed prior to new O&M dredging. No relocation issues anticipated. Cost for ***FPL*** cable is external to Federal project.	Construction	Unlikely	Marginal	Low	Unlikely	Marginal	Low
CON-6	Construction	All Construction	Mods and Claims Related to Other Unknown Conditions	The risk register identifies project risks related to mods and claims for hurricanes, rock and dredge material quantities, and unanticipated work restrictions. Other unknown risks not identified by the PDT may result in mods and claims.	Because this risk relates to unknown conditions not specifically identified by the PDT, it was not qualitatively assessed in regard to probability and impact. Rather, the sum of identified mods and claims rates was subtracted from historical Jacksonville District dredging project mods and claims rates to identify potential residual mods and claims risk that exceeds that identified by the PDT.	Construction	Likely	Significant	[illegible]	Likely	Negligible	Low
CON-7	Construction	Drilling & Blasting	Environmental Concerns for Blasting	There may be added costs associated with penalty fees or procedure changes related to blasting.	Environmental monitors for blasting may need to be specialized subcontractors. There is no incidental take for Manatees.	Environmental/Construction	Likely	Marginal	MODERATE	Likely	Negligible	Low
EST-1	Estimate and Schedule	Construction Management	Construction Management Duration	Additional construction management costs may be incurred if the construction duration is longer than assumed.	Differing or unforeseen site conditions may add to construction duration and increase construction management costs.	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	Low
EST-2	Estimate and Schedule	Mechanical Dredging	Production Rates	Blasting and dredging production rates assumed for cost estimate and schedule may be inaccurate.	Blasting and dredging records, including Miami, were used to develop production rates. Unlikely that dredge size plan is incorrect due to past experience. Estimate conservatism reduced the probability and impact of this risk. Plan is for 100% excavator (no clamshell).	Engineering	Very Unlikely	Significant	Low	Very Unlikely	Marginal	Low
EST-3	Estimate and Schedule	Planning, Engineering and Design	PED Cost Estimate	PED cost estimate may be too low.	PED cost estimate is approximately 1.8% of construction cost and may not be sufficient for actual expenditures.	Engineering	Unlikely	Marginal	Low	Unlikely	Negligible	Low
EST-4	Estimate and Schedule	Construction Management	CM Cost Estimate	CM cost estimate may be too low.	CM cost estimate is approximately 3.5% of construction cost and may not be sufficient for actual expenditures.	Engineering	Unlikely	Marginal	Low	Unlikely	Negligible	Low
EST-5	Estimate and Schedule	All Construction	Escalation for Long Term Contract	Contractors are likely to include contingency in their bids to cover potential cost escalation and escalation risk over the contract period.	Contract duration is five years. Future contractor expectations about future escalation rates are uncertain.	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	Low
EXT-1	External Risks	All Construction	Local Community Objections to Construction	Local high rise residents and NGOs may have objections related to air quality (diesel), equipment and staging area/equipment lighting, construction noise and blasting (perceived physical impacts).	Near certain risk that will be realized. Impact is managing PR. Public objections may cause impacts resulting in litigation or the need for further studies.	PM	Unlikely	Critical	MODERATE	Unlikely	Marginal	Low
EXT-2	External Risks	Total Project	Legal Challenges	Legal challenges may occur during NEPA coordination and permit authorizations.	Project has good political support, but there is always a threat of lawsuit. EIS is designed to limit potential lawsuits. Administrative challenge to WQC certification/permit is likely. It is relatively easy to challenge NEPA. ***THIS ITEM IS CONSIDERED IN EXT-1 SO RISK IS SET TO LOW-LOW TO AVOID DOUBLE COUNTING.***	PM	Unlikely	Negligible	Low	Unlikely	Negligible	Low
EXT-3	External Risks	Mobilization	Fuel Price Impact on Mobilization	Future fuel prices are uncertain and may not match cost estimate assumptions.	Fuel price increases and market volatility directly affect bid prices.	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	Low
EXT-4	External Risks	Mechanical Dredging	Fuel Price Impact on Dredging	Future fuel prices are uncertain and may not match cost estimate assumptions.	Fuel price increases and market volatility directly affect bid prices. Weather delays are considered in historical production analysis. Fuel cost is an important component of dredging cost.	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	Low
EXT-5	External Risks	Mechanical Dredging	Mods and Claims Related to Adverse Weather	Adverse weather, such as a hurricane or tropical storm, during dredging operations may result in contractor mods and claims.	Delays to current operations and a temporary suspension for re-survey would be potential impacts.	Construction	Unlikely	Significant	MODERATE	Unlikely	Marginal	Low
EXT-6	External Risks	Total Project	Adequacy of Incremental Project Funding	Actual project funding may not be sufficient to achieve schedule.	Estimate and schedule assume incremental funding. 5-year construction schedule is based on realistic funding stream. Risk of WRDA passing without FEH project authority is not included in this risk.	PM	Very Unlikely	Critical	Low	Very Unlikely	Critical	Low
EXT-7	External Risks	Total Project	Influential Stakeholders Request Scope Changes	Influential stakeholders may request late changes that impact project cost and schedule.	Project has a long history and the scope has evolved to address stakeholder issues. New requests by influential stakeholders are very unlikely due to project maturity. Impacts could be critical if risk were to occur. ***Descoping is possibility.***	PM	Very Unlikely	Critical	Low	Very Unlikely	Critical	Low
EXT-8	External Risks	Total Project	Authorization and Appropriation	Project funding delay.	***WRDA recently passed, next one expected in 2-5 years, possibly longer. State of Florida is very supportive of project and may provide funding similar to Miami.***	PM/Congress	Unlikely	Marginal	Low	Unlikely	Crisis	
EXT-9	External Risks	Mechanical Dredging	Mods and Claims Related to Unanticipated Work Restrictions	Claims and mods related to unanticipated work restrictions may occur.	Public complaints may result in unanticipated work restrictions.	Construction	Unlikely	Marginal	Low	Unlikely	Marginal	Low

