Environmental Assessment
For

Issuance of Incidental Harassment Authorizations
for the
U.S. Army Corps of Engineers Confined Blasting Operations during the Port of Miami Construction Project in Miami, Florida

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Lead Agency: U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Office of Protected Resources

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Location: Port of Miami, Florida

Abstract: The National Marine Fisheries Service (NMFS) proposes to issue several one-year Incidental Harassment Authorizations (IHA) for takes of marine mammals in the wild, pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA, 16 U.S.C. 1361 *et seq.*). The IHAs would authorize the incidental taking, by Level B harassment of small numbers of Atlantic bottlenose dolphins (*Tursiops truncatus*) during confined blasting operations on the deepening of Miami Harbor in Miami-Dade County, Florida.

CHAPTER 1 PURPOSE OF AND NEED FOR ACTION

1.1 DESCRIPTION OF ACTION

1.1.1 Summary of IHA Request

On May 17, 2011, the National Marine Fisheries Service (NMFS), Permits and Conservation Division received a request from the U.S. Army Corps of Engineers (ACOE) to take, by Level B harassment only, small numbers of Atlantic bottlenose dolphins, incidental to confined blasting operations in the Miami Harbor, Port of Miami in Miami-Dade County, Florida. The IHA application was considered adequate and complete on September 9, 2011. The ACOE proposes to conduct four components as part of the project in Miami Harbor. These components include the widening of Cut 1 and deepening of Cut 1 and Cut 2, adding a turn widener and deepening at the southern intersection of Cut 3 within Fisherman's Channel, widening and deepening the Fisher Island Turning Basin, and expanding the Federal Channel and Port of Miami berthing areas in Fisherman's Channel and the Lummus Island Turning Basin. The construction will likely be completed using a combination of mechanical dredge (i.e., clamshell or backhoe), cutterhead dredge, and rock pre-treatment by confined blasting. The dredging will remove approximately 5,000,000 cubic yards (cy) (3,822,774.2 cubic meters [m^3]) of material from the harbor. Material removed from the dredging will be placed in Miami Harbor Ocean Dredged material Disposal Site, or used to construct seagrass and reef mitigation projects. The confined blasting is proposed to take place beginning during the fall/winter of 2012 (November, 2012), and is expected to take up to 24 months in Miami, Florida. Confined blasting means that the shots would be "confined" in the rock with stemming that prevents the explosive energy from going upward from the hole into the water column, and forces it to go laterally into the surrounding rock. IN confined blasting, each charge is placed in a hole drilled in the rock approximately 5 to 10 feet deep; 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. A charge is the total weight of the explosives to be detonated during a blast. This can also be broken down into the weight of the individual delays. This process is referred to as "stemming the hole." On November 18, 2011, NMFS published a notice in the *Federal Register* (76 FR 71517) disclosing the effects on marine mammals, making preliminary determinations and including a proposed IHA. The notice initiated a 30 day public comment period. As such, NMFS proposes to issue an IHA pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1371 *et seq*.), and the regulations governing the taking and importing of marine mammals (50 CFR Part 216).

1.1.2 Purpose and Need

MMPA Incidental Take Authorization Process

The purpose and need of the action is to ensure compliance with the MMPA and its implementing regulations for the activities associated with the ACOE. The 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*.) direct the Secretary of Commerce 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.

An authorization to take small numbers of marine mammals shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and other means of effecting the least practicable impact (mitigation), 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."

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the U.S. can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Except with respect to certain activities not relevant here, the MMPA defines "harassment" as

> "...any act of pursuit, torment, or annoyance which (a) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (b) has the potential to 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]."
> (16 USC 1362[18])

Section 101(a)(5)(D) establishes a 45-day time limit for NMFS review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of small numbers of marine mammals. Within 45 days of the close of the comment period, NMFS must either issue or deny issuance of the authorization.

NEPA Requirements and Scope of NEPA Analysis

NMFS' decision of whether or not to issue the ACOE an IHA is a major Federal action that requires an analysis of its effect on the human environment pursuant to the National Environmental Policy Act (NEPA). This Environmental Assessment (EA) contains that analysis and is intended to support NMFS' issuance of an IHA authorizing the incidental take of small numbers of marine mammals associated with the ACOE's Miami Harbor Deepening Project.

The proposed issuance of authorization for incidental take of marine mammals through an IHA is not categorically excluded from NEPA review. In addition, it is not the type of action normally requiring preparation of an Environmental Impact Statement (EIS). NMFS has prepared this EA to assist in determining whether the direct, indirect, and cumulative impacts related to its issuance of the authorization for incidental take under the MMPA are likely to result in significant impacts to the human environment, or whether the analysis contained herein,

including documents referenced and incorporated by reference and public comments received on the proposed IHA, support the issuance of a Finding of No Significant Impact (FONSI). Given the limited scope of the decision for which NMFS is responsible (i.e., whether or not to issue the authorization including prescribed means of take, mitigation and monitoring measures) that this EA is intended to inform, the scope of analysis is limited to evaluating and disclosing impacts to living marine resources and their habitat likely to be affected by the reconstruction operations. As described more fully below, the EA identifies all marine mammals, species protected under the Endangered Species Act (ESA), and essential fish habitat (EFH) likely to occur within the action area. The primary analysis focuses on the impacts to Atlantic bottlenose dolphins likely to result from the proposed blasting operations in the Port of Miami that would be conducted under the IHA and associated mitigation, monitoring, and reporting requirements, impacts that would result from the alternatives that are presented, and to consider potential cumulative environmental impacts. Impacts to other species and habitat located in the action area were considered unlikely, and, thus did not receive detailed evaluation. The need for this EA is to provide a NEPA analysis informing the decision of whether or not to issue the IHA and to determine whether the proposed action has any potential for significant impacts.

The Jacksonville District of the ACOE prepared a *Final General Reevaluation Report and Environmental Impact Statement on the Miami Harbor Navigation Study, Miami-Dade County, Florida* (FEIS), and a Record of Decision (ROD) for the project was signed on May 22, 2006; however this document does not analyze NMFS' action, the issuance of the IHA for the ACOE's activity. The FEIS evaluated various structural and non-structural components of transit of larger commercial vessels with more cargo tonnage onboard. These components of alternatives were evaluated for costs, benefits, and environmental impacts associated with implementation. Technical and economic criteria used in the formulation of alternative plans were those specified in the Water Resources Council's *Principles and Guidelines*. The ACOE considered all applicable laws, executive orders, regulations, and local government plans in evaluating the alternatives. All practicable means to avoid or minimize adverse environmental effects have been incorporated into the recommended plan. The recommended plan is not the environmentally preferable plan, but is the one that delivers substantial benefits in a cost effective manner while meeting the overall Federal and State objectives. The recommended plan contains features for mitigation that will avoid, minimize and compensate for adverse environmental and social impacts. Based on review of these evaluations, the ACOE finds that the benefits gained by implementation of the recommended plan far outweigh any adverse impacts and the overall public interest will best be served. NMFS incorporates the FEIS by reference in this EA.

1.1.3 Objectives of the Miami Harbor Deepening Project

The ACOE proposes to deepen and widen the Federal channels at Miami Harbor, Port of Miami, in Miami-Dade County, Florida. The recommended plan (Alternative 2 of the ACOE's FEIS) consists of four components, which include the widening of Cut 1 and deepening of Cut 1 and Cut 2, adding a turn widener and deepening at the southern intersection of Cut 3 within Fisherman's Channel, widening and deepening the Fisher Island Turning Basin, and expanding Federal Channel and Port of Miami berthing areas in Fisherman's Channel and the Lummus Island Turning Basin. For the new construction at Miami Harbor, the ACOE expects the

proposed project may take multiple years, and the ACOE will seek subsequent renewals of this IHA after issuance, with sufficient time to prevent any delay to the project.

1.2 PUBLIC INVOLVEMENT

While the Council on Environmental Quality's (CEQ) regulations and NOAA Administrative Order 216-6, implementing the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*), do not require that a draft EA be made available for public comment, NMFS uses the IHA review process to inform the public of environmental issues and information related to the proposed action being analyzed in the EA and to obtain public comment for consideration prior to making final determinations regarding the significance of environmental impacts.

Under 50 CFR 216.104(b) of NMFS' implementing regulations for the MMPA, NMFS must, after deeming the application adequate and complete, publish in the *Federal Register* a notice of proposed IHA or receipt of a request for the implementation or re-implementation of regulations governing the incidental taking. Information gathered during the associated comment period is considered by NMFS in ensuring adequacy of preliminary determinations and proposed monitoring and mitigation measures for IHAs. In accordance, a notice of proposed issuance of an IHA was published in the *Federal Register* on November 18, 2011 (76 FR 71517) and made available for public review and comment for 30 days. Comments received on the proposed IHA were also used to develop the scope of this EA.

Pursuant to 50 CFR §216.33(d)(2), NMFS consulted with the Marine Mammal Commission (Commission) in reviewing the application for an IHA under the MMPA. Concurrent with the publication of the proposed IHA in the *Federal Register* for the availability of public comment, copies of the IHA application were forwarded to the Commission and its Committee of Scientific Advisors for review.

The Commission provided comments on the proposed action. Generally, the Commission comments recommended that NMFS issue the IHA, provided it requires the ACOE to: (1) conduct empirical sound propagation measurements during two detonation events per day using various delay weights and numbers of delays to verify that the danger and exclusion zones are sufficient to protect marine mammals from sound exposure levels, including the 182 and 177 dB re 1 μPa^2 second thresholds – the zones then should be adjusted accordingly; and (2) suspend all activities if the authorized number of takes is reached.

These comments were considered by NMFS in developing the IHA and specific responses will be provided in the *Federal Register* notice announcing the issuance of the IHA. While some comments mentioned cumulative impacts, NMFS did not receive any NEPA-specific comments during the public comment period of the proposed IHA.

1.3 APPLICABLE LAWS AND NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

This section summarizes Federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action, as well as who is responsible for

obtaining them. Even when it is the applicant's responsibility to obtain such permissions, NMFS is obligated under NEPA to ascertain whether the applicant is seeking other Federal, state, or local approvals for their action.

1.3.1 National Environmental Policy Act

The NEPA was enacted in 1969 and its environmental review requirements set forth in section 102(C) are applicable to all "major" Federal actions with the potential to result in significant affecting the quality of the human environment. A major Federal action is an activity that is fully or partially funded, regulated, conducted, or approved by a Federal agency. NMFS' issuance of incidental take authorizations represents approval and regulation of activities. While NEPA does not dictate substantive requirements for permits, licenses, etc., it requires consideration of environmental issues in Federal agency planning and decision making. The procedural provisions outlining Federal agency responsibilities under NEPA are provided in the CEQ's implementing regulations (40 CFR Parts 1500-1508).

NOAA has, through NOAA Administrative Order (NAO) 216-6, established agency procedures for complying with NEPA and the implementing regulations issued by the CEQ. NAO 216-6 specifies that issuance of incidental take authorizations under the MMPA is among a category of actions that are generally exempted (categorically excluded) from further environmental review if they are tiered to a pre-existing programmatic environmental review, except under extraordinary circumstances. When a proposed action that would otherwise be categorically excluded is the subject of public controversy based on potential environmental consequences, has uncertain environmental impacts or unknown risks, established a precedent or decision in principle about future proposals, may result in cumulatively significant impacts, or may have an adverse effect upon endangered or threatened species or their habitats, preparation of an EA or EIS is required. NMFS has not prepared a programmatic NEPA analysis covering the proposed IHA. Since issuance of the IHA has the potential to adversely affect species protected under the MMPA, NMFS has decided to prepare an EA to evaluate the context and intensity of such impacts to determine whether or not they have the potential to be significant. This EA is prepared in accordance with NEPA, its implementing regulations, and NAO 216-6.

As noted above, the ACOE, Jacksonville District, has prepared a FEIS and a ROD for the project was signed on May 22, 2006; however, that document does not analyze NMFS' action, the issuance of IHAs for the ACOE's activities. All applicable laws, executive orders, regulations, and local plans were considered in evaluating the alternatives. The recommended plan is not the environmentally preferable plan, but is the one that delivers substantial benefits in a cost effective manner while meeting the overall Federal and state objectives and incorporates features to avoid, minimize, or mitigate adverse environmental and social effects. Based on review of these evaluations, the ACOE finds that the benefits gained by implementation of the recommended plan far outweigh any adverse impacts and the overall public interest will best be served. NMFS has reviewed the ACOE FEIS for consistency with regulations published by the CEQ and NAO 216-6, Environmental Review Procedures for Implementing the NEPA. While NMFS has incorporated that document and analysis by reference and does not repeat the analysis contained therein, it is conducting this EA as a separate NEPA analysis to evaluate the effects of

authorizing the incidental take of marine mammals and the issuance of IHAs to the ACOE with a focus on effects to marine mammals and their habitat.

1.3.2 Marine Mammal Protection Act

The 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 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. For authorizations associated with activities that could impact marine mammals in Arctic waters (i.e., waters north of 60º North), the action agency must also consider means of effecting the least practicable impact on the availability of the species for subsistence uses.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act requires consultation with the appropriate Federal agency (either NMFS or the U.S. Fish and Wildlife Service) for Federal actions that "may affect" a listed species or adversely modify critical habitat. NMFS' issuance of an authorization

affecting ESA-listed species or designated critical habitat, directly or indirectly, is a Federal action subject to these section 7 consultation requirements. Section 7 requires Federal agencies to use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. NMFS is further required to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any threatened or endangered species or result in destruction or adverse modification of habitat for such species. Regulations specify the procedural requirements for these consultations (50 Part CFR 402).

1.3.4 Magnuson-Stevens Fishery Conservation and Management Act

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802[10]). The EFH provisions of the MSFCMA offer resource managers means to accomplish the goal of giving heightened consideration to fish habitat in resource management. NMFS Office of Protected Resources is required to consult with NMFS Office of Habitat Conservation for any action it authorizes (e.g., research permits), funds, or undertakes, or proposes to authorize, fund, or undertake that may adversely affect EFH. This includes renewals, reviews, or substantial revisions of actions.

1.3.5 Coastal Zone Management Act

Congress enacted the Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 *et seq*.) to protect the coastal environment from growing demands associated with residential, recreational, commercial, and industrial uses (e.g., State and Federal offshore oil and gas development). Those coastal states with an approved Coastal Zone Management Plan, which defines permissible land and water use within the state's coastal zone, can review Federal actions, licenses, or permits for "Federal consistency." "Federal consistency" is the requirement that those Federal permits and licenses likely to affect any land/water use or natural resources of the coastal zone be consistent with the Program's enforceable policies. NMFS consults with states on issuance of permits for activities that fall within the state's Coastal Zone Management Plan.

CHAPTER 2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the range of potential actions (alternatives) determined reasonable with respect to achieving the stated purpose and need for the proposed action, as well as alternatives eliminated from detailed study. This chapter also summarizes the expected outputs and any related mitigation of each alternative. One alternative is the "No Action" alternative where the proposed authorization(s) would not be issued. The No Action alternative is the baseline for the rest of the analyses. The Proposed Action alternative represents the activity proposed in the submitted application for an IHA, with standard IHA mitigation, monitoring, and reporting requirements specified by NMFS.