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Port Everglades Harbor, FL Feasibility Study - LPP Depth of 48'

Brief Scope Presentation: The project consists of construction dredging, bulkhead improvements and mitigation costs for the 48' LPP depth which is the Locally Preferred Plan. Dredging will occur in the Outer Entrance Channel, Inner Entrance Channel, Main Turning Basin (MTB), Widener, South Port Access Channel, Turning Notch, and Berths located south of the MTB along the Intercoastal Waterway, Broward County, Florida. The project depth costs include a one foot required and one foot allowable overdepth.

Risk No.	RBS Level III	Feature of Work	Risk/Opportunity Event	PDT Event Concerns	PDT Discussions	Responsibility/POC	Project Cost Likelihood	Project Cost Impact	Project Cost Risk Level	Project Schedule Likelihood	Project Schedule Impact	Project Schedule Risk Level
PPM-1	Project & Program Management	Total Project	Inadequate PDT Staffing Levels	There is a dedicated USACE staff in place for completing the Chief's Report by *May 2015*. No concerns at this time regarding staffing for PED activities.	Not a concern for FY15. Some concern in out years, subject to future funding levels.	PM	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-2	Project & Program Management	Total Project	Delayed Project Decisions	Compressed schedule for Chief's Report requires timely decisions.	Risk is partially mitigated by conducting in-progress reviews. More of a potential schedule impact than cost. Examples of potential delayed decisions include the PPA. Impact is somewhat dependent on the specific decision that is delayed.	PM/Sponsor	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-3	Project & Program Management	Total Project	Contractor Delays	Some concern regarding environmental sub-contractor's ability to perform within this time frame.	EIS is primarily done by a contractor.	PM	Unlikely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-4	Project & Program Management	Total Project	Late Requests for Additional Analysis	Unanticipated requests for additional analysis could delay the Chief's Report.	Chief's Report on expedited schedule is fully funded as of now. Additional requests create risk to schedule. IEPR reviewer doesn't agree with the methodology used to predict O&M quantities. May be required to do further analysis (not likely low risk), but would require 6 month. (or modeling).	PM	Unlikely	Marginal	LOW	Unlikely	Critical	MODERATE
PPM-5	Project & Programs Management	Total Project	Competition for Resources within the District	Higher priority projects could divert resources away from this project.	***Project is one of District and Division priorities.*** Schedule is accelerated already due to priority. There is always a risk of losing key staff to other projects (hurricane response, etc.) Risk applies to both PED and construction phases.	PM	Very Unlikely	Marginal	LOW	Very Unlikely	Critical	LOW
CA-1	Contract Acquisition	All Construction	Funding Stream Impacts to Contract Acquisition	Funding stream may require base bid and options or separate contracts.	Acquisition plan under development during feasibility phase. Construction schedule reflects current acquisition assumptions. Schedule is based on realistic funding stream assumptions. Phasing or continuing contract clause would be potential issues if used. ASA approval required for continuing contract clause use. Acquisition plan will go to Deputy Secretary for Acquisition for approval. Unanticipated funding stream impacts may result in contractor claims, multiple contracts or multiple mobilizations.	Contracting	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
CA-2	Contract Acquisition	Drilling & Blasting	Mods and Claims Related to Rock Quantities	There is uncertainty in the estimated quantity of rock material	Additional geotechnical investigation will be performed in PED to further define rock quantities and characteristics. Complexity of project suggest moderate level of mods and claims (less than a typical civil works project). For a claim, the contractor would need to show that core logs were not representative in terms of volume. Mods could arise from hardness of rock issues.	Engineering	Unlikely	Significant	MODERATE	Unlikely	Negligible	LOW
CA-3	Contract Acquisition	Dredging	Industry Availability/Bidding Climate	Limited competition due to large contract value.	There is only one dredging company that likely could handle the work alone. 3-4 companies could JV and bid. Number of proposals will likely be 3-4. Industry day will be held to provide maximum exposure to potential bidders to encourage competition. Anticipating one prime contractor for construction (however, USCG station ***reconfiguration*** may be under separate contract). Could be base + options, continuing contracting clause, etc. Acquisition strategy not completely defined. Impact based on future market conditions. Future market conditions are difficult to forecast.	Contracting	Likely	Critical		Likely	Negligible	LOW
CA-4	Contract Acquisition	Dredging	Bonding Capacity	Competition may be limited due to bonding capacity issues.	Joint ventures (JV's) will likely be necessary due to the size of the anticipated contract. Several market participants have existing JV agreements. Bonding capacity is also impacted by the number of dredging projects being performed in the same time frame.	Contracting	Likely	Marginal	MODERATE	Likely	Critical	
CA-5	Contract Acquisition	Environmental Mitigation	Separate Contract for Mitigation	A separate environmental mitigation contractor may result in coordination issues with the dredging contractor. Performance of two separate contractors may not be aligned.	A separate mitigation subcontractor under the dredging prime is preferred at this time to facilitate construction scheduling. Coral relocation will be performed before construction. Risks placed on prime contractor (not the independent mitigation contractor). ***Coral propagation to be separate contract.***	Contracting	Very Unlikely	Negligible	LOW	Very Unlikely	Marginal	LOW
CA-6	Contract Acquisition	Associated General Items	Prime Contractor Markups for AGI's	Risk is that a single prime contractor adds significant markups to subcontractors resulting in unfavorable pricing.	By keeping all work under a single prime contractor there would be a sole source of responsibility for coordinating the different work elements and avoid scheduling and resource issues. However, use a separate contractor in certain instances may reduce costs. Impact is potential cost savings, but there is a potential for schedule risk due to smaller contractor performance and additional recovery cost. USCG station ***reconfiguration*** could be a separate design build contract.	Contracting	Likely	Marginal	MODERATE	Likely	Negligible	LOW
CA-7	Contract Acquisition	Mechanical Dredging	Mods and Claims Related to Dredge Material Quantities	There is uncertainty in the estimated quantity of material to be dredged.	Additional physical surveys will be performed during the PED phase to increase confidence in the dredge material quantities. Another source of mods is typically upland disposal for dredge materials. This project is ocean disposal only.	Engineering	Very Unlikely	Significant	LOW	Very Unlikely	Negligible	LOW
TL-1	Technical	Drilling & Blasting	Blasting Design Maturity	Uncertainty related to physical surveys and rock properties.	Field set of surveys will include bathymetric surveys, resistivity surveys, and coring to greater depths. Historical cores do not go as deep as necessary. Some change is likely. Impact can be positive or negative based on refined understanding of physical conditions. May have opportunities to dredge instead of blast.	Engineering	Likely	Significant		Likely	Negligible	LOW
TL-2	Technical	Aids to Navigation	USCG Coordination	Uncertainty regarding USCG ability to deliver ATON's on schedule and budget.	Past experience with the USCG demonstrate a high degree of reliability. Long term coordination with USCG for this project. No range markers anticipated.	Engineering	Likely	Negligible	LOW	Likely	Negligible	LOW