2.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, NMFS would not issue an IHA to the ACOE authorizing the take of small numbers of marine mammals incidental to the specified activity. The ACOE would still be authorized to conduct the activity; however, the MMPA prohibits all takings of marine mammals unless authorized by a permit or exempted under the MMPA. Thus, moving forward with blasting operations that could affect Atlantic bottlenose dolphins could result in the unauthorized take of marine mammals and monitoring and mitigation measures would not be required by the IHA, however, the ACOE has committed to implement them as part of their NEPA and ESA analyses. While the ACOE is unlikely to do this, and this alternative is thus not feasible for selection, NMFS has included it in the EA to establish an environmental baseline against which the environmental impacts of the preferred alternative, including mitigation and monitoring measures, can be compared and contrasted.

2.2 ALTERNATIVE 2 – PROPOSED ACTION (ISSUANCE of IHAs, PREFERRED ALTERNATIVE)

Under the Proposed Action (preferred) alternative, several one-year IHAs would be issued for takes of small numbers of marine mammals incidental to specified activities as proposed by the applicant, with the mitigation, monitoring, and reporting conditions contained within the ACOE's application and NMFS' proposed IHA *Federal Register* notice (76 FR 71517, November 18, 2011). The primary distinction between the proposed action and no action alternative is the proposed action's requirement to implement mitigation and monitoring measures to minimize impacts to marine mammals. The monitoring, mitigation, and reporting requirements in this document are incorporated into the IHA.

2.2.1 Dates, Duration, and Specific Geographic Area

At this time the ACOE has not yet awarded a contract or given a Notice to Proceed (NTP) with a specific date for the initiation of construction activities within the Port of Miami. However, the ACOE requested that the first IHA be issued by the end of July, 2012, with an effective date of March 15, 2013, to allow for the advertisement of the contract for construction in September, 2012; award the contract and provide the NTP to the selected contractor in February, 2013, resulting in construction work beginning in March, 2013. After receiving the NTP, the contractor will have 45 days to begin dredging activities, but blasting activities shall not begin until after March 15, 2013. The proposed construction activities are expected to take up to 26 months and based on the information available at this time, it is possible that confined blasting could take place at any time during construction. The ACOE also notes that multiple IHAs (up to three) will be needed and requested for this project due to the project duration.

The confined blasting activities will be limited to waters shallower than 60 ft (18.3 m) and located entirely on the continental shelf and will not take place seaward of the outer reef. The specified geographic area of the construction will be within the boundaries of the Port of Miami, in Miami, Florida (see Figure 11 of the ACOE's IHA application). The Port of Miami is an island facility consisting of 518 upland acres and is located in the northern portion of Biscayne Bay in South Florida. The City of Miami is located on the west side of the Biscayne Bay; the City of Miami Beach is located on an island on the northeast side of Biscayne Bay, opposite of Miami. Both cities are located in Miami-Dade County, Florida, and are connected by several

causeways crossing the bay. The Port of Miami is the southernmost major port on the Atlantic Coast. The Port of Miami's landside facilities are located on Dodge-Lummus Island, which has a GPS location 25° 46' 05" North 80° 09' 40" West. See Figure 11 of the ACOE's IHA application for more information on the location of the proposed project area in the Port of Miami.

Referenced to other major ports in the south Atlantic region, the Port of Miami is located 21 nautical miles (nmi) (38.9 kilometers [km]) south of Port Everglades (Fort Lauderdale), Florida; 83 nmi (153.7 km) south of Palm Beach, Florida; 173 nmi (320.4 km) south of Port Canaveral, Florida; 306 nmi (566.7 km) south of Jacksonville, Florida, the northern port on Florida's Atlantic coast; 386 nmi (714.9 km) south of Savannah, Georgia; and 420 nmi (777.8 km) south of Charleston, South Carolina.

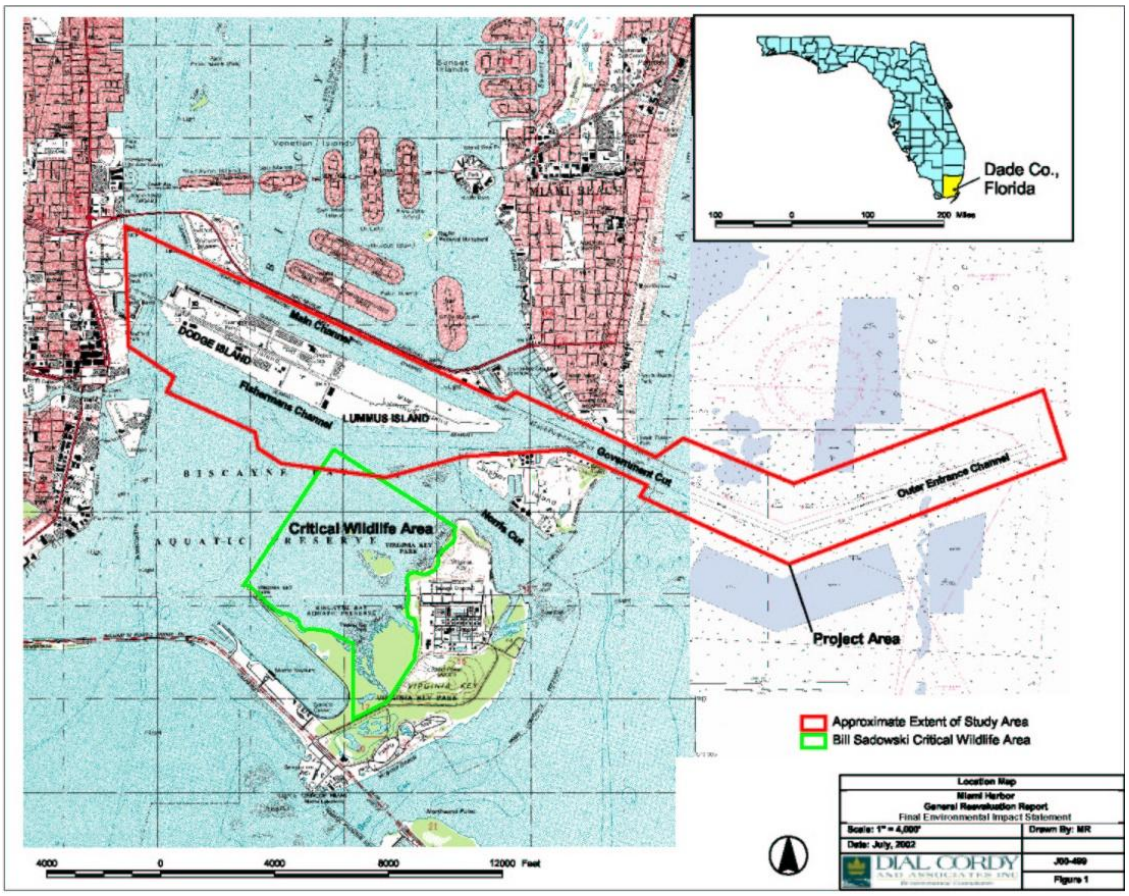

Figure 1 – (Figure 11 of the ACOE's IHA application) Location of the Port of Miami, Florida.

2.2.2. Specified Activity

The ACOE plans to deepen and widen the Federal channels at Miami Harbor, Port of Miami, in Miami-Dade County, Florida. The recommended plan (Alternative 2 of the Environmental Impact Statement [EIS]) includes four components (see Figure 1):

(1) Widen the seaward portion of Cut 1 from 500 to 800 feet (ft) (152.4 to 243.8 meters [m]) and deepen Cut 1 and Cut 2 from a project depth of -44 to -52 ft (13.4 to 15.9 m);
(2) Add a turn widener at the southern intersection of Cut 3 within Fisherman's Channel and deepen to a project depth of -50 ft (-15.2 m);
(3) Increase the Fisher Island Turning Basin from 1,200 to 1,500 ft (365.8 to 457.2 m), truncate the northeast section of the turning basin to minimize seagrass impacts, and deepen from -42 ft (-12.8 m) to a project depth of -50 ft; and
(4) Expand the Federal Channel and Port of Miami berthing areas in Fisherman's Channel and in the eastern end of the Lummus Island Turning Basin (LITB) by 60 ft (18.3 m) to the south for a total of a 160 ft (48.8 m) wide berthing area and will be deepened from -42 ft to a project depth of -50 ft. The Federal Channel will be widened 40 ft (12.2 m) to the south, for a 100 ft (30.5 m) total width increase in Fisherman's Channel. This component (referred to as Component 5) will deepen Fisherman's Channel and the LITB from -42 ft to a project depth of -50 ft. See Figure 1 of ACOE's IHA application for a map of the proposed project's components.

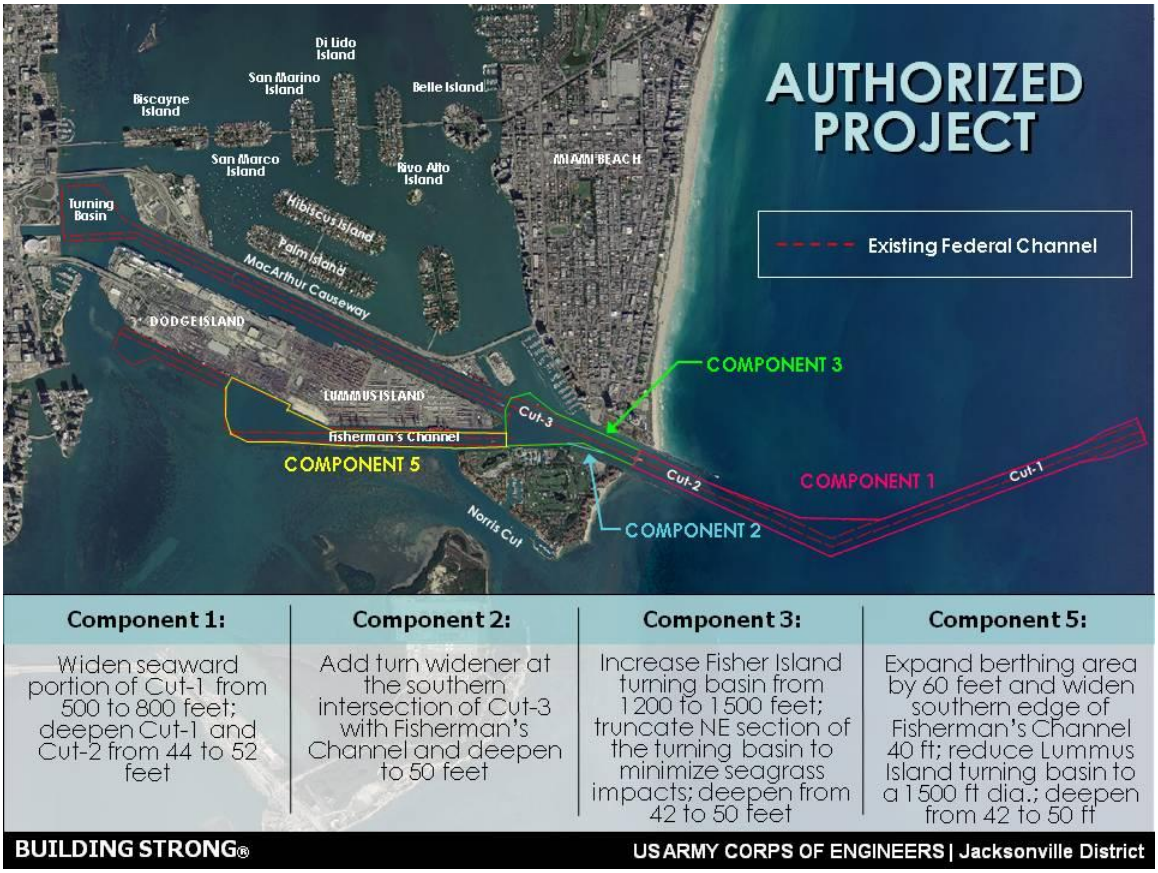

Figure 2 – (Figure 1 of the ACOE's IHA application) Miami Harbor Deepening Project components.

Disposal of the estimated five million cubic yards of dredged material would occur at up to three disposal sites (seagrass mitigation area, offshore artificial reef mitigation areas, and the Miami Offshore Dredged Material Disposal Site). This project was previously evaluated under an

Environmental Impact Statement (EIS) titled "Miami Harbor Miami-Dade County, Florida Navigation Study, Final General Reevaluation Report and Environmental Impact Statement," prepared under the NEPA, and a Record of Decision for the proposed project was signed on May 22, 2006. The original proposed project included six components, two of which (components four and six) have been removed. The FEIS provides a detailed explanation of project location as well as all aspects of project implementation. It is also available online for public review at: http://www.saj.usace.army.mil/Divisions/Planning/Branches/Environmental/DOCS/OnLine/Dade/MiamiHarbor/NAV_STUDY_VOL-1_MIAMI.pdf

To achieve the deepening of the Miami Harbor from the existing depth of -45 ft (-13.7 m) to project depth of -52 ft, pretreatment of some of the rock areas may be required using confined underwater blasting, where standard construction methods are unsuccessful due to the hardness of the rock. The ACOE has used two criteria to determine which areas are most likely to need confined blasting for the Miami Harbor expansion: (1) areas documented by core borings to contain hard and/or massive rock; and (2) areas previously blasted in the harbor during the 2005 confined blasting and dredging project.

The duration of the confined blasting is dependent upon a number of factors including hardness of rock, how close the drill holes are placed, and the type of dredging equipment that will be used to remove the pretreated rock. Without this information, an exact estimate of how many confined "blast days" will be required for the project cannot be determined. The harbor deepening project at Miami Harbor in 2005 to 2006 estimated between 200 to 250 days of confined 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 confined blasts. A shot, or blast is an explosion made up of a group of blast holes set in a pattern referred to as a blast array that are detonated all at once or in a staggered manner with delays between them. A blast hole is the hole drilled into the bottom substrate that will be filled with explosives, capped with stemming, and detonated.

The upcoming expansion at Miami Harbor scheduled to begin in fall/winter of 2012 currently estimates a maximum of 600 blast days for the entire multi-year project footprint. The ACOE estimates a maximum number of 313 blast days for the duration of an IHA (i.e., 365 days in a year minus 52 Sundays [no confined blasting is allowed on Sundays due to local ordinance]). A blast day is defined as one confined blast event/day. A blast event is made up of all the actions during a shot, this includes the Notice of Project Team and Local Authorities, which occurs two hours before the blast is detonated, through the end of the protected species watch, which lasts 30 minutes after the blast detonation. A typical blast timeline consists of: Notice to Project Team and Local Authorities (T minus 2 hours), protected species watch begins (T minus 1 hour), Notice to Mariners (channel closes, T minus 15 minutes), fish scare (T minus 1 minute), blast detonation, all clear signal (T plus 5 minutes), protected species watch ends (T plus 30 minutes), and delay capsule – 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 volition, from both the danger and safety zones (can occur between T minus 1 hour and detonation). There may be more than one confined blast event in a calendar day. While confined blasting events will occur only during the daylight hours, typically six days a week. Other operations associated with the proposed action (i.e., dredging activities) will take place 24 hours a day, typically seven days a week. Confined

blasting activities will not take place on Sundays due to local ordinances. The contractor may drill the blast array (i.e., physically drill the holes in the substrate to be removed in the pattern designed by the blasting engineer to remove the rock in the manner he/she needs to achieve the needed results) at night and then blast after at least two hours after sunrise (one hour to reach full light conditions, plus one hour of monitoring). After detonation of the first explosive array, a second array may be drilled and detonated before the one-hour before sunset prohibition is triggered. An explosive array is the pattern of blast holes drilled into the bottom substrate that will be fractured by the blast detonation.