Risk No.	RBS Level III	Feature of Work	Risk/Opportunity Event	PDT Event Concerns	PDT Discussions	Responsibility/POC	Project Cost			Project Schedule		
							Likelihood	Impact	Risk Level	Likelihood	Impact	Risk Level
TL-3	Technical	All Construction	Feasibility Level Designs	Current design level is appropriate for feasibility level, however, designs will be refined during the PED phase. Refinement is likely to impact costs.	Current conceptual design and cost estimates are considered conservative and will be refined during the PED phase. ***PED may result in cost savings.***	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	LOW
TL-4	Technical	All Construction	Results of PED Studies Impact Costs	Further studies will be performed during the PED phase. The results of these studies could impact the cost estimate	The level of study completion is appropriate for feasibility phase. Future geotechnical and environmental surveys have the greatest potential for impacts. New seagrass and coral surveys will be completed ***during PED***	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	LOW
TL-5	Technical	Associated General Items	Environmentally Friendly Buildowards (EFBs)	EFB design is new application for USACE projects	While EFB designs are new for USACE, EFBs are used by industry and is not a new application in general. Environmental groups are providing inputs to engineering.	Engineering	Unlikely	Marginal	LOW	Unlikely	Negligible	LOW
LD-1	Lands and Damages	Associated General Items	Real Estate Plan	Inaccurate real estate plan assumptions could impact project cost or schedule	Non real estate acquisitions planned. USACE not give **a permit to reconfigure**. An estate is not required. USCG is not giving up land	Real Estate	Very Unlikely	Significant	LOW	Very Unlikely	Significant	LOW
LD-2	Lands and Damages	Associated General Items	Westlake Park Mitigation Area	Westlake Park will include construction as part of mitigation. Real estate is already been acquired by state for a conservation area. State has leased land to County. County will provide a right of entry to USACE. State cannot sell property to USACE by state law	Not an easement. Only a permission is required. Intent is for the Port to perform mitigation before Federal construction project begins. Mitigation work will be contracted by Broward County. Counts as part of the Port's cost share. ***VT may question innovative approach.***	Real Estate	Very Unlikely	Significant	LOW	Very Unlikely	Significant	LOW
REG-1	Regulatory and Environmental	Environmental Mitigation	Mitigation Design Maturity	Scope is well defined, however, new baseline surveys for sea-grass, corals, and mangrove will be required in PED. Conservative values based on historical records have been used for planning purposes.	Resource surveys will be updated and refinements will be made in PED. Potential for larger areas than estimated. Stakeholders may ask for increased seagrass mitigation. This risk is separate from engineering issues such as rock quantities. Likelihood is unlikely because of conservatism of estimate and high degree of confidence in environmental design.	Environmental	Unlikely	Marginal	LOW	Unlikely	Negligible	LOW
REG-2	Regulatory and Environmental	Mechanical Dredging	Disposal Area Uncertainty	EPA could reject ODMDS as a disposal area.	EPA has never denied a USACE request for disposal areas approval. There are no known issue that would result in denial. EPA process includes rule making for the disposal site so there is some uncertainty. Majority of material will be rock rather than sediments that have a greater potential for issues.	Engineering	Very Unlikely	Marginal	LOW	Very Unlikely	Significant	LOW
REG-3	Regulatory and Environmental	Mechanical Dredging	Hazardous Waste Concerns	No hazardous waste concerns identified during feasibility phase, however, if Section 103 testing identifies that a portion of dredge material unsuitable for ODMDS disposal, the Port has decreased ability to provide upland disposal capacity	Disposal material will primarily be rock. Federal channels rarely have contamination issues. Berthing areas may have issues from operations. Risk is meeting Federal standards and standards for placing material in ocean disposal site. EIS indicates that no alternatives have hazardous waste issues. If an issue arises, sponsor would be responsible for cost. Impact to Federal project would be schedule. Berths are historically responsibility of Port.	Environmental	Very Unlikely	Negligible	LOW	Very Unlikely	Significant	LOW
REG-4	Regulatory and Environmental	Environmental Mitigation	Adaptive Management Features	Adaptive management is very likely to be used.	Cost estimate and schedule include adaptive management. Adaptive management could be augmented based on on-going negotiations. Additional costs may be moved to adaptive management in current plan. Cost impact could be zero or increase (no opportunity for cost savings)	Environmental	Likely	Significant	HIGH	Likely	Negligible	LOW
REG-5	Regulatory and Environmental	Total Project	Cultural Resources, Endangered Species and Wetlands Identification	Unknown cultural resources, endangered species or wetlands could be identified in the PED phase.	No cultural resources have been identified. Wetlands are well known. All species have been identified, including proposed listing species. Construction schedule reflects restrictive on blasting during winter and use of clam shell dredging.	Environmental	Very Unlikely	Marginal	LOW	Very Unlikely	Critical	LOW
REG-6	Regulatory and Environmental	Total Project	Status of Permits	Permits will be obtained during PED phase.	Permits may be untimely. There could be administrative appeal on a Florida DOP permit. Impact weighed as a percentage of mitigation cost. Current estimate is about $42 million for mitigation. PDT believes a 20% potential cost impact is possible. Recent changes in Florida law have schedule impacts.	Environmental	Likely	Significant	HIGH	Likely	Marginal	MODERATE
REG-7	Regulatory and Environmental	Environmental Mitigation	NFMS Concerns	The state and federal regulatory agencies have given the EIS favorable reviews with the exception of NMFS. Possibility exists that NMFS will elevate their concerns.	Project has a 17-year history and some regulatory opinions may be entrenched. NMFS agenda may not be aligned with USACE mission. NMFS delays related to staffing issues are historically common. USACE may need to modify plan based on NMFS review concerns. Potential issues may be elevated within established timelines. Resolution is uncertain and may delay Chief's Report. Extensive consultation with NMFS in the 2nd quarter of FY14 resulted in a scope and quantity sufficient to allow issuance of a favorable Biological Opinion. Costs were solicited by NFMS from several vendors (and provided to USACE) to ensure adequate funding	Environmental	Likely	Significant	HIGH	Likely	Significant	HIGH
CON-1	Construction	All Construction	Unanticipated Permit or Environmental Work Windows	Unanticipated permit or environmental work windows.	No blasting during winter. Certain dredging equipment use is seasonal. Cost estimates and schedule reflect restrictions already. Unanticipated restrictions are very unlikely, but the impact could be critical level if the risk occurs.	Construction	Unlikely	Marginal	LOW	Unlikely	Negligible	LOW