At this time, the ACOE has not selected a contractor and thus does not have a contractor-developed confined blasting plan from the contractor specifically identifying the number of holes that will be drilled, the amount of explosives that will be used for each hole, the number of confined blasts per day (usually no more than two per a day) or the number of days the construction is anticipated to take to complete. The ACOE is required to have all authorizations and permits completed (including the possession of an IHA) prior to the request for proposal and advertising the contract, per the Competition in Contracting Act, and the Federal Acquisition Regulations. While the ACOE does not have contract bids at this time, it is possible to make reasonable estimates of the bounds based on previous similar projects that have been conducted by the ACOE here and at other locations. NMFS supports the use of the worst-case scenarios to estimate confined blasting activities and associated potential impacts.

Drill holes are small in diameter (typically 2 to 4 in [5.1 to 10.2 cm] in diameter) and only 5 to 10 ft (1.5 to 3.1 m) deep, and drilling activities take place for a short time duration, with no more than three holes being drilled at the same time (based on the current drill-rigs available in the industry that range from one to three drills). During the 2005 confined blasting event, dolphins were seen near the drill barge during drilling events and the ACOE did not observe avoidance behavior. No measurements associated with noise from drilling small blast holes have been recorded. The ACOE does not expect incidental harassment from drilling operations and is not requesting take associated with this activity.

Although the ACOE does not have a specific contractor-provided confined blasting plan, the ACOE developed plans and specifications for the project that direct the contractor to do certain things in certain ways and are basing these plans and specifications on the previous deepening project in Miami Harbor (construction was conducted in 2005 to 2006).

The previous ACOE project in Miami Harbor required a maximum weight of explosives used in each delay of 376 pounds (lb) (170.6 kilograms [kg]) and the contractors blasted once or twice daily from June 25 to August 25, 2005, for a total of 40 individual blasts in 38 days of confined blasting. The 2005 project, which utilized confined blasting, was limited to Fisherman's Channel and the Dodge-Lummus Island Turning Basin (see Figure 2 of ACOE's IHA application, which shows the confined blasting footprint for the 2005 project), whereas the project described in the ACOE's application includes Fisherman's Channel, Dodge-Lummus Island Turning Basin, Fisher Island Turning Basin, and Inner and Outer Entrance Channel. This larger area will result in more confined blasting for this project than was completed in 2005, as it includes areas not previously blasted in 2005.

A copy of the *Federal Register* notice of issuance for the IHA from 2003 (68 FR 32016, May 29, 2003), the IHA renewal from 2005 (70 FR 21174, April 25, 2005), and the final biological monitoring report from the ACOE's Miami Harbor Phase II project (completed in 2006) is attached to the ACOE's application and available on NMFS' website at: http://www.nmfs.noaa.gov/pr/permits/incidental.htm#iha. For the new construction at Miami Harbor, the ACOE expects the proposed project may take multiple years, and the ACOE will seek subsequent renewals of this IHA after issuance, with sufficient time to prevent any delay to the project.

Figure 3 – (Figure 2 of the ACOE's IHA application) Blasting footprint for Phase II project.

For the proposed deepening at Miami Harbor, the ACOE has consulted with blasting industry experts and believes, based on the rock hardness and composition at Miami Harbor, a maximum charge weight per delay of 450 lbs (204.1 kg) should be expected. The minimum charge weight will be 10 lbs (4.5 kg). A delay is a period of time (in milliseconds) between small detonations that are part of the total charge weight of the entire detonation.

The focus of the proposed confined blasting work at the Miami Harbor is to pre-treat the massive limestone formation that makes up the base of Miami Harbor prior to removal by a dredge. Utilizing "confined blasting" means the explosive shots would be "confined" in the rock. Typically, each blast array is set up in a square or rectangle area divided into rows and columns (see Figures 3, 4, and 5 in the ACOE's IHA application). A typical blast array is 10 holes long by 4 holes wide with holes being spaced 40 ft (12.2 m) apart, covering an area of 4,000 ft^2 (371.6 m^2). Blast arrays near bulkheads can be long-linear feature of one-hole wide by 8 or 10 holes long (see Figure 4 of the IHA application).

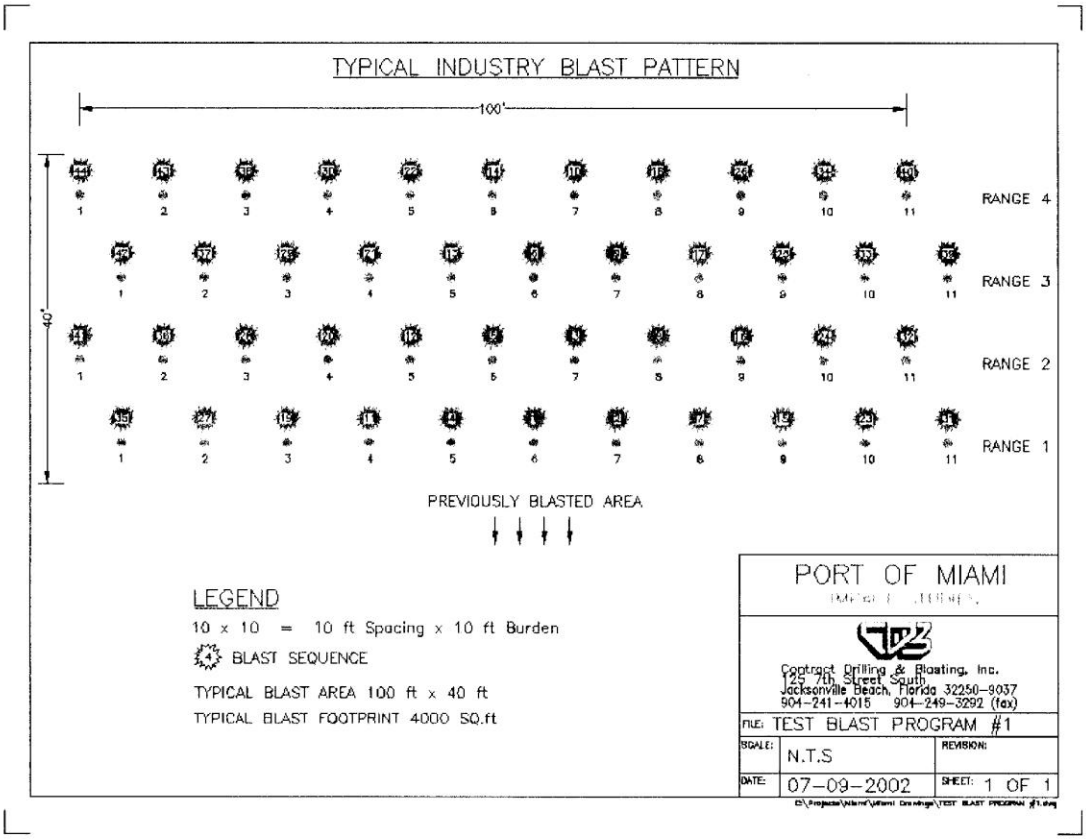

Figure 4 – (Figure 3 of the ACOE's IHA application) Typical blast array – 10 holes x 10 holes; 100 ft long by 40 ft wide; 4,000 ft^2 area per detonation.

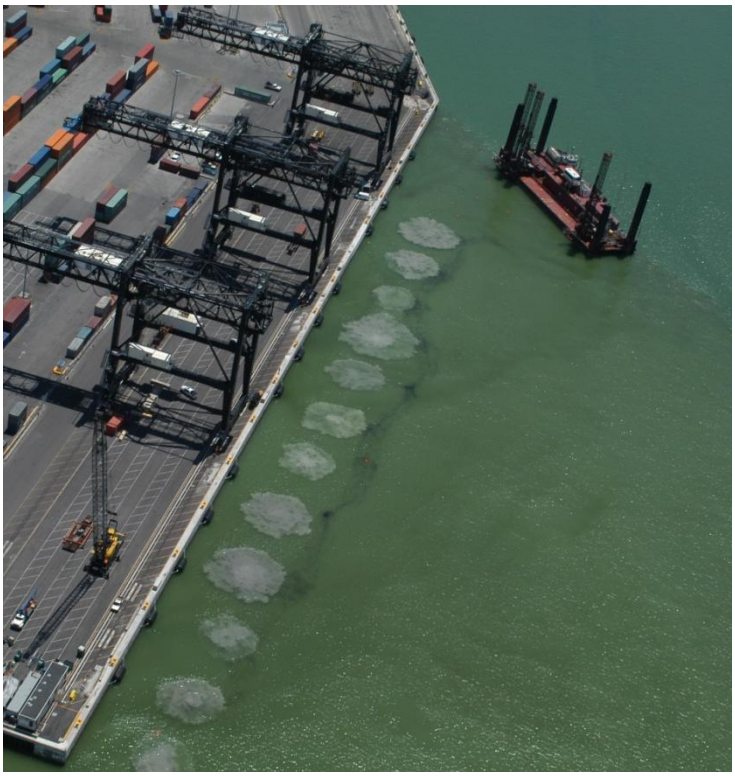

Figure 5 – (Figure 4 of the ACOE's IHA application) Linear blast array along a bulkhead.

Figure 6 – (Figure 5 of the ACOE's IHA application) Typical rectangular blast array.

In confined blasting, each charge is placed in a hole drilled in the rock approximately 5 to 10 ft (1.5 to 3.0 m) deep; 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. This process is referred to as "stemming the hole" (see Figure 6 and 7 of ACOE's IHA application; each bag as shown contains approximate volume of material used per discharge). The ACOE used this technique previously at the Miami Harbor Phase II project in 2005. NMFS issued an IHA for

that operation on May 22, 2003 (68 FR 32016, May 29, 2003) and renewed the IHA on April 19, 2005 (70 FR 21174, April 25, 2005).

For the Port of Miami expansion project (Miami Harbor Phase II) that used confined blasting as a pre-treatment technique, the stemming material was angular crushed rock. (Stemming is the process of filling each borehole with crushed rock after the explosive charge has been placed. After the blasting charge has been set, then the chain of explosives within the rock is detonated. A chain of explosives refers to all of the detonations within the blast array, without regard to how many holes are in the array. They will detonate within milliseconds of each other. Stemming reduces the strength of the outward pressure wave produced by blasts.) The optimum size of stemming material is material that has an average diameter of approximately 0.05 times the diameter of the blast-hole. The selected material must be angular to perform properly (Konya, 2003). For the ACOE's proposed project, specifications will be prepared by the geotechnical branch of the Jacksonville 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 calculations. The minimum stemming shall be 2 ft (0.6 m) 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 sub-angular, hard stone chips without fines having an approximate diameter of 1/2 inch (in; 1.3 centimeters [cm]) to 3/8 in (1 cm). A barrier shall be placed between the stemming and explosive product, if necessary, to prevent the stemming from setting into the explosive product. Anything contradicting the effectiveness of stemming shall not extend through the stemming (see Figure 6 of ACOE's IHA application for a typical drill hole configuration with stemming).

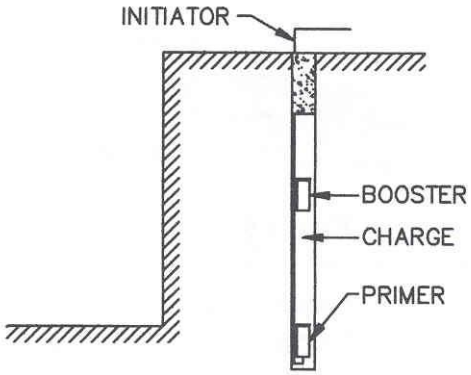

Figure 7 – (Figure 6 of the ACOE's IHA application) Typical drill-hole configuration with stemming.

Figure 8 – (Figure 7 of the ACOE's IHA application) Stemming material.

The specifications for any construction utilizing the confined blasting for the deepening of Miami Harbor would have similar stemming requirements as those that were used for the Miami Harbor Phase II project in 2005 to 2006. The length of stemming material would vary based on the length of the hole drilled, however a minimum of two 2-ft (0.6 m) walls would be included in the project specific specifications. Studies have shown that stemmed blasts have up to a 60 to 90 percent 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 (unconfined) blasts (see Figure 8 of ACOE's IHA application), 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 9 of ACOE's IHA application.

Figure 9 – (Figure 8 of the ACOE's IHA application) Unconfined blast of 7 lbs of explosives.

Figure 10 – (Figure 9 of the ACOE's IHA application) Confined blast of 3,000 lbs total charge weight of explosives.

In confined blasting, the detonation is conveyed from the drill barge to the primer and the charge itself by Primacord and Detaline. These are used to safely fire the blast from a distance to ensure

human safety from the blast. The Primacord and Detaline used on this project have a specific grain weight, and they burn like a fuse. They are not electronic. The time delay from activation to detonation of the charge is less than one second.

To estimate the maximum poundage of explosives that may be utilized for this proposed project, the ACOE has reviewed previous confined blasting projects, including San Juan Harbor, Puerto Rico in 2000, and Miami Harbor, Florida in 2005. Additional data was also reviewed from the New York Harbor deepening project (ACOE, 2004 and Keevin *et al*., 2005) and the Wilmington Harbor project (Settle *et al*., 2002). The San Juan Harbor and 2005 Miami Harbor projects are most similar to the existing project in general environment, hardness/massiveness of rock, and species composition. The San Juan Harbor project's heaviest confined blast event using explosives was 375 lbs (170.1 kg) per delay and in Miami it was 376 lbs (170.6 kg) per delay. Based on discussion with the ACOE's geotechnical engineers, it is expected that the maximum weight of delays for Miami Harbor will be larger since the rock is deeper, and expected to be harder and massive, in comparison to the previous two blasting projects.

Based upon industry standards and ACOE Safety & Health Regulations, the confined blasting program will follow these operating guidelines:

- The weight of explosives to be used in each confined blast will be limited to the lowest poundage of explosives that can adequately break the rock.
- Drill patterns (i.e., holes in the array) are restricted to a minimum of 8 ft (2.4 m) separation from a loaded hole.
- Hours of confined blasting are restricted from two hours after sunrise to one hour before sunset to allow for adequate observation of the proposed project area for marine mammals.
- 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.
- Loaded blast holes will be individually delayed to reduce the maximum lbs per delay at point detonation, which in turn will reduce the mortality radius.
- 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.
- Delay timing adjustments with a minimum of 8 milliseconds (ms) between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water.

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 protective monitoring and mitigation measures in place for protected species as blasting operations 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; and
- 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 proposed 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 the construction blasting plan.

During the test blast program, the following data will be used to develop a regression analysis:

- Distance;
- Pounds per delay;
- Peak particles velocities (Threshold Limit Value [TVL]);
- Frequencies (TVL);
- Peak vector sum; and
- Air blast, overpressure.

As part of the development of the protected species monitoring and mitigation protocols, which will be incorporated into the plans and specification for the proposed project, ACOE will continue to coordinate with the resource agencies and non-governmental organizations (NGOs) to address concerns and potential impacts associated with the use of blasting as a construction technique.

Additional details regarding the proposed blasting and dredging project can be found in the ACOE's IHA application and EIS. The EIS can also be found online at: http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications

CHAPTER 3 AFFECTED ENVIRONMENT

This chapter presents baseline information necessary for consideration of the alternatives, and describes the resources that would be affected by the alternatives, as well as environmental components that would affect the alternatives if they were to be implemented. The effects of the alternatives on the environment are discussed in Chapter 4.

3.1 PHYSICAL ENVIRONMENT

3.1.1 Miami, Florida

The Port of Miami is an island facility located in the northern portion of Biscayne Bay in South Florida. The City of Miami is located on the west side of Biscayne Bay; the City of Miami Beach is located on an island on the northeast side of the bay, opposite Miami. Both cities are located in Miami-Dade County, Florida, and are connected by several causeways crossing the bay. The Port of Miami is the southernmost major port on the Atlantic Coast (ACOE, 2004).

The Port of Miami lies in the north side of Biscayne Bay, a shallow, expansive, subtropical lagoon that extends from the City of North Miami south to the northern end of Key Largo (at the juncture of Miami-Dade and Monroe Counties). Land surrounding the Port of Miami waters is essentially fully developed, except for Virginia Key. Terrestrial and marine habitats in the vicinity include beaches, mangroves, seagrass beds, hardbottom and reef communities, rock/rubble bottom, and unvegetated bottom. The Biscayne Bay Aquatic Preserve and the Bill Sadowski Critical Wildlife Area are located in the vicinity. Manatees, crocodiles, sea turtles, and many species of managed fishes and invertebrates utilize Biscayne Bay and offshore habitats (ACOE, 2004).

Biscayne Bay is a long, narrow, water body approximately 38 miles (mi) (61.2 km) long, and three to nine mi (4.8 to 14.5 km) wide. Average depth is six to ten feet (ft) (1.8 to 3.1 m). Biscayne Bay is bordered on the west by the mainland of peninsular Florida and on the east by both the Atlantic Ocean and a series of barrier islands consisting of sand and carbonate deposits over limestone bedrock (ACOE, 2004).

A thin layer of sediment less than six inches (in) (15.2 cm) in depth characterizes the bay bottom over the most of its area. Sediment thickness is increased up to 40 in (101.6 cm) in the northern part of Biscayne Bay near Miami Beach. Two major natural communities inhabit the bay bottom: seagrass communities and hardbottom communities. In the Atlantic Ocean, water ward of Biscayne Bay and barrier islands, similar communities occur. Nearshore seagrass beds give way to mixed seagrass and hardbottom, deeper channels and, finally the Florida Reef Tract, which runs from Soldier Key south through the Florida Keys (ACOE, 2004).

Tides within the Miami area are semi-diurnal having two high and two low tides each day. The mean range at Miami Beach is 2.5 ft (0.8 m) (3 ft [0.9 m] in spring). The lowest tide is 1.4 ft (0.4 m) below mean low water. The Florida Gulf Stream current off the east coast of Florida flows north and varies in velocity from 17 miles (27.4 km) per day in November to 37 miles (59.5 km) per day in July. Maximum tidal current velocities through Government Cut are approximately 5.5 ft (1.7 m) per second on average tide, but occasional velocities of approximately 6.2 ft (1.9 m) per second have been recorded during spring tide. Flood tidal currents are often oriented perpendicular to the Entrance Channel centerline in the vicinity of the seaward ends of the jetties. This affects vessels handling especially inbound when speed is being reduced approaching docks and wharves.

During the months of September though February the prevailing winds and predominant waves approach from the northeast to east. During March, April, and May, winds and waves usually approach from an easterly direction. June through August, the winds and waves prevail from the southeast. Waves and swells have no effect on deep draft navigation due to their amplitude and short period (ACOE, 2004).

ACOE's FEIS (2004) includes an in-depth analysis on the affected environment, particularly on location, geology and sediments, water quality, seagrass communities, hardbottom and reef communities, unvegetated bottom, rock/rubble communities, air quality, noise and in the action area and that section is incorporated here by reference.

3.1.2 Sanctuaries, Parks, Historic Sites, etc.

Manatee Protection Areas

Fisherman's Channel of the Port of Miami and its vicinity has been designated as essential manatee habitat under the 1995 Miami-Dade County Manatee Protection Plan. Three manatee protection zones designated by Miami-Dade County's Environmental Resources Management are located in the vicinity of the Port of Miami. A Miami-Dade County designated Manatee Population Zone Limited Marine Construction Area is located along the western portion of the Venetian Causeway, and an Essential Manatee Habitat designated area is located south and west of Dodge Island and Lummus Island which extends into the Port of Miami boundary. The existing Bill Sadowski Critical Wildlife Area has also been designated as a No-Entry Manatee Protection Zone. Additionally, all of the water in Miami-Dade County were designated critical habitat for the manatee under the ESA in 1976 (50 CFR 17.95(a)) (ACOE, 2004).

Bill Sadowski Critical Wildlife Area

Located south of the Port of Miami, the Bill Sadowski Critical Wildlife Area was established in 1990 by the Florida Game and Fresh Water Fish Commission (now called the Florida Fish and Wildlife Conservation Commission). This area of about 700 acres was designated to protect the shallow submerged seagrass and hardbottom habitats, intertidal mudflats, and coastal mangrove wetlands in the Biscayne Bay area of Virginia Key. When first established, the area was protected primarily as a refuge for shorebirds and wading birds, but the boundary was later expanded to include important manatee habitat including calving grounds. Buoys mark the Bill Sadowski Critical Wildlife Area boundary on-site and the area is closed to boating year-round (ACOE, 2004).

Biscayne Bay Aquatic Preserve

The Port of Miami is located within the Biscayne Bay Aquatic Preserve. The preserve, which includes all of the waters of Biscayne Bay south to Biscayne National Park, was established in 1980 under Ch. 18-18, F.A.C. and is considered to be State-Owned Submerged Land under the jurisdictional authority of the Florida Department of Environmental Protection. All aquatic preserves in Florida are designated Outstanding Florida Water. Authorized channels within the Port of Miami are excluded from the aquatic preserve due to their status as Federal navigation channels. New construction or other marine activities cannot result in a degradation of water quality outside of specially designated mixing zones (ACOE, 2004).

Biscayne National Park

The northernmost boundary of the Biscayne National Park lies approximately seven miles south of the Port of Miami and covers the widest part of Biscayne Bay down to its southern limit where it meets Card Sound (ACOE, 2004).

Recreation

The Port of Miami is a working port conducting operations on a twenty-four hour basis. It has not been designed to accommodate recreational opportunities for the general public because of attendant safety and security consideration, particularly for cargo operations. For this reason, public access points to the Port of Miami shoreline and public access facilities providing recreational opportunities such as roads with scenic overlooks, marinas, boat ramps, and public docks are limited. However, recreational boating and other water-dependent activities are commonly seen in Biscayne Bay and surrounding waters (ACOE, 2004).

Cultural Resources

Biscayne Bay is frequently mentioned in historic literature and significant historic properties may be located in the Port of Miami vicinity. Shipwrecks occurred within Biscayne Bay, although exact locations of these wrecks are not known. To determine if any potentially historic or cultural resources exist within the specific project area, archival research and consultation with the State Historic Preservation Officer (SHPO) was conducted. In addition, a remote sensing survey was completed by the ACOE. Neither the archival review nor the remote sensing survey identified any historical or cultural resources within the study area. The ACOE also conducted additional coordination with the SHPO for the placement of artificial reef mitigation sites that are not previously permitted by Miami-Dade County Permitting, Environment, and Regulatory Affairs (formerly Environmental Resources Management). As with the previous coordination, neither the archival review nor the remote sensing survey identified any historical or cultural resources within the mitigation site area (ACOE, 2012).

The ACOE's FEIS analyses impacts to cultural resources and includes mitigation for the blasting activities. The issuance of an IHA to the ACOE is not expected to impact these particular resources, and therefore this aspect of the environment will not be further discussed or analyzed.

3.1.3 Essential Fish Habitat

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, "waters" include aquatic areas that are used by fish and their associated physical, chemical, and biological properties and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures, underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem ; and "spawning, breeding, feeding, or growth to maturity" covers a species' entire life cycle.

EFH in estuarine areas (i.e., Fisher Island, Main Channel, and Inner Entrance Channel) of the action area include seagrass, estuarine water column, and algae. EFH in the marine areas (i.e., Entrance Channel, and nearshore and offshore areas) of the action area include live/hardbottom,

coral and coral reef, artificial reef, algae, and water column. Members of the 73 species Snapper-Grouper Complex that commonly use the inshore habitats for part of their life cycle include blue strip grunts (*Haemulon sciurus*), French grunts (*Haemulon flavolineatum*), mahogany snapper (*Lutjanus mahogoni*), yellowtail snapper (*Ocyurus chysurus*), and Nassau grouper (*Epinephelus striatus*). These species utilize the inshore habitats as juveniles and sub-adults. As adults, they utilize the hardbottom and reef communities offshore. In the offshore habitats, the number of species within the Snapper-Grouper Complex that may be encountered increases. 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. In particular, the king mackerel (*Scomberomorus cavalla*), and the Spanish mackerel (*Scomberomorus maculatus*) are the most common. As many as 60 coral species have been documented off the coast of Florida. Those observed in the study area are described in Section 3.5.2 of the ACOE's FEIS. All coral species fall under the protection of the South Atlantic Fishery Management Plan (ACOE, 2004). The ACOE's FEIS also contains information on the habitat associations of selected EFH managed species (Table 6 of the ACOE's FEIS), biological attributes for selected EFH managed species (Table 7 of the ACOE's FEIS), and reproductive requirements of selected EFH species (Table 8 of the ACOE's FEIS), which are incorporated here by reference.

NMFS, Office of Protected Resources, Permits and Conservation Division has determined that the issuance of an IHA(s) for the taking of marine mammals incidental to the blasting and dredging operations will not have an adverse impact on EFH, therefore, an EFH consultation is not required.

3.1.4 Designated Critical Habitat

The ESA mandates the Federal government to designate "critical habitat" for every listed species except in limited circumstances. Critical habitat is an area deemed essential to the conservation of a species listed under the ESA. ESA-designated critical habitat for Johnson's seagrass (*Halophila johnsonii*), and elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) coral occurs within the action area. There is no designated critical habitat for ESA-listed marine mammals within the action area. NMFS previously issued a Biological Opinion (BiOp), dated 2003, which stated that designated critical habitat for Johnson's seagrass may be adversely affected by the proposed action. Based NMFS' updated review of the proposed project in the BiOp, dated 2011, NMFS determined that the project is not likely to adversely affect the critical habitat of Johnson's seagrass. The NMFS BiOp (2011) includes a discussion regarding the designated critical habitat for elkhorn and staghorn coral, and that section is incorporated here in this EA by reference.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Description of Marine Mammals in the Activity Area

Several cetacean species and a single species of sirenian are known to or could occur in the Miami Harbor action area and off the Southeast Atlantic coastline (see Table 1 below). Species

listed as endangered under the ESA, includes the humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), North Atlantic right (*Eubalaena glacialis*), and sperm (*Physeter macrocephalus*) whale, and West Indian (Florida) manatee (*Trichechus manatus latirostris*). The marine mammals that occur in the Atlantic Ocean off the U.S. southeast coast belong to three taxonomic groups: mysticetes (baleen whales), odontocetes (toothed whales), and sirenians (the manatee). The West Indian manatee in Florida and U.S. waters is managed under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) and therefore is not considered further in this analysis. Table 1 below outlines the marine mammal species and their habitat in the region of the proposed project area.

Table 1. (Table 1 of the ACOE's IHA application) The habitat and conservation status of marine mammals inhabiting the proposed study area in the Atlantic Ocean off the U.S. southeast coast.

Species	Habitat	ESA[1]	MMPA[2]
Mysticetes			
North Atlantic right whale (*Eubalaena glacialis*)	Coastal and shelf	EN	D
Humpback whale (*Megaptera novaeangliae*)	Pelagic, nearshore waters, and banks	EN	D
Bryde's whale (*Balaenoptera brydei*)	Pelagic and coastal	NL	NC
Minke whale (*Balaenoptera acutorostrata*)	Shelf, coastal, and pelagic	NL	NC
Blue whale (*Balaenoptera musculus*)	Pelagic and coastal	EN	D
Sei whale (*Balaenoptera borealis*)	Primarily offshore, pelagic	EN	D
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	EN	D
Odontocetes			
Sperm whale (*Physeter macrocephalus*)	Pelagic, deep seas	EN	D
Cuvier's beaked whale (*Ziphius cavirostris*)	Pelagic	NL	NC
Gervais' beaked whale (*Mesoplodon europaeus*)	Pelagic	NL	NC
True's beaked whale (*Mesoplodon mirus*)	Pelagic	NL	NC
Blainville's beaked whale (*Mesoplodon densirostris*)	Pelagic	NL	NC
Dwarf sperm whale (*Kogia sima*)	Offshore, pelagic	NL	NC
Pygmy sperm whale (*Kogia breviceps*)	Offshore, pelagic	NL	NC
Killer whale (*Orcinus orca*)	Widely distributed	NL EN (Southern Resident)	NC D (Southern Resident, AT1 Transient)
Short-finned pilot whale (*Globicephala macrorhynchus*)	Inshore and offshore	NL	NC
False killer whale (*Pseudorca crassidens*)	Pelagic	NL	NC
Mellon-headed whale (*Peponocephala electra*)	Pelagic	NL	NC
Pygmy killer whale (*Feresa attenuata*)	Pelagic	NL	NC

Risso's dolphin (*Grampus griseus*)	Pelagic, shelf	NL	NC
Bottlenose dolphin (*Tursiops truncatus*)	Offshore, Inshore, coastal, and estuaries	NL	NC S (Biscayne Bay and Central Florida Coastal stocks) D (Western North Atlantic Coastal)
Rough-toothed dolphins (*Steno bredanensis*)	Pelagic	NL	NC
Fraser's dolphin (*Lagenodelphis hosei*)	Pelagic	NL	NC
Striped dolphin (*Stenella coeruleoalba*)	Pelagic	NL	NC
Pantropical spotted dolphin (*Stenella attenuata*)	Pelagic	NL	NC D (Northeastern Offshore)
Atlantic spotted dolphin (*Stenella frontalis*)	Coastal to pelagic	NL	NC
Spinner dolphin (*Stenella longirostris*)	Mostly pelagic	NL	NC D (Eastern)
Clymene dolphin (*Stenella clymene*)	Pelagic	NL	NC
Sirenians			
West Indian (Florida) manatee (*Trichechus manatus latirostris*)	Coastal, rivers, and estuaries	EN	D

[1] U.S. Endangered Species Act: EN = Endangered, T = Threatened, NL = Not listed.

[2] U.S. Marine Mammal Protection Act: D = Depleted, S = Strategic, NC = Not classified.

The one species of marine mammal under NMFS jurisdiction known to commonly occur in close proximity to the proposed blasting area of the Port of Miami is the Atlantic bottlenose dolphin, specifically the stocks living near the Port of Miami within Biscayne Bay (the Biscayne Bay stock) or transiting the outer entrance channel (Western North Atlantic Central Florida Coastal stock).