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Risk No.	RBS Level III	Feature of Work	Risk/Opportunity Event	PDT Event Concerns	PDT Discussions	Responsibility/POC	Project Cost Likelihood	Project Cost Impact	Project Cost Risk Level	Project Schedule Likelihood	Project Schedule Impact	Project Schedule Risk Level
CON-2	Construction	All Construction	Potential to Accelerate Construction Schedule	Sponsor prefers a faster schedule.	If a faster schedule is adopted, more than one contract may be needed. There are only 2-3 contractors that are anticipated to be proficient in the project work. Estimate is based on Receivator. A few individual contractors have up to three rock-capable dredges and could complete the work. Some schedule acceleration is possible using a single contractor. Significant acceleration would require a second contractor. Two contractors each have two cutter suction dredges that could be used with little blasting. Two dredges is probably the maximum possible due to level of port activity (would require 3 years). Accelerating the project may also impact level of competition. 3 years is the minimum (one contractor with two dredges); 4 years is possible with one contractor, 5 years will be least expensive and create the best bidding environment. Cost risk/schedule opportunity. Cost impact is second mob and lower efficiency operations	Construction	Unlikely	Significant	MODERATE	Unlikely	Crisis	[illegible]
CON-3	Construction	Mechanical Dredging	Cross Current Impact on Productivity	Dredge will need to be removed from the channel when ships enter due to the cross current.	Schedule assumes that dredge will be removed from the channel.	Construction	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
CON-4	Construction	Drilling & Blasting	Cruise Industry Impacts to Blasting	Cruise ships not likely to enter port if explosives are set.	Could be a delay after explosives are loaded due to maritime presence. Technical issues can add delays while holes are loaded. Potential loss of cruise ship revenue for sponsor may result in requirements to change construction techniques or scheduling.	Construction	Unlikely	Marginal	LOW	Unlikely	Significant	MODERATE
CON-5	Construction	Associated General Items	Relocation Issues	Relocations issues that result in higher costs or schedule delays	USCG station **reconfiguration** is a navigation feature (not a relocation) and **could** be completed before construction begins. One FPL electrical cable (in south channel) will be removed prior to next O&M dredging. No relocation issues anticipated. Cost for **FPL** cable is external to Federal project	Construction	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
CON-6	Construction	All Construction	Mods and Claims Related to Other Unknown Conditions	The risk register identifies project risks related to mods and claims for hurricanes, rock and dredge material quantities, and unanticipated work restrictions. Other unknown risks not identified by the PDT may result in mods and claims	Because the risk related to unknown conditions not specifically identified by the PDT, it was not qualitatively assessed in regard to probability and impact. Rather, the sum of identified mods and claims risks was subtracted from historical Jacksonville District dredging project mods and claims rates to identify potential residual mods and claims risk that exceeds that identified by the PDT	Construction	Likely	Significant	[illegible]	Likely	Negligible	LOW
CON-7	Construction	Drilling & Blasting	Environmental Concerns for Blasting	There may be added costs associated with penalty fees or procedure changes related to blasting	Environmental monitors for blasting may need to be specialized subcontractors. There is no incidental take for Manatees.	Environmental/Construction	Likely	Marginal	MODERATE	Likely	Negligible	LOW
EST-1	Estimate and Schedule	Construction Management	Construction Management Duration	Additional construction management costs may be incurred if the construction duration is longer than assumed.	Differing or unforeseen site conditions may add to construction duration and increase construction management costs	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	LOW
EST-2	Estimate and Schedule	Mechanical Dredging	Production Rates	Blasting and dredging production rates assumed for cost estimate and schedule may be inaccurate	Blasting and dredging records, including Miami, were used to develop production rates. Unlikely that dredge size plan is incorrect due to past experience. Estimate conservatism reduced the probability and impact of this risk. Plan is for 100% excavation (no clamshell).	Engineering	Very Unlikely	Significant	LOW	Very Unlikely	Marginal	LOW