Atlantic Bottlenose Dolphin

Atlantic bottlenose dolphins are distributed worldwide in tropical and temperate waters, and in U.S. waters occur in multiple complex stocks along the U.S. Atlantic coast. The coastal morphotype of bottlenose dolphins is continuously distributed along the Atlantic coast south of Long Island, New York, to the Florida peninsula, including inshore waters of the bays, sounds, and estuaries. Except for animals residing within the Southern North Carolina and Northern North Carolina Estuarine Systems (e.g., Waring *et al*., 2009), estuarine dolphins along the U.S. east coast have not been previously included in stock assessment reports. Several lines of evidence support a distinction between dolphins inhabiting coastal waters near the shore and those present in the inshore waters of the bays, sounds, and estuaries. Photo-identification (photo-ID) and genetic studies support the existence of resident estuarine animals in several inshore areas of the southeastern United States (Caldwell, 2001; Gubbins, 2002; Zolman, 2002; Mazzoil *et al*., 2005; Litz, 2007), and similar patterns have been observed in bays and estuaries along the Gulf of Mexico coast (Well *et al*., 1987; Balmer *et al*., 2008). Recent genetic analyses using both mitochondrial DNA and nuclear microsatellite markers found significant

differentiation between animals biopsied along the coast and those biopsied within the estuarine systems at the same latitude (NMFS, unpublished data). Similar results have been found off the west coast of Florida (Sellas *et al*., 2005).

Biscayne Bay Stock

Biscayne Bay is a shallow estuarine system located along the southeast coast of Florida in Miami-Dade County. The Bay is generally shallow (depths less than 5 m [16.4 ft]) and includes a diverse range of benthic communities including seagrass beds, soft coral and sponge communities, and mud flats. The northern portion of Biscayne Bay is surrounded by the cities of Miami and Miami Beach and is therefore heavily influenced by industrial and municipal pollution sources. The water flow in this portion of Biscayne Bay is very restricted due to the construction of dredged islands (Bialczak *et al*., 2001). In contrast, the central and southern portions of Biscayne Bay are less influenced by development and are better flushed. Water exchange with the Atlantic Ocean occurs through a broad area of grass flats and tidal channels termed the Safety Valve. Biscayne Bay extends south through Card Sound and Barnes Sound, and connects through smaller inlets to Florida Bay.

The Biscayne Bay stock of bottlenose dolphins is bounded by Haulover Inlet to the north and Card Sound Bridge to the south. This range corresponds to the extent of confirmed home ranges of bottlenose dolphins observed residing in Biscayne Bay by a long-term photo ID study conducted by the Southeast Fisheries Science Center (Litz, 2007; SEFSC unpublished data). It is likely that the range of Biscayne Bay dolphins extends past these boundaries; however, there have been few surveys outside of this range. These boundaries are subject to change upon further study of dolphin home ranges within the Biscayne Bay estuarine system and comparison to an extant photo-ID catalog from Florida Bay to the south.

Dolphins residing within estuaries north of this stock along the southeastern coast of Florida are currently not included in a stock assessment report. There are insufficient data to determine whether animals in this region exhibit affiliation to the Biscayne Bay stock, the estuarine stock further to the north in the Indian River Lagoon Estuarine System (IRLES), or are simply transient animals associated with coastal stocks. There is relatively limited estuarine habitat along this coastline; however, the Intracoastal Waterway extends north along the coast to the IRLES. It should be noted that during 2003 to 2007, there were three stranded bottlenose dolphins in this region in enclosed waters. One of these had signs of human interaction from a boat strike and another was identified as an offshore morphotype of bottlenose dolphin.

Bottlenose dolphins have been documented in Biscayne Bay since the 1950's (Moore, 1953). Live capture fisheries for bottlenose dolphins are known to have occurred throughout the southeastern U.S. and within Biscayne Bay during the 1950's and 1960's; however, it is unknown how many individuals may have been removed from the population during this period (Odell, 1979; Wells and Scott, 1999).

The Biscayne Bay bottlenose dolphin stock has been the subject of an ongoing photo-ID study conducted by the NMFS SEFSC since 1990. From 1990 to 1991, preliminary information was collected focusing on the central portion of Biscayne Bay. The survey was re-initiated in 1994,

and it was expanded to include the northern portion of Biscayne Bay and south to the Card Sound Bridge in 1995 (SEFSC unpublished data; Litz, 2007). Through 2007, the photo-ID catalog included 229 unique individuals. Approximately 80% of these individuals may be long-term residents with multiple sightings over the 17 years of the study (SEFSC, unpublished data). Analyses of the sighting histories and associations of individuals from the Biscayne Bay segregated along a north/south gradient (Litz, 2007).

Remote biopsy samples of Biscayne Bay animals were collected between 2002 and 2004 for analyses of population genetic structure and persistent organic pollutant concentrations in blubber. Genetic structure was investigated using both mitochondrial DNA and nuclear (microsatellite) markers, and the data from Biscayne Bay were compared to data from Florida Bay dolphins to the south (Litz, 2007). Within Biscayne Bay, dolphins sighted primarily in the northern half of Biscayne Bay were significantly differentiated from those sighted primarily in the southern half at the microsatellite loci but not at the mitochondrial locus. There was not sufficient genetic information between these groups to indicate true population subdivision (Litz, 2007). However, genetic differentiation was found between the Biscayne Bay and Florida Bay dolphins in both markers (Litz, 2007). The observed genetic differences between resident animals in Biscayne Bay and those in an adjacent estuary combined with the high levels of sight fidelity observed, demonstrate that the resident Biscayne Bay bottlenose dolphins are a demographically distinct population stock.

The total number of bottlenose dolphins in the Biscayne Bay stock is unknown. During small boat surveys between 2003 and 2007, 157 unique individuals were identified using standard methods, however, this catalog size does not represent a valid estimate of population size because the residency patterns of dolphins in Biscayne Bay is not fully understood. Litz (2007) determined that 69 animals in Biscayne Bay have a northern home range. Based on Waring *et al*. (2010), the maximum population of animals that may be in the proposed project area is equal to the total number of uniquely identified animals for the entire photo-ID study of Biscayne Bay – 229 individuals. Present data are insufficient to calculate a minimum population estimate, and to determine the population trends, for the Biscayne Bay stock of bottlenose dolphins. The total human-caused mortality and serious injury for this stock is unknown and there is insufficient information available to determine whether the total fishery-related mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate. Documented human-caused mortalities in recreational fishing gear entanglement and ingestion of gear reinforce concern for this stock. Because the stock size is currently unknown, but likely small and relatively few mortalities and serious injuries would exceed potential biological removal, NMFS considers this stock to be a strategic stock.

Western North Atlantic Central Florida Coastal Stock

On the Atlantic coast, Scott *et al*. (1988) hypothesized a single coastal migratory stock ranging seasonally from as far north as Long Island, to as far south as central Florida, citing stranding patterns during a high mortality event in 1987 to 1988 and observed density patterns. More recent studies demonstrate that the single coastal migratory stock hypothesis is incorrect, and there is instead a complex mosaic of stocks (McLellan *et al*., 2003; Rosel *et al*., 2009).

The coastal morphotype is morphologically and genetically distinct from the larger, more robust morphotype primarily occupying habitats further offshore (Hoelzel *et al*., 1998; Mead and Potter, 1995; Rosel *et al*., 2009). Aerial surveys conducted between 1978 and 1982 (CETAP, 1982) north of Cape Hatteras, North Carolina, identified two concentrations of bottlenose dolphins, one inshore of the 82 ft (25 m) isobath and the other offshore of the 164 ft (50 m) isobath. The lowest density of bottlenose dolphins was observed over the continental shelf, with higher densities along the coast and near the continental shelf edge. It was suggested, therefore, that north of Cape Hatteras, North Carolina, the coastal morphotype is restricted to waters less than 82 ft deep (Kenney, 1990). Similar patterns were observed during summer months in more recent aerial surveys (Garrison and Yeung, 2001; Garrison *et al*., 2003). However, south of Cape Hatteras during both winter and summer months, there was no clear longitudinal discontinuity in bottlenose dolphin sightings (Garrison and Yeung, 2001; Garrison *et al*., 2003). To address the question of distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected from large vessel surveys during the summers of 1998 and 1999, from systematic biopsy sampling efforts in nearshore waters from New Jersey to central Florida conducted in the summers of 2001 and 2002, and from winter biopsy collection effort in 2002 and 2003 in nearshore continental shelf waters of North Carolina and Georgia. Additional biopsy samples were collected in deeper continental shelf waters south of Cape Hatteras during the winter of 2002. Genetic analyses using mitochondrial DNA sequences of these biopsies identified individual animals to the coastal or offshore morphotype. Using the genetic results from all surveys combined, a logistic regression was used to model the probability that a particular bottlenose dolphin group was of the coastal morphotype as a function of environmental variables including depth, sea surface temperature, and distance from shore. These models were used to partition the bottlenose dolphin groups observed during aerial surveys between the two morphotypes (Garrison *et al*., 2003).

The genetic results and spatial patterns observed in aerial surveys indicate both regional and seasonal differences in the longitudinal distribution of the two morphotypes in coastal Atlantic waters. Generally, from biopsy samples collected, the coastal morphotype is found in nearshore waters, the offshore morphotype in deeper waters and a spatial overlap between the two morphotypes in intermediate waters. More information on the seasonal differences and genetic studies off of the Carolina's, Georgia, and Florida, differentiating morphotypes of bottlenose dolphins can be found online in the NMFS stock assessment reports.

In summary, the primary habitat of the coastal morphotype of bottlenose dolphin extends from Florida to New Jersey during summer months and in waters less than 65.6 ft (20 m) deep, including estuarine and inshore waters.

In addition to inhabiting coastal nearshore waters, the coastal morphotype of bottlenose dolphin also inhabits inshore estuarine waters along the U.S. east coast and Gulf of Mexico (Wells *et al*., 1987; Wells *et al*., 1996; Scott *et al*., 1990; Weller, 1998; Zolman, 2002; Speakman *et al*., 2006; Stolen *et al*., 2007; Balmer *et al*., 2008; Mazzoil *et al*., 2008). There are multiple lines of evidence supporting demographic separation between bottlenose dolphins residing within estuaries along the Atlantic coast. In Biscayne Bay, Florida, there is a similar community of bottlenose dolphins with evidence of year-round residents that are genetically distinct from animals residing in a nearby estuary in Florida Bay (Litz, 2007). A few published studies

demonstrate that there are significant genetic distinctions and differences between animals in nearshore coastal waters and estuarine waters (Caldwell, 2001; Rosel *et al*., 2009). Despite evidence for genetic differentiation between estuarine and nearshore populations, the degree of spatial overlap between these populations remains unclear. Photo-ID studies within estuaries demonstrate seasonal immigration and emigration and the presence of transient animals (e.g., Speakman *et al*., 2006). In addition, the degree of movement of resident estuarine animals into coastal waters on seasonal or shorter time scales is poorly understood. However, for the purposes of this analysis, bottlenose dolphins inhabiting primarily estuarine habitats are considered distinct from those inhabiting coastal habitats. Initially, a single stock of coastal morphotype bottlenose dolphins was thought to migrate seasonally between New Jersey (summer months) and central Florida based on seasonal patterns in strandings during a large scale mortality event occurring during 1987 to 1988 (Scott *et al*., 1988). However, re-analysis of stranding data (McLellan *et al*., 2003) and extensive analysis of genetic (Rosel *et al*., 2009), photo-ID (Zolman, 2002) and satellite telemetry (NMFS, unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are five coastal stocks of bottlenose dolphins: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock, and a Central Florida Coastal stock.

The spatial extent of these stocks, their potential seasonal movements, and their relationships with estuarine stocks are poorly understood. More information on the migratory movements and genetic analyses of bottlenose dolphins can be found online in the NMFS stock assessment reports.

The NMFS stock assessment report addresses the Central Florida Coastal stock, which is present in coastal Atlantic waters from 29.4° North south to the western end of Vaca Key (approximately 24.69° North to 81.11° West) where the stock boundary for the Florida Keys stock begins (see Figure 1 of the NMFS Stock Assessment Report). There has been little study of bottlenose dolphin stock structure in coastal waters of southern Florida; therefore the southern boundary of the Central Florida stock is uncertain. There is no obvious boundary defining the offshore extent of this stock. The combined genetic and logistic regression analysis (Garrison *et al*., 2003) indicated that in waters less than 32.8 ft (10 m) depth, 70% of the bottlenose dolphins were of the coastal morphotype. Between 32.8 ft and 65.6 ft depth, the percentage of animals of the coastal morphotype dropped precipitously, and at depths greater than 131.2 ft (40 m) nearly all (greater than 90%) animals were of the offshore morphotype. These spatial patterns may not apply in the Central Florida Coastal stock, as there is a significant change in the bathymetric slope and a close approach of the Gulf Stream to the shoreline south of Cape Canaveral.

Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic were conducted during winter (January to February) and summer (July to August) of 2002. Abundance estimates for bottlenose dolphins in each stock were calculated using line-transect methods and distance analysis (Buckland *et al*., 2001). More information on the survey tracklines, design, effort, animals sighted, and methods for calculating estimated abundance can be found online in the NMFS stock assessment reports.

The estimated best and minimum population for the Central Florida Coastal Stock is 6,318 and 5,094 animals, respectively. There are insufficient data to determine the population trends for this stock. From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted. This stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units and again in 2008 and 2010 to recognize resident estuarine stocks and migratory and resident coastal stocks. The total U.S. fishery-related mortality and serious injury for the Central Florida Coastal stock likely is less than 10% of the calculated PBR, and thus can be considered to be insignificant and approaching zero mortality and serious injury rate. However, there are commercial fisheries overlapping with this stock that have no observer coverage. This stock retains the depleted designation as a result of its origins from the originally delineated depleted coastal migratory stock. The species is not listed as threatened or endangered under the ESA, but this is a strategic stock due to the depleted listing under the MMPA.

Further information on the biology and local distribution of these species and others in the region can be found in ACOE's IHA application, which is available upon request (see ADDRESSES), and the NMFS Marine Mammal Stock Assessment Reports, which are available online at: http://www.nmfs.noaa.gov/pr/species/

ESA-Listed Marine Species

Several ESA-listed species potentially present in the Miami Harbor Deepening Project action area were identified by the USFWS and NMFS. Species listed as threatened or endangered under NMFS' jurisdiction that may occur in or near the action area include blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), North Atlantic right whale (*Eubalaena glacialis*), loggerhead sea turtle (*Caretta caretta*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*), green sea turtle (*Chelonia mydas*), smalltooth sawfish (*Pristis pectinata*), Johnson's seagrass (*Halophila johnsonii*), elkhorn coral (*Acropora palmata*), and staghorn coral (*Acropora cervicornis*). A more detailed description and analysis on these species and there occurrence can be found in NMFS' BiOp (2011), which is incorporated here by reference.

3.3 SOCIAL AND ECONOMIC ENVIRONMENT

Economic and social factors are listed in the definition of effects in the NEPA regulations. However, the definition of human environment states that "economic and social effects are not intended by themselves to require preparation of an EIS." An EA must include a discussion of a proposed action's economic and social effects when these effects are related to the natural or physical environment.

The Port of Miami is one of the nation's most important ports. The Port of Miami offers the greatest frequency of cargo service, with the largest number of shipping lines, calling at the most destinations, in the world. The Port of Miami has more than 35 shipping lines calling on over

100 countries and over 254 ports. It is Florida's largest container port and it is the tenth biggest container port in the U.S. In addition to its strength as a cargo port, the Port of Miami is also the largest multi-day cruise passenger homeport in the world. The Port of Miami's link to important trading and cruise routes, as well as the strength and characteristics of its large and growing hinterland, have positioned the Port of Miami as a top performer, and will continue to drive the Port of Miami's growth as long as the infrastructure to support marine transportation is in place. The total economic impact of Port of Miami operations on the nation is estimated at more than $8 billion per year. More than 45,000 jobs are directly or indirectly attributable to Port of Miami operations. Jobs created by Port of Miami and trade activity tend to be good jobs: they pay significantly more than other job growth sectors in the local economy, have better long-term opportunities for employees and offer better training programs (particularly for minorities). The Port of Miami also utilizes the local, regional, and inter-regional transportation network components consisting of roads, railway lines, and channels to facilitate the efficient movement of goods and passengers (ACOE, 2004).

Improvements including channel deepening and widening are required to ensure navigational safety and allow for more effective handling of the existing and future commercial ship fleet. The recommended improvements would also allow commercial ships with increased draft and cargo tonnage to call at the Port of Miami, resulting in transportation cost savings (ACOE, 2004).

ACOE's FEIS (2004) includes an in-depth analysis on economic factors, including information on cargo, cruise, supporting infrastructure, future growth, economic impact, and current and future challenges in the action area and that section is incorporated here by reference.

NMFS' proposed action is to issue an IHA authorizing harassment of marine mammals within the action area. There are no subsistence uses of marine mammals within the action area.

3.4 IMPACT OF AVAILABILITY OF AFFECTED SPECIES FOR TAKING FOR SUBSISTENCE USES

Under the MMPA, NMFS must determine that an activity would not have an unmitigable adverse impact on the subsistence needs for marine mammals. While this includes usage of both cetaceans and pinnipeds, the primary impact by blasting operations is expected to be impacts from noise generated by construction operations on Atlantic bottlenose dolphins. In 50 CFR 216.103, NMFS has defined unmitigable adverse impact as:

> An impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) causing the marine mammals to abandon or avoid hunting areas, (ii) directly displacing subsistence users, or (iii) placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

There is no subsistence hunting for marine mammals in the waters off of the coast of Florida that implicates MMPA section 101(a)(5)(D) and thus no potential for an unmitigable adverse effect on the availability of marine mammals for subsistence uses.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

The impact of Federal actions must be considered prior to implementation to determine whether the action will significantly affect the quality of the human environment. In this section, an analysis of the environmental impacts of issuing an IHA to the ACOE and the alternatives to that proposed action are presented with a primary focus on impacts to marine mammals and their habitat.

This chapter represents the scientific and analytic basis for comparison of the direct, indirect, and cumulative effects of the alternatives. Regulations for implementing the provisions of NEPA require consideration of both the context and intensity of a proposed action (40 CFR Parts 1500-1508).

4.1 EFFECTS OF ALTERNATIVE 1: NO ACTION

Under the No Action alternative, NMFS would deny the ACOE an authorization to take marine mammals, by Level B harassment, incidental to blasting operations during the Miami Harbor Deepening Project. To avoid violation of the MMPA if no IHA is issued, the ACOE would have to shut-down all blasting operations whenever a marine mammal is sighted approaching or within the Level B harassment zone during activities using the detonation of explosives. These underwater Level B harassment zone has been modeled to extend 1,992 ft (607.2 m), based on the maximum weight of explosives, for blasting operations. The no action alternative would move forward without implementation of the mitigation or monitoring requirements imposed by the IHA. Therefore, the risk of exposure of marine mammals to underwater sound resulting from blasting activities would increase due to a decrease in mitigation-monitoring and the likely detection of marine mammals in the action area during such activities. The no action alternative could therefore result in a higher level of take by incidental harassment of all species of affected marine mammals when compared to the preferred alternative. The impacts to other environmental resources, such as water quality and EFH, would not differ meaningfully from the preferred alternative as the applicant would be required to implement the recommendations and other mitigation measures required by EFH consultation.

4.2 EFFECTS OF ALTERNATIVE 2: PROPOSED ACTION (ISSUANCE OF IHA, PREFERRED ALTERNATIVE)

This section describes potential impacts to the human environment from issuance of a MMPA IHA allowing the harassment of marine mammals incidental to the Miami Harbor Deepening Project.

4.2.1 Potential Effects of Activities on Marine Mammals

Confined blasting operations at the Port of Miami may temporarily impact marine mammals within the action area due to elevated in-water noise levels. NMFS has prepared, supplemented, or adopted numerous EAs leading to Findings of No Significant Impact (FONSI's) for blasting activities in general, including ones for the ACOE in Miami Harbor (Phase II) and Jacksonville Transportation Authority's Beach Boulevard Bridge projects which involved the detonation of confined explosives in Florida. The analysis of confined blasting impacts to marine mammals and their environment under NEPA have been conducted to facilitate issuance of other IHAs. Examples of such EAs include:

> *Environmental Assessment on the Authorization for the Incidental take of Marine Mammals Associated with Confined Underwater Blasting as a Construction Method for Civil Works Projects Along the Coast of Florida by the Jacksonville District of the U.S. Army Corps of Engineers* (March, 2005); and
>
> *Supplemental Environmental Assessment on the Issuance of an Authorization for the Incidental Take of Marine Mammals, Associated with Confined Underwater Blasting as a Demolition Method for the Removal of Bridge Support Structures in Duval County, Florida by the Jacksonville Transportation Authority* (December, 2008).

In general, potential impacts to marine mammals from explosive detonations could include mortality, serious injury, as well as Level A harassment (injury) and Level B harassment. In the absence of mitigation, marine mammals could be killed or injured as a result of an explosive detonation due to the response of air cavities in the body, such as the lungs and bubbles in the intestines. Effects would be likely to be most severe in near surface waters where the reflected shock wave creates a region of negative pressure called "cavitation."

A second potential possible cause of mortality (in the absence of mitigation) is the onset of extensive lung hemorrhage. Extensive lung hemorrhage is considered debilitating and potentially fatal. Suffocation caused by lung hemorrhage is likely to be the major cause of marine mammal death from underwater shock waves. The estimated range for the onset of extensive lung hemorrhage to marine mammals varies depending upon the animal's weight, with the smallest mammals having the greatest potential hazard range.

NMFS' criteria for determining potential for non-lethal injury (Level A harassment) from explosives are the peak pressure that will result in: (1) the onset of slight lung hemorrhage, or (2) a 50 percent probability level for a rupture of the tympanic membrane (TM). These are injuries from which animals would be expected to recover on their own.

NMFS has established dual criteria for what constitutes Level B harassment: (1) an energy based temporary threshold shift (TTS) in hearing at received sound levels of 182 dB re 1 μPa^2-s cumulative energy flux in any 1/3 octave band above 100 Hz for odontocetes (derived from experiments with bottlenose dolphins (Ridgway *et al*., 1997; Schlundt *et al*., 2000); and (2) 12 psi peak pressure cited by Ketten (1995) as associated with a safe outer limit for minimal, recoverable auditory trauma (i.e., TTS). The threshold for sub-TTS behavioral harassment is 177 dB re 1 μPa^2-s. The Level B harassment zone is the distance from the mortality, serious

injury, injury (Level A harassment) zone to the radius where neither of these criterion is exceeded.

Table 2. (Table 2 of the ACOE's IHA application) NMFS' threshold criteria and metrics utilized for impact analyses from the use of explosives.

Mortality	Level A Harassment (Non-lethal injury)		Level B Harassment (Non-injurious; TTS and associated behavioral disruption [dual criteria])	Level B Harassment (Non-injurious behavioral, Sub-TTS)
31 psi-msec (onset of severe lung injury [mass of dolphin calf])	205 dB re 1 $\mu Pa^2 \cdot s$ EFD (50 percent of animals would experience TM rupture)	13 psi-msec positive pressure (onset of slight lung injury)	182 dB re 1 $\mu Pa^2 \cdot s$ EFD*; 23 psi peak pressure (< 2,000 lb) 12 psi peak pressure (> 2,000 lb)	177 dB re 1 $\mu Pa^2 \cdot s$EFD* (for multiple detonations only)

* Note: In greatest 1/3-octave band above 10 Hz or 100 Hz.

The primary potential impact to the Atlantic bottlenose dolphins occurring in the Port of Miami action area from the proposed detonations is Level B harassment incidental to noise generated by explosives. In the absence of any monitoring or mitigation measures, there is a very small chance that a marine mammal could be injured, seriously injured, or killed when exposed to the energy generated from an explosive force on the sea floor. However, the ACOE and NMFS believe that the proposed monitoring and mitigation measures will preclude this possibility in the case of this particular specified activity.

Non-lethal injurious impacts (Level A harassment) are defined in this proposed IHA as TM rupture and the onset of slight lung injury. The threshold for Level A harassment corresponds to a 50 percent rate of TM rupture, which can be stated in terms of an energy flux density (EFD) value of 205 dB re 1 μPa^2 s. TM rupture is well-correlated with permanent hearing impairment (Ketten, 1998) indicates a 30 percent incidence of permanent threshold shift (PTS) at the same threshold. The farthest distance from the source at which an animal is exposed to the EFD level for the Level A harassment threshold is unknown at this time.

Level B (non-injurious) harassment includes temporary (auditory) threshold shift (TTS), a slight, recoverable loss of hearing sensitivity. One criterion used for TTS is 182 dB re 1 μPa^2 s maximum EFD level in any 1/3-octave band above 100 Hz for toothed whales (e.g., dolphins). A second criterion, 23 psi, has been established by NMFS to provide a more conservative range of TTS when the explosive or animals approaches the sea surface, in which case explosive energy is reduced, but the peak pressure is not. For the proposed project in Miami Harbor, the distance from the blast array at which the 23 psi threshold could be met for various charge detonation weights can be, and has been calculated.

The threshold for sub-TTS behavioral harassment is 177 dB re 1 μPa^2 s. However, as described previously, this criterion would not apply to the ACOE's proposed activity because there will

only be a maximum of two blasting events a day (minimum four to six hours apart), and the multiple (staggered) detonations are within a few milliseconds of each other and do not last more than a few seconds in total duration per a blasting event.

For a fully confined blast, the pressure at the edge of the danger zone is expected to be 6 psi. Utilizing the pressure data collected the Miami Harbor Phase II project in 2005, for a maximum charge weight of 450 lbs in a fully confined blast, the pressure is expected to be 22 psi approximately 700 ft (213.4 m) from the blast, which is below the threshold for Level B harassment (i.e., 23 psi criteria for explosives less than 2,000 lb). However to ensure the protection of marine mammals, and in case of an incident where a detonation is not fully confined, the ACOE assumes that any animal within the boundaries of a designated "danger zone" at the time of detonation would be taken by Level B harassment.

The ACOE is planning to implement, and NMFS has proposed, a series of monitoring and mitigation measures to protect marine mammals from the potential impacts of the proposed confined blasting activities. The ACOE has designated a "danger zone" as the area within which the potential for Level B harassment occurs, and the "exclusion zone" as the area within which if an animal crosses and enters that zone then the confined blast will be delayed until the animal leaves the zone of its own volition. The exclusion zone is larger than the area where the ACOE has determined that Level B harassment will occur, so if the monitoring and mitigation measures implemented are successful as expected, and no detonation occurs when an animal is inside of the exclusion zone, no take by Level B harassment is likely to occur. However, to be conservative, the ACOE has calculated the potential exists for Level B harassment and is pursuing an IHA from NMFS. More information on how the danger and exclusion zones are determined is included in the "Mitigation Measures" section of this document (see below).

In a previous monitoring report for ACOE's Miami Harbor Phase II project in 2005, it was noted that a bottlenose dolphin outside the exclusion zone, in the deeper water channel, exhibited a startle response immediately following a confined blast. Details of that event from the monitoring report are included below:

> Any animals near the exclusion zone were watched carefully during the blast for any changes in behavior or noticeable reaction to the blast. The only observation that showed signs of a possible reaction to the blast was on July 27, when two dolphins were in the channel west of the blast. The dolphins were stationary at approximately 2,400 ft (731.5 m) from the blast array, feeding and generally cavorting. Due to the proximity of the dolphins, the drill barge was contacted prior to the blast to confirm that the exclusion zone calculation was 1,600 ft (487.7 m) for the lower weight of explosives used that day. The topography of the bottom in that area is very shallow (approximately 3.3 ft [1 m]) to the south, then an exceptionally steep drop off into the channel at 40 plus ft ending at the bulkhead wall to the north. Westward, the channel continues and has a more gradual upward slope. At the time of the blast, one of the dolphins was at the surface in the shallows, while the other dolphin was underwater within the channel. The dolphin that was underwater showed a strong reaction to the blast. The animal jumped fully out of the water in a 'breaching' fashion; behavior that had not been exhibited prior to the blast. The animal was observed jumping out of the water immediately before the observers

> heard the blast suggesting that the animal reacted to the blast and not some other stimulus. It is probable that, because this animal was located in the channel, the sound and pressure of the blast traveled either farther or was more focused through the channeling and the reflection from the bulkhead, thus causing the animal to react even though it was well outside the safety radius. These two dolphins were tracked for the entire 30 min post blast period and no obvious signs of distress or behavior changes were observed. Other animals observed near the safety radius during the blast were all to the south of the blasting array, well up on the seagrass beds or in the pipe channel that runs through the seagrass beds. None of these animals showed any reaction to the blast.

Individual dolphins from other stocks and within the Biscayne Bay and Western North Atlantic Central Florida Coastal stocks potentially move both inshore and offshore of Biscayne Bay due to the openness of this bay system and closeness of the outer continental shelf. These movements are not fully understood and the possibility exists that these other stocks may be affected in the same manner as the Biscayne Bay and Western North Atlantic Central Florida Coastal stocks.

Based on the data from the Miami Harbor project in 2005 and the implementation of the proposed monitoring and mitigation measures, the ACOE and NMFS expects limited potential effects of the proposed construction and confined blasting activities on marine mammals in the Port of Miami action area.

4.2.2 Estimated Take by Harassment

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

> Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to 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].

The ACOE is requesting authorization for the take of Atlantic bottlenose dolphins, by Level B harassment only, incidental to proposed confined blasting activities at Miami Harbor. The ACOE application notes that multiple IHAs (up to three) will likely be needed and requested for the proposed project due to the three-year duration of the planned blasting activities. See Table 2 (above) for NMFS' threshold criteria and metrics utilized for impact analyses from the use of explosives. The ACOE application and the NMFS MMPA IHA document provide detailed information on methodology ACOE and NMFS used to estimate how many marine mammals may be taken by harassment incidental to the blasting activities. Those documents are incorporated by reference into this EA and the section below summarizes the take estimation calculations.

In its application the ACOE used the marine mammal population abundance and distribution information from the NMFS Marine Mammal Stock Assessment Report to estimate the number of Atlantic bottlenose dolphins that may be impacted by the proposed action during the course of one year. As discussed in Chapter 2, individuals from two separate stocks of Atlantic bottlenose

dolphins may be present in the action area, individuals from two separate stocks of Atlantic bottlenose dolphins may be present in the action area, individuals from the Biscayne Bay stock and the Western North Atlantic Central Florida Coastal stock. Also, as discussed in Chapter 2, the spatial extent of these stocks, their potential seasonal movements and habitat use patterns, and the relationships between the stocks are poorly understood. In addition, the ACOE also considered information collected during the ACOE Miami Harbor Phase II project in 2005, and information on the Biscayne Bay stock developed during photo-ID studies conducted by Litz (Litz, 2003) and other information from the NMFS Southeast Fisheries Science Center (Waring *et al*., 2010).