EST-3	Estimate and Schedule	Planning, Engineering and Design	PED Cost Estimate	PED cost estimate may be too low	PED cost estimate is approximately 1.8% of construction cost and may not be sufficient for actual expenditures.	Engineering	Unlikely	Marginal	LOW	Unlikely	Negligible	LOW
EST-4	Estimate and Schedule	Construction Management	CM Cost Estimate	CM Cost Estimate may be too low.	CM cost estimate is approximately 2.5% of construction cost and may not be sufficient for actual expenditures.	Engineering	Unlikely	Marginal	LOW	Unlikely	Negligible	LOW
EST-5	Estimate and Schedule	All Construction	Escalation for Long Term Contract	Contractors are likely to include contingency in their bids to cover potential cost escalation and escalation risk over the contract period	Contract duration is five years. Future contractor expectations about future escalation rates are uncertain.	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	LOW
EXT-1	External Risks	All Construction	Local Community Objections to Construction	Local high rise residents and NGOs may have objections related to air quality (diesel), equipment and staging area/equipment lighting, construction noise and blasting (perceived physical impacts).	Near certain risk that will be realized. Impact to managing PM. Public objections may cause projects resulting in litigation or the need for further studies.	PM	Unlikely	Critical	MODERATE	Unlikely	Marginal	LOW
EXT-2	External Risks	Total Project	Legal Challenges	Legal challenges may occur during NEPA coordination and permit authorizations	Project has good political support, but there is always a threat of lawsuit. EIS is designed to limit potential lawsuits. Administrative challenge to WQC certification/permit is likely. It is relatively easy to challenge NEPA. ***THIS ITEM IS CONSIDERED IN EXT-1 SO RISK IS SET TO LOW-LOW TO AVOID DOUBLE COUNTING.***	PM	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
EXT-3	External Risks	Mobilization	Fuel Price Impact on Mobilization	Future fuel prices are uncertain and may not match cost estimate assumptions	Fuel price increases and market volatility directly affect bid prices.	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	LOW
EXT-4	External Risks	Mechanical Dredging	Fuel Price Impact on Dredging	Future fuel prices are uncertain and may not match cost estimate assumptions	Fuel price increases and market volatility directly affect bid prices. Weather delays are considered as historical production analysis. Fuel cost is an important component of dredging cost	Engineering	Likely	Marginal	MODERATE	Likely	Negligible	LOW
EXT-5	External Risks	Mechanical Dredging	Mods and Claims Related to Adverse Weather	Adverse weather, such as a hurricane or tropical storm, during dredging operations may result in contractor mods and claims.	Delays to current operations and a temporary suspension for re-survey would be potential impacts.	Construction	Unlikely	Significant	MODERATE	Unlikely	Marginal	LOW
EXT-6	External Risks	Total Project	Adequacy of Incremental Project Funding	Actual project funding may not be sufficient to achieve schedule	Estimate and schedule assume incremental funding. 5-year construction schedule is based on realistic funding stream. Risk of WRDA passing without PEH project authority is not included in this risk.	PM	Very Unlikely	Critical	LOW	Very Unlikely	Critical	LOW
EXT-7	External Risks	Total Project	Influential Stakeholders Request Scope Changes	Influential stakeholders may request late changes that impact project cost and schedule.	Project has a long history and the scope has evolved to address stakeholder issues. New requests by influential stakeholders are very unlikely due to project maturity. Impacts could be critical if risk were to occur. ***Descoping is possibility.***	PM	Very Unlikely	Critical	LOW	Very Unlikely	Critical	LOW
EXT-8	External Risks	Total Project	Authorization and Appropriation	Project funding delay.	***WRDA recently passed, next one expected in 2-5 years, possibly longer. State of Florida is very supportive of project and may provide funding similar to Miami.***	PM/Congress	Unlikely	Marginal	LOW	Unlikely	Crisis	[illegible]
EXT-9	External Risks	Mechanical Dredging	Mods and Claims Related to Unanticipated Work Restrictions	Claims and mods related to unanticipated work restrictions may occur.	Public complaints may result in unanticipated work restrictions	Construction	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW

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G6. TOTAL PROJECT COST SUMMARY

The Total Project Cost Summary (TPCS) addresses inflation through project completion (accomplished by escalation to mid-point of construction per ER 1110-2-1302, Appendix C, Page C-2). It is based on the scope of the Recommended Plan and the official project schedule. The TPCS includes Federal and Non-Federal costs for Lands and Damages, all construction features, PED, S&A, along with the appropriate contingencies and escalation associated with each of these activities. The TPCS is formatted according to the WBS and uses Civil Works Construction Cost Indexing System factors for escalation (EM 1110-2-1304) of construction costs and Office of Management and Budget (EC 11-2-18X, 20 Feb 2008) factors for escalation of PED and S&A costs. The Total Project Cost Summary was prepared using the MCACES/MII cost estimate on the Recommended Plan, as well as the contingency set by the risk analysis and the official project schedule.

G.6.1 Total Project Cost Summary Spreadsheet

Refer to the Total Project Cost Summary Spreadsheet in this report.

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Port Everglades Harbor Deepening [47' NED]
PROJECT NO: 113180
LOCATION: Port Everglades, FL

DISTRICT: SAJ Jacksonville
POC: CHIEF, COST ENGINEERING,
PREPARED: 10/6/2014

This Estimate reflects the scope and schedule in report; Port Everglades Harbor Engineering Appendix

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1-Oct-14 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
02	RELOCATIONS	$148	$39	26%	$187	1.9%	$150	$40	$190	$0		$163	$43	$206
06	FISH & WILDLIFE FACILITIES	$40,317	$10,603	26%	$50,920	1.9%	$41,072	$10,802	$51,874	$0		$44,440	$11,688	$56,128
12	NAVIGATION PORTS & HARBORS	$230,319	$60,574	26%	$290,892	1.9%	$234,630	$61,708	$296,337	$0		$253,676	$66,769	$320,445
	CONSTRUCTION ESTIMATE TOTALS:	$270,783	$71,216		$341,999	1.9%	$275,852	$72,549	$348,401	$0		$298,479	$78,500	$376,979
01	LANDS AND DAMAGES	$0	$0 -		$0	-	$0	$0	$0	$0		$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$4,453	$1,171	26%	$5,624	3.4%	$4,606	$1,211	$5,817	$0		$4,771	$1,255	$6,026
31	CONSTRUCTION MANAGEMENT	$6,675	$1,755	26%	$8,430	3.4%	$6,904	$1,816	$8,720	$0		$8,051	$2,118	$10,169
	PROJECT COST TOTALS:	$281,911	$74,143	26%	$356,053		$287,362	$75,576	**$362,938**	$0		$311,301	$81,872	$393,173

GNEIDING-JAMES.THERESA.ANNE.1399797847 — CHIEF, COST ENGINEERING,

PEREZ.CYNTHIA.BERRIOS.1232160[illegible] — PROJECT MANAGER, Cynthia Perez

ORMEROD.AUDREY.Y.C.1230602634 — CHIEF, REAL ESTATE, Audrey Ormerod

CHIEF, PLANNING, Eric Bush

CHIEF, ENGINEERING, Laureen Borochaner

CHIEF, OPERATIONS, Jim Jeffords

CHIEF, CONSTRUCTION, Steve Duba

CHIEF, CONTRACTING, Carlos Clarke

CHIEF, PM-PB, Dan Haubner

CHIEF, DPM, Dave Hobbie

ESTIMATED FEDERAL COST:	**75%**	**$294,880**
ESTIMATED NON-FEDERAL COST:	**25%**	**$98,293**
ESTIMATED TOTAL PROJECT COST:		**$393,173**

NOTE: CONTINGENCIES IN ACCORDANCE WITH CSRA.

Filename: TPCS_PEHHBR_47'_Sep2014_R4.xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Port Everglades Harbor Deepening [47' NED]
LOCATION: Port Everglades, FL
This Estimate reflects the scope and schedule in report; Port Everglades Harbor Engineering Appendix