Biscayne Bay Stock

The Biscayne Bay stock of Atlantic bottlenose dolphins is bounded by Haulover Inlet to the north and Card Sound Bridge to the south. Biscayne Bay is 428 square mi (mi^2) (1,108.5 square km [km^2]) in area. The Port of Miami channel, within the boundaries of Biscayne Bay, is approximately 7,200 ft (2,194.6 m) long by 500 ft (152.4 m) wide, with the 3,425 ft (1,044 m) long by 1,400 ft (426.7 m) wide Dodge-Lummus Island turning basin (total area 0.3 mi^2 [0.8 km^2]) at the western terminus of Fisherman's Channel. The Port of Miami's channels consist of approximately 0.1% of the entire area of Biscayne Bay.

To determine the maximum area of Biscayne Bay in which bottlenose dolphins may experience pressure levels greater than or equal to the 23 psi threshold for explosives less than 2,000 lb (907.2 kg), which has the potential to result in Level B harassment due to temporary threshold shift (TTS) and associated behavioral disruption, the ACOE may utilize a maximum charge weight of 450 lb (204.1 kg) with a calculated danger zone of 1,995 ft (608.1 m). Using this radius, the total area of this zone is approximately 0.1% of Biscayne Bay (12,503,617 ft^2 [1,161,624 m^2]).

Utilizing the pressure data collected the Miami Harbor Phase II project in 2005, for a maximum charge weight of 450 lbs in a fully confined blast, the pressure is expected to be 22 psi approximately 700 ft (213.4 m) from the blast, which is below the threshold for Level B harassment (i.e., 23 psi criteria for explosives less than 2,000 lb). However to ensure the protection of marine mammals, and in case of an incident where a detonation is not fully confined, the ACOE assumes that any animal within the boundaries of the danger zone would be taken by Level B harassment.

Litz (2007) identified 69 individuals of the Biscayne Bay stock that she classified as the "northern dolphins" meaning animals with a mean sighting history from 1994 to 2004 north of 25.61° North. The photo-ID study that Litz's data is based on encompassed an area of approximately 200 mi^2 (518 km^2), approximately 50% of Biscayne Bay. The estimated maximum population of animals that may be in the proposed project area is equal to the total number of uniquely identified animals for the entire photo-ID study of Biscayne Bay is 229 individuals (Waring et al., 2010). The best population estimate for Biscayne Bay is 157 individuals, which is based on SEFSC's most consistent survey effort conducted during the 2003 to 2007 photo-ID survey seasons (Waring *et al*., 2010).

Table 3 (below) presents the estimated incidental take, by Level B harassment, for varying charge weight delays likely to be used during the proposed blasting activities and the estimated impacts based on the population estimates used in this analysis. In all cases, less than one bottlenose dolphin is expected to be taken incidental to each blasting event (0.049 minimum to 0.162 maximum). This assumes that the distribution of bottlenose dolphins is equal throughout all of Biscayne Bay.

Table 3. (Table 3 of the ACOE's IHA application) The estimated incidental take of bottlenose dolphins from the Biscayne Bay stock, per each blasting event, based on the maximum charge weight/delay and population density.

Maximum (lbs/delay)	Danger Zone (ft)	Estimated Take Based on Minimum Population Estimate (69 animals)	Estimated Take Based on Best Population Estimate (157 animals)	Estimated Take Based on Maximum Population Estimate (229 animals)
450	1,992	0.072	0.164	0.239
200	1,518	0.042	0.095	0.139
119	1,277	0.030	0.067	0.098
50	957	0.017	0.038	0.055
17	668	0.008	0.018	0.027

The ACOE accessed the NMFS SEFSC photo-ID survey data from 1990 to 2004 in Biscayne Bay via the OBIS-Seamap database (http://seamap.env.duke.edu/) and downloaded the Google Earth overlay of the data. Figure 12 of the ACOE's IHA application shows the general area of the Port of Miami and hot spots of bottlenose dolphin sightings both north and south of Miami Harbor. The data were used to see if sightings across all parts of the Biscayne Bay were equal. This sighting frequency data was not used to calculate the potential take numbers of marine mammals incidental to the proposed blasting activities.

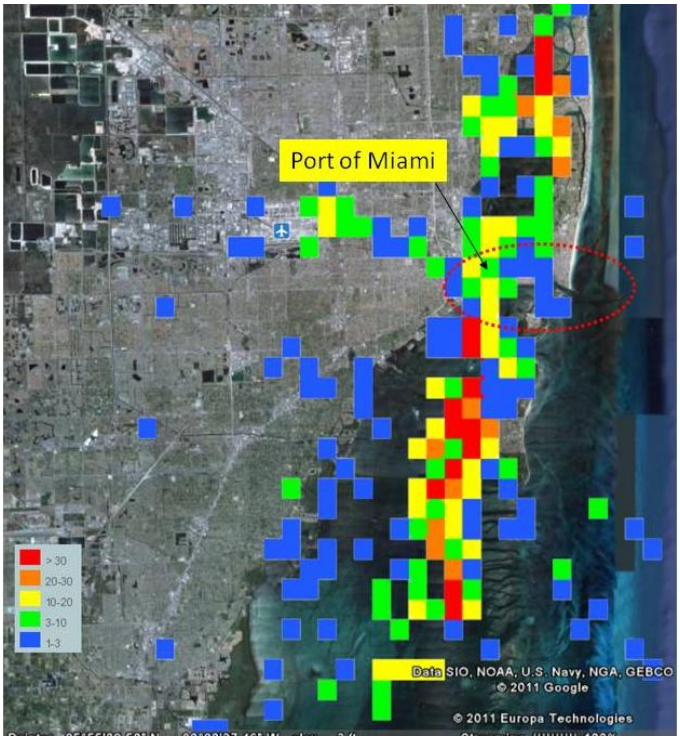

Figure 11 – (Figure 12 of the ACOE's IHA application) NOAA NMFS SEFSC, South Florida bottlenose dolphin photo-ID cooperative.

Reviewing the data from the Miami Harbor Phase II project in 2005, the ACOE noted that for the 40 detonations, 28% of all animals sighted within the proposed action area (Fisherman's Channel) were bottlenose dolphins (the other animals sighted were manatees and sea turtles). Bottlenose dolphins were sighted inside the exclusion zone 12 times with a total of 30 individuals, with an average of 2.5 animals per sighting out of the total 58 bottlenose dolphins recorded during the project; therefore, groups of dolphins entered the exclusion zone multiple times. Also, dolphins entered the exclusion zone during 30% of the blasting events. Not all of the incidents where dolphins entered the exclusion zone resulted in a project delay, it is dependent upon when during the countdown the animals cross the line demarcating the exclusion zone, and how long they stay in the exclusion zone.

During the Miami Harbor Phase II project in 2005, bottlenose dolphins in the exclusion zone triggered delays on four occasions during the 13 blasting events (31%). If the maximum 313 365 calendar days/year minus 52 Sundays/year [no confined blasting will occur on Sundays]) potential detonations for the duration of the one year IHA have an equal percentage of delays as the 2005 project (assuming construction starts in June with blasting June, 2012 to June, 2013 timeframe, with no blasting on Sundays), 94 of the detonations would be delayed for some period of time due to the presence of protected species and 29 of those delays would specifically be for bottlenose dolphins.

As a worst case, using the area of the danger zone, and recognizing that the Port of Miami is within the boundaries of the northern area described in Litz (2007), and that the danger zone of any blasting event using equal to or less than 450 lbs/delay will be approximately 0.1% of Biscayne Bay, the ACOE assumes that because animals are not evenly distributed throughout

Biscayne Bay, that they travel as single individuals or in groups (as documented in the OBIS-Seamap data and the monitoring data from the Miami Harbor Phase II project in 2005), and that without any monitoring and mitigation measures to minimize potential impacts, up to three bottlenose dolphins from the Biscayne Bay stock may be taken, by Level B harassment, incidental to each blasting event.

Assuming that the delays will be spread equally across the proposed action area and using the calculation of 29 delays and that three bottlenose dolphins would be inside the danger zone, 15 of the delayed blasting events would take place in Biscayne Bay since it compromises 52% of the proposed action area. Three bottlenose dolphins times 15 detonations is equal to 45 bottlenose dolphins potentially exposed to a underwater sound and pressure resulting in Level B harassment over a 1-year period for an IHA incidental to the proposed blasting activities at the Port of Miami.

Western North Atlantic Central Florida Coastal Stock

The Western North Atlantic Central Florida Coastal stock of bottlenose dolphins is present in the coastal Atlantic waters shallower than 65.6 ft (20 m) in depth between latitude 29.4° North to the western end of Vaca Key (approximately 29.69° North to 81.11° West) where the stock boundary for the Florida Key stock begins, with an area of 3,007 mi^2 (7,789 km^2). The outer entrance channel of the Port of Miami is approximately 15,500 ft long (4,724.4 m) by 500 ft wide, which is approximately 0.28 mi^2 (0.73 km^2). The Port of Miami's channels consist of approximately 0.009% of the stocks boundaries.

The same calculations for assessing the potential impacts to bottlenose dolphins from the proposed blasting activities that were used for the Biscayne Bay stock were also applied to this stock. To determine the maximum area of the coastal Atlantic in which bottlenose dolphins may experience pressure levels greater than or equal to the 23 psi threshold for explosives less than 2,000 lb (907.2 kg), which has the potential to result in Level B harassment due to TTS and associated behavioral disruption, the ACOE may utilize a maximum charge weight of 450 lb (204.1 kg) with a calculated danger zone of 1,995 ft (608.1 m). Using this radius, the total area of this zone is approximately 0.015% of coastal Atlantic where this stock is expected to occur).

For an open-water, unconfined blast, the pressure edge of the danger zone is expected to be 23 psi. For a fully confined blast, the pressure at the edge of the danger zone is expected to be 6 psi. Utilizing the pressure data collected the Miami Harbor Phase II project in 2005, for a maximum charge weight of 450 lbs in a fully confined blast, the pressure is expected to be 22 psi approximately 700 ft (213.4 m) from the blast, which is below the threshold for Level B harassment (i.e., 23 psi criteria for explosives less than 2,000 lb). However to ensure the protection of marine mammals, and in case of an incident where a detonation is not fully confined, the ACOE assumes that any animal within the boundaries of the danger zone would be taken by Level B harassment.

Waring *et al*. (2010) estimates the minimum population for the Western North Atlantic Central Florida stock to be 5,094 animals, and estimates the best population to be 6,318 animals.

Table 4 (below) presents the estimated incidental take, by Level B harassment, for varying charge weight delays likely to be used during the proposed blasting activities and the estimated impacts based on the population estimates used in this analysis. In all cases, less than one bottlenose dolphin is expected to be taken incidental to each blasting event (0.102 minimum to 0.948 maximum). This assumes that the distribution of bottlenose dolphins is equal throughout all of the stock's range.

Table 4. (Table 4 of the ACOE's IHA application) The estimated incidental take of bottlenose dolphins from the Western North Atlantic Central Florida Coastal stock, per each blasting event, based on the maximum charge weight/delay and population density.

Maximum (lbs/delay)	Danger Zone (ft)	Estimated Take Based on Minimum Population Estimate (5,094)	Estimated Take Based on Best Population Estimate (6,318)
450	1,992	0.758	0.940
200	1,520	0.441	0.547
119	1,279	0.312	0.387
50	958	0.175	0.217
17	668	0.085	0.106

Other than the aerial surveys conducted by NMFS used to develop the stock assessment report, the ACOE has not been able to locate any additional photo-ID or habitat usage analysis. As a result, the ACOE is unable to determine if animals are evenly distributed throughout the stock's range, particularly in the southernmost portion of the stock's range where the proposed action area is located.

To be conservative, the ACOE will use the same assumptions for the Western North Atlantic Central Florida Coastal stock as was used for the Biscayne Bay stock. Reviewing the data from the Miami Harbor Phase II project in 2005, the ACOE noted that for the 40 detonations, 28% of all animals sighted within the proposed action area (Fisherman's Channel) were bottlenose dolphins (the other animals sighted were manatees and sea turtles). Bottlenose dolphins were sighted inside the exclusion zone 12 times with a total of 30 individuals, with an average of 2.5 animals per sighting out of the total 58 bottlenose dolphins recorded during the project; therefore, groups of dolphins entered the exclusion zone multiple times. Also, dolphins entered the exclusion zone during 30% of the blasting events. Not all of the incidents where dolphins entered the exclusion zone resulted in a project delay, it is dependent upon when during the countdown the animals cross the line demarcating the exclusion zone, and how long they stay in the exclusion zone.

During the Miami Harbor Phase II project in 2005, bottlenose dolphins in the exclusion zone triggered delays on four occasions during the 13 blasting events (31%). If the maximum 313 planned detonations for the duration of the one year IHA (equal to 365 calendar days/year minus 52 Sundays/year [no confined blasting will occur on Sundays) have an equal percentage of delays as the 2005 project (assuming construction starts in November with blasting November, 2012 to October, 2013 [and possibly beyond] timeframe, with no blasting on Sundays), 94 of the

detonations would be delayed for some period of time due to the presence of protected species and 29 of those delays would specifically be for bottlenose dolphins.

As a worst case, using the area of the danger zone, and that the danger zone of any blasting event using equal to or less than 450 lbs/delay will be approximately 0.009% of the stock's range. The ACOE assumes that because animals are not evenly distributed throughout the stock's range, that they travel as single individuals or in groups (as documented in the monitoring data from the Miami Harbor Phase II project in 2005), and that without any monitoring and mitigation measures to minimize potential impacts, up to three bottlenose dolphins from the Western North Atlantic Central Florida Coastal stock may be taken, by Level B harassment, incidental to each blasting event.

Assuming that delays will be spread equally across the proposed action area and using the calculation of 29 delays and that three bottlenose dolphins would be inside the danger zone, 14 of the delayed blasting events would take place in Biscayne Bay since it compromises 48% of the proposed action area. Three bottlenose dolphins times 14 detonations is equal to 42 bottlenose dolphins potentially exposed to underwater sound and pressure over a one year period for an IHA incidental to the proposed blasting activities at the Port of Miami.

Summary of Requested Estimated Take

Without the implementation of the proposed monitoring and mitigation measures, the ACOE has calculated up to 87 bottlenose dolphins (45 from the Biscayne Bay stock, 42 of the Western North Atlantic Central Florida stock) may be potentially taken, by Level B harassment, incidental to the proposed blasting operations over the course of the one year IHA. Due to the protective measures of confined blasts, the implementation of the proposed monitoring and mitigation measures (i.e., danger, exclusion, safety, and watch zones, use of the confined blasting techniques, as well as PSOs), the ACOE is requesting the take, by Level B harassment only, of a total of 22 bottlenose dolphins (12 bottlenose dolphins from the Biscayne Bay stock and 10 bottlenose dolphins from the Western North Atlantic Central Florida Coastal stock). The ACOE believes that the implementation of the protective measures of confined blasts reduces the potential for take to approximately 25% of the calculated take without any monitoring and mitigation measures. Based on the previous project by the ACOE at Miami Harbor, with 40 blast events and no documented take, this estimated take is likely high.

4.2.3 Effects to the Social and Economic Environment

The proposed action is NMFS' issuance of an IHA to the ACOE authorizing the harassment of marine mammals incidental to the blasting operations associated with the Miami Harbor Deepening Project. As described in Chapter 3, there is no commercial, recreational, or subsistence use of marine mammals within the action area. Therefore, the proposed action is not anticipated to effect the social and economic environment.

4.2.4 Effects on the Physical Environment

The issuance of an IHA authorizing harassment to marine mammals would not affect the physical environment. NMFS' authorization solely authorizes take, by Level B harassment, of marine mammals incidental to a specified activity in a specified geographic region. NMFS has determined that the issuance of an IHA for the taking of marine mammals incidental to the basting operations as part of the Miami Harbor Deepening Project will not have an adverse impact on EFH; therefore, an EFH consultation is not required.