DISTRICT: SAJ Jacksonville
POC: CHIEF, COST ENGINEERING,
PREPARED: 10/6/2014

Estimate Prepared: 9/2/2014
Effective Price Level: 1-Oct-2014

Program Year (Budget EC): 2016
Effective Price Level Date: 1 OCT 15

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
02	RELOCATIONS	$148	$39	26%	$187	1.9%	$150	$40	$190	2020Q1	8.2%	$163	$43	$206
06	FISH & WILDLIFE FACILITIES	$40,317	$10,603	26%	$50,920	1.9%	$41,072	$10,802	$51,874	2020Q1	8.2%	$44,440	$11,688	$56,128
12	NAVIGATION PORTS & HARBORS	$2,421	$637	26%	$3,057	1.9%	$2,466	$649	$3,115	2020Q1	8.2%	$2,668	$702	$3,370
12	NAVIGATION PORTS & HARBORS	$26,922	$7,080	26%	$34,002	1.9%	$27,426	$7,213	$34,638	2020Q1	8.2%	$29,675	$7,805	$37,480
12	NAVIGATION PORTS & HARBORS	$78,322	$20,599	26%	$98,921	1.9%	$79,788	$20,984	$100,772	2020Q1	8.2%	$86,333	$22,706	$109,038
12	NAVIGATION PORTS & HARBORS	$3,569	$939	26%	$4,508	1.9%	$3,636	$956	$4,593	2020Q1	8.2%	$3,934	$1,035	$4,969
12	NAVIGATION PORTS & HARBORS	$119,085	$31,319	26%	$150,404	1.9%	$121,314	$31,906	$153,219	2020Q1	8.2%	$131,265	$34,523	$165,788
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$270,783	$71,216	26%	**$341,999**		$275,852	$72,549	$348,401			$298,479	$78,500	$376,979
01	LANDS AND DAMAGES	$0	$0	26%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.06%	Project Management	$173	$45	26%	$218	3.4%	$179	$47	$226	2016Q1	0.0%	$179	$47	$226
0.41%	Planning & Environmental Compliance	$1,100	$289	26%	$1,389	3.4%	$1,138	$299	$1,437	2016Q1	0.0%	$1,138	$299	$1,437
0.59%	Engineering & Design	$1,600	$421	26%	$2,021	3.4%	$1,655	$435	$2,090	2016Q1	0.0%	$1,655	$435	$2,090
0.06%	Reviews, ATRs, IEPRs, VE	$150	$39	26%	$189	3.4%	$155	$41	$196	2016Q1	0.0%	$155	$41	$196
0.04%	**Life Cycle Updates (cost, schedule, risks**	$100	$26	26%	$126	3.4%	$103	$27	$131	2016Q1	0.0%	$103	$27	$131
0.04%	Contracting & Reprographics	$120	$32	26%	$152	3.4%	$124	$33	$157	2016Q1	0.0%	$124	$33	$157
0.01%	Engineering During Construction	$35	$9	26%	$44	3.4%	$36	$10	$46	2020Q1	16.6%	$42	$11	$53
0.34%	Planning During Construction	$925	$243	26%	$1,168	3.4%	$957	$252	$1,208	2020Q1	16.6%	$1,116	$293	$1,409
0.09%	Project Operations	$250	$66	26%	$316	3.4%	$259	$68	$327	2016Q1	0.0%	$259	$68	$327
31	CONSTRUCTION MANAGEMENT													
2.47%	Construction Management (S&A + S&I)	$6,675	$1,755	26%	$8,430	3.4%	$6,904	$1,816	$8,720	2020Q1	16.6%	$8,051	$2,118	$10,169
0.00%	Project Operation:				$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.00%	Project Management				$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$281,911	$74,143		**$356,053**		$287,362	$75,576	$362,938			$311,301	$81,872	**$393,173**

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: Port Everglades Harbor Deepening [48' LPP]
PROJECT NO: 113180
LOCATION: Port Everglades, FL

DISTRICT: SAJ Jacksonville
POC: CHIEF, COST ENGINEERING,
PREPARED: 10/6/2014

This Estimate reflects the scope and schedule in report; Port Everglades Harbor Engineering Appendix

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1-Oct-14 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
02	RELOCATIONS	$148	$39	26%	$187	1.9%	$150	$40	$190	$0		$164	$43	$208
06	FISH & WILDLIFE FACILITIES	$41,812	$10,996	26%	$52,808	1.9%	$42,595	$11,202	$53,797	$0		$46,552	$12,243	$58,796
12	NAVIGATION PORTS & HARBORS	$243,077	$63,929	26%	$307,007	1.9%	$247,627	$65,126	$312,753	$0		$270,638	$71,178	$341,816
	CONSTRUCTION ESTIMATE TOTALS:	$285,037	$74,965		$360,001	1.9%	$290,372	$76,368	$366,740	$0		$317,355	$83,464	$400,820
01	LANDS AND DAMAGES	$0	$0 -		$0	-	$0	$0	$0	$0		$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN	$4,453	$1,171	26%	$5,624	3.4%	$4,606	$1,211	$5,817	$0		$4,794	$1,261	$6,054
31	CONSTRUCTION MANAGEMENT	$6,675	$1,755	26%	$8,430	3.4%	$6,904	$1,816	$8,720	$0		$8,210	$2,159	$10,369
	PROJECT COST TOTALS:	$296,164	$77,891	26%	$374,056		$301,882	$79,395	**$381,277**	$0		$330,359	$86,884	$417,243

GNEITING-JAMES.THERESA.ANNE.1397797847 — CHIEF, COST ENGINEERING,

PEREZ.CYNTHIA.BERRIOS.1232161309 — PROJECT MANAGER, Cynthia Perez

NIXON.KARL.JAMES.1229751057 — CHIEF, REAL ESTATE, Audrey Ormerod

CHIEF, PLANNING, Eric Bush

CHIEF, ENGINEERING, Laureen Borochaner

CHIEF, OPERATIONS, Jim Jeffords

CHIEF, CONSTRUCTION, Steve Duba

CHIEF, CONTRACTING, Carlos Clarke

CHIEF, PM-PB, Dan Haubner

CHIEF, DPM, Dave Hobbie

ESTIMATED FEDERAL COST:	**75%**	**$312,932**
ESTIMATED NON-FEDERAL COST:	**25%**	**$104,311**
ESTIMATED TOTAL PROJECT COST:		**$417,243**

NOTE: CONTINGENCIES IN ACCORDANCE WITH CSRA.

Filename: TPCS_PEHHBR_48'_Sep2014_R4.xlsx
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Port Everglades Harbor Deepening [48' LPP]
LOCATION: Port Everglades, FL
This Estimate reflects the scope and schedule in report; Port Everglades Harbor Engineering Appendix

DISTRICT: SAJ Jacksonville
POC: CHIEF, COST ENGINEERING,
PREPARED: 10/6/2014

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 9/2/2014 Effective Price Level: 1-Oct-2014				Program Year (Budget EC): 2016 Effective Price Level Date: 1 OCT 15								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
02	RELOCATIONS	$148	$39	26%	$187	1.9%	$150	$40	$190	2020Q3	9.3%	$164	$43	$208
06	FISH & WILDLIFE FACILITIES	$41,812	$10,996	26%	$52,808	1.9%	$42,595	$11,202	$53,797	2020Q3	9.3%	$46,552	$12,243	$58,796
12	NAVIGATION PORTS & HARBORS	$2,421	$637	26%	$3,057	1.9%	$2,466	$649	$3,115	2020Q3	9.3%	$2,695	$709	$3,404
12	NAVIGATION PORTS & HARBORS	$28,709	$7,550	26%	$36,259	1.9%	$29,246	$7,692	$36,938	2020Q3	9.3%	$31,964	$8,406	$40,370
12	NAVIGATION PORTS & HARBORS	$88,310	$23,226	26%	$111,536	1.9%	$89,963	$23,660	$113,624	2020Q3	9.3%	$98,323	$25,859	$124,182
12	NAVIGATION PORTS & HARBORS	$4,039	$1,062	26%	$5,101	1.9%	$4,114	$1,082	$5,196	2020Q3	9.3%	$4,497	$1,183	$5,679
12	NAVIGATION PORTS & HARBORS	$119,589	$31,454	26%	$151,053	1.9%	$121,837	$32,043	$153,881	2020Q3	9.3%	$133,159	$35,021	$168,180
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$285,037	$74,965	26%	**$360,001**		$290,372	$76,368	$366,740			$317,355	$83,464	$400,820
01	LANDS AND DAMAGES	$0	$0	26%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.06%	Project Management	$173	$45	26%	$218	3.4%	$179	$47	$226	2016Q1	0.0%	$179	$47	$226
0.39%	Planning & Environmental Compliance	$1,100	$289	26%	$1,389	3.4%	$1,138	$299	$1,437	2016Q1	0.0%	$1,138	$299	$1,437
0.56%	Engineering & Design	$1,600	$421	26%	$2,021	3.4%	$1,655	$435	$2,090	2016Q1	0.0%	$1,655	$435	$2,090
0.05%	Reviews, ATRs, IEPRs, VE	$150	$39	26%	$189	3.4%	$155	$41	$196	2016Q1	0.0%	$155	$41	$196
0.04%	**Life Cycle Updates (cost, schedule, risks**	$100	$26	26%	$126	3.4%	$103	$27	$131	2016Q1	0.0%	$103	$27	$131
0.04%	Contracting & Reprographics	$120	$32	26%	$152	3.4%	$124	$33	$157	2016Q1	0.0%	$124	$33	$157
0.01%	Engineering During Construction	$35	$9	26%	$44	3.4%	$36	$10	$46	2020Q3	18.9%	$43	$11	$54
0.32%	Planning During Construction	$925	$243	26%	$1,168	3.4%	$957	$252	$1,208	2020Q3	18.9%	$1,138	$299	$1,437
0.09%	Project Operations	$250	$66	26%	$316	3.4%	$259	$68	$327	2016Q1	0.0%	$259	$68	$327
31	CONSTRUCTION MANAGEMENT													
2.34%	Construction Management (S&A + S&I)	$6,675	$1,755	26%	$8,430	3.4%	$6,904	$1,816	$8,720	2020Q3	18.9%	$8,210	$2,159	$10,369
0.0%	Project Operation:				$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
0.0%	Project Management				$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	CONTRACT COST TOTALS:	$296,164	$77,891		**$374,056**		$301,882	$79,395	$381,277			$330,359	$86,884	**$417,243**

Filename: TPCS_PEHHBR_48'_Sep2014_R4.xlsx
TPCS

G7. COST MCX TPCS CERTIFICATION

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For Project No. 113180

SAJ – Port Everglades Harbor Deepening (48' NED/LPP)

The Port Everglades Harbor Deepening – 48' project, as presented by Jacksonville District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering. The Cost MCX certifies the estimated total project cost:

NED Plan (47' Depth)
FY 2016 Price Level: $362,938,000
Fully Funded Amount: $393,173,000

LPP (48' Depth)
FY 2016 Price Level: $381,277,000
Fully Funded Amount: $417,243,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

Digitally signed by CALLAN.KIM.C.1231558221
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=CALLAN.KIM.C.1231558221

Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

US Army Corps of Engineers®

FOR CONTINUATION OF HOUSE DOCUMENT 114-104

**PORT EVERGLADES BROWARD COUNTY, FLORIDA
ENVIRONMENTAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT**

SEE PART 2