Potential Effects of Activities on Marine Mammal Habitat

No information is currently available that indicates resident bottlenose dolphins in the proposed action area specifically utilize the inner and outer channels, walls, and substrate of the Port of Miami as habitat for feeding, resting, mating, or other biologically significant functions. The bottom of the channel has been previously blasted, and the rock and sand dredged. The walls of the channels are composed of vertical rock. The ACOE acknowledges that while the port may not be suitable foraging habitat for bottlenose dolphins in Biscayne Bay, it is likely that dolphins may use the area to traverse to and from North Biscayne Bay or offshore via the main channel (i.e., Government Cut).

The temporary modification of the action area by the proposed construction and confined blasting activities may potentially impact the two stocks of bottlenose dolphins expected to be present in the Port of Miami, however, these impacts are not expected to be adverse. If animals are using the Port of Miami project area to travel from south to north Biscayne Bay or vice-versa and/or exiting the Biscayne Bay via the main shipping channel, the proposed construction and confined blasting activities may delay or detour their movements.

Confined blasting within the boundaries of the Port of Miami will be limited both spatially and temporally. The explosives utilized in the proposed confined blasting operations are water soluble and non-toxic. If an explosive charge is unable to be fired and must be left in the drill hole, it is designed to break down. Also, each drill hole has a booster with detonator and detonation cord. Most of the detonation cord is recovered onto the drill barge by pulling it back onboard the drill barge after the confined blasting event. Small amounts of detonation cord may remain in the water after the blasting event has taken place, and will be recovered by small vessels with scoop nets. Any material left in the drill hole after the confined blast event will be recovered through the dredging process, when the cutterhead dredge excavates the fractured rock material.

With regard to prey species (mainly fish), a very small number of fish are expected to be impacted by the proposed Miami Harbor project, based on the results of the 2005 blasting project in Miami Harbor. That project consisted of 40 confined blast events over a 38 day time frame. Of these 40 confined blast events, 23 were monitored (57.5% of the total) by the State and injured and dead fish were collected after the all clear was given (the "all-clear" is normally at least two to three min after the shot is fired, since seagulls and frigate birds quickly learned to approach the confined blast site and swoop in to eat some of the stunned, injured, and dead fish floating on the surface of the water). State biologists and volunteers collected the carcasses of the floating fish (note that not all dead fish float after a blasting event), and due to safety concerns, there are no plans to put divers on the bottom of the channel in the blast zone to collect

non-floating fish carcasses. The fish were described to the lowest taxonomic level possible (usually species) and the injury types were categorized. The data forms are available from the FWC and ACOE upon request.

A summary of those data shows that 24 different genera were collected during the previous Miami Harbor blasting project. The species with the highest abundance were white grunts (*Haemulon plumier*, N = 51), scrawled cowfish (*Lactophrys quadricornis*, N = 43), and pygmy filefish (*Monocanthus setifer*, N = 30). The total fish collected during the 23 confined 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 fish killed (see Table 4 of ACOE's application) and reviewing the maximum charge weight per delay for the Miami Harbor project, it appears that there is no direct correlation between the charge weight and fish killed that can be determined from such a small sample. Reviewing the 23 confined blasting events where dead and injured fish were collected after the "all-clear" signal was given, no discernable pattern exists. Factors that affect fish mortality include, but are not limited to fish size, body shape (fusiform, etc.), proximity of the blast to a vertical structure like a bulkhead (e.g., see the August 10, 2005 blast event, a much smaller charge weight resulted in a higher fish kill due to the closeness of a bulkhead).

Table 5. (Table 5 of the ACOE's IHA application) Confined blast maximum charge weight and number of fish killed during Miami Harbor 2005 project.

Date	Max Charge Weight/Delay (lb)	Fish Killed
July 25, 2005	112	35
July 26, 2005	85	38
August 10, 2005	17	28

In the past, to reduce the potential for fish to be injured or killed by the confined blasting, the resource agencies have requested, and ACOE has allowed, that confined blasting contractors utilize a small, unconfined explosive charge, usually a 1 lb (0.5 kg) booster, detonated about 30 seconds before the main confined blast, to drive fish away from the confined 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 confined blast. Blasting companies use this method as a "good faith effort" to reduce the potential impacts to aquatic natural resources. The explosives industry recommends firing a "warning shot" to frighten fish out of the area before seismic exploration work is begun (Anonymous, 1978 in Keevin *et al*., 1997).

There are 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. 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 (i.e., largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), and flathead catfish (*Pylodictis olivaris*), equipping each fish with an internal radio tag to allow the fishes movements to be tracked before and after the scare charge. Fish movement was compared with a predicted lethal dose (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 blast events.

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

To calculate the potential loss of prey species from the proposed project area as an impact of the confined blasting events, the ACOE used a 12.5 fish kill per blasting event estimate based on the Miami Harbor 2005 project, and multiplied it by the 40 shots, reaching a total estimate of 500 floating fish. As stated previously, not all carcasses float to the surface and there is no way to estimate how many carcasses did not float. Using an estimate of 12.5 fish kill per blasting event, and the maximum 600 detonations for the entire multi-year proposed project, the minimum number of fish expected to be killed by the proposed project is approximately 7,500 fish across the entire 28,500 ft (8,686.8 m) long channel footprint, assuming the worst case scenario and the entire channel needs to be blasted.

NMFS anticipates that the proposed action will result in no significant impacts to marine mammal habitat beyond rendering the areas immediately around the Port of Miami less desirable shortly after each blasting event and during dredging operations and potentially eliminating a relatively small amount of locally available prey. The impacts will be localized and instantaneous. Impacts to marine mammal habitat, as well as invertebrate and fish species are not expected to be significantly detrimental.

4.3 SUMMARY OF COMPLIANCE WITH APPLICABLE LAWS, NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

As summarized below, NMFS has determined that the proposed IHA is consistent with the purposes, policies, and applicable requirements of the NEPA, MMPA, ESA, MSFCMA, and NMFS regulations. NMFS issuance of the permit would be consistent with the MMPA and ESA.

4.3.1 National Environmental Policy Act

In compliance with the NEPA of 1969 (42 U.S.C. 4321 *et seq*.), NMFS has prepared this EA analyzing the effects of the proposed action (i.e., issuance of an IHA) on the human environment. Based on the analyses in the EA, NMFS has not identified any significant impacts on the human environment resulting from issuance of the IHA. The EA will serve as the basis for preparing a Finding of No Significant Impact.

4.3.2 Marine Mammal Protection Act

The ACOE submitted an application for an authorization under section 101(a)(5)(D) of the MMPA, which was consistent with applicable issuance criteria in the MMPA and NMFS implementing regulations. The views and opinions of scientists or other persons or organizations knowledgeable of the marine mammals that are the subject of the application or of other matters germane to the application were considered, and support NMFS' determinations regarding the application. In summary, NMFS has determined that the proposed action may potentially expose bottlenose dolphins to sounds and pressure levels considered the threshold for Level B harassment (i.e., short-term, minor hearing impairment and associated behavioral disruption due to the instantaneous duration of the blasting events) during blasting operations during the ACOE's project at the Port of Miami. The specifid activities associated with the ACOE's blasting operations are not likely to cause auditory injury, or other non-auditory injury, serious injury, or death to affected marine mammals. Hence, the ACOE's specified activities will result in the incidental take of small numbers of marine mammals, by Level B harassment only, and the total taking will have a negligible impact on the affected species or stocks.

An incidental take authorization issued by NMFS would contain standard terms and conditions stipulated in the MMPA and NMFS' regulations. As required by the MMPA, the authorization would specify:

(1) the location and effective date of the authorization;
(2) the number and kinds (species and stock) of marine mammals that may be taken;
(3) the manner in which they may be taken;
(4) appropriate monitoring and mitigation measures designed to minimize impacts to affected marine mammals;
(5) a monitoring plan designed to detect impacts or lack thereof; and
(6) reporting requirements.

4.3.3 Endangered Species Act

Under section 7 of the ESA, the ACOE requested formal consultation with the NMFS SERO, on the proposed project to improve the Port of Miami on September 5, 2002, and reinitiated consultation on January 6, 2011. NMFS determined that the proposed action is likely to adversely affect one ESA-listed species and prepared a Biological Opinion (BiOp) issued on September 8, 2011, that analyzes the project's effects on staghorm coral (*Acropora cervicornis*). It is NMFS' biological opinion that the action, as proposed, is likely to adversely affect staghorn coral, but is not likely to jeopardize its continued existence or destroy or adversely modify its designated critical habitat. Based upon NMFS SERO's updated analysis, NMFS no longer expects the proposed project is likely to adversely affect Johnson's seagrass (*Halophila johnsonii*) or its designated critical habitat. NMFS SERO has determined that the ESA-listed marine mammals (Blue, fin, sei, humpback, North Atlantic right, and sperm whales) smalltooth sawfish (*Pristis pectinata*), and leatherback sea turtles (*Dermochelys coriacea*) are not likely to be adversely affected by the proposed action. Previous NMFS BiOps have determined that hopper dredges may affect hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), green (*Chelonia mydas*), and logger head (*Caretta caretta*) sea turtles through entrainment by the draghead. Any incidental take of loggerhead, green, Kemp's ridley, or hawksbill sea turtles due to hopper dredging has been previously authorized in NMFS' 1997

South Atlantic Regional BiOp on hopper dredging along the South Atlantic Regional BiOp. When a new BiOp is issued by NMFS, the Terms and Conditions of that South Atlantic Regional BiOp will be incorporated into the proposed project. NMFS SERO believes that the monitoring and mitigation measures in combination with stemming the hole the explosives are placed in (which greatly reduce the explosive energy released into the water column) will reduce the proposed action's effects on marine mammals and sea turtles to insignificant levels.

Under section 7 of the ESA, the ACOE requested consultation with the USFWS on the proposed project. The USFWS concurred with the ACOE's determination that the proposed construction activities related to the modification of Miami Harbor to accommodate the expansion of the Port of Miami may affect, but is not likely to adversely affect the West Indian manatee and the American crocodile (*Crocodylus acutus*) since appropriate monitoring to minimize these effects will be incorporated into the project design (Service Log No. 4103I76). In addition, the effects of the action will not result in the adverse modification to designated critical habitat for the West Indian manatee if sufficient mitigation is provided for seagrass impacts. The final concurrence is included on page 64 of the ACOE's Final Fish and Wildlife Coordination report and is incorporated here by reference.

4.3.4 Magnuson-Stevens Fishery Conservation and Management Act, Essential Fish Habitat

The ACOE requested consultation on EFH, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267, 16 U.S.C 1801 *et seq.*) and its implementing regulations 50 CFR 600.920(a). NMFS reviewed ACOE's letter dated August 13, 2001, regarding the notice of intent to prepare a Draft EIS for the Miami Harbor Navigation Improvements in Biscayne Bay, Miami-Dade County, Florida. Considering the potential impact from the proposed project on EFH, Habitat Areas of Particular Concern (HAPC), and other NMFS-trust resources, NMFS recommend that the following be included in the DEIS: (1) an EFH assessment should be completed that identifies and describes EFH and other fishery resources in the vicinity of the project, describes the impacts to EFH associated with each action alternative, identifies the ACOE views regarding the effects of the action on EFH, and discusses the proposed mitigation to fully offset any losses of the functions and values of wetlands, aquatic resources, and EFH; and (2) the mitigation plan should include a complete analysis of the proposed locations for wetland and estuarine/marine benthic habitat restoration and/or creation for this project. In-kind mitigation for all habitat types to be impacted and long-term monitoring to document success should be provided. A contingency mitigation should be developed to provide out-of-kind mitigation if in-kind is not successful. The ACOE prepared and submitted an EFH assessment with the Draft EIS that described existing EFH and potential impacts to EFH with project implementation. The comprehensive Fishery Management Plan prepared by the South Atlantic Fishery Management Council established mangrove, seagrass, nearshore, and offshore reefs as EFH for coral, coral reefs, live-bottom habitat, snapper-grouper complex, red drum, penaeid shrimp, and coastal migratory pelagic. Furthermore, the plan established EFH Habitat Areas of Particular Concern within these areas for the spiny lobster (*Panulirus argus*), snapper-grouper complex, and penaeid shrimp. Areas meeting the criteria of the management plan were identified within the study area and noted during the study.

Appendix F of the ACOE's FEIS contains EFH coordination documents between NMFS and ACOE. On April 28, 2003, NMFS wrote a letter to the ACOE that included EFH conservation

recommendations for the Port of Miami Navigation Project in Miami-Dade County. The ACOE provided NMFS a detailed reply to NMFS' 19 EFH recommendations and intends to comply with most of them (2, 3, 4, 5, 6, 7, 10, 11, 12, 14, 15, 16, 17, and 19); the remaining recommendations are not under the ACOE's jurisdiction or are economically infeasible to implement. Appendix F of the ACOE's FEIS contains more information on NMFS' 19 EFH recommendations and the ACOE's responses, that section is incorporated here by reference.

NMFS, Office of Protected Resources, Permits and Conservation Division has determined that issuance of an IHA for the taking of marine mammals incidental to the blasting and dredging operations will not have an adverse impact on EFH, therefore, an EFH consultation is not required.

4.3.5 Coastal Zone Management Act

The ACOE prepared a Federal consistency determination in accordance with 15 CFR 930 Subpart C is included in Appendix D of the ACOE's FEIS. The State of Florida reviewed the ACOE's Draft EIS and on May 14, 2003, determined that the proposed project is in compliance with the Florida Coastal Management Program. NMFS has identified a negative determination for the Coastal Zone Management Act and a consistency determination under the CZMA is not required.

4.4 MITIGATION MEASURES

In order to issue an Incidental Take Authorization (ITA) under section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence uses.

Over the last 10 years, the ACOE's Jacksonville District has been collecting data concerning the effects of confined blasting projects on marine mammals. This effort began in the early 1990's when the ACOE contracted with Dr. Calvin Koyna, Precision Blasting Services, to review previous ACOE blasting projects. The ACOE also received recommendations from the Florida Fish and Wildlife Conservation Commission (FWC, then known as the Florida Department of Natural Resources) and the USFWS to prepare for a harbor deepening project at Port Everglades, Florida, which was conducted in the mid-1980s. The recommendations prepared for the project were specifically aimed at protecting endangered manatees and endangered and threatened sea turtles.

The ACOE will develop and implement four zones as protective measures that are based on the use of an unconfined blast. The use of unconfined blast in development of these protective zones for a confined blast will increase the conservation measures afforded marine mammals in the proposed action area. These four zones are referred to as the danger zone (i.e., inner most zone, located closest to the blast), the exclusion zone (i.e., the danger zone plus 500 ft (152.4 m) to add an additional layer of conservatism for marine mammals), the safety zone (i.e., the third zone), and the watch zone (i.e., the outer most zone). All of these zones are noted in Figure 11 of ACOE's IHA application and described in further detail in this section of the document (see below). Of these four zones, only the danger zone is associated with an MMPA threshold. The

danger zone has been determined to be larger than or equal to the threshold for Level B harassment, as defined by the MMPA. Injury (Level A harassment), serious injury, or mortality are expected to occur at closer distances to the blasting array within the danger zone. These four zone calculations will be included as part of the specifications package that the contractors will bid on before the project is awarded.

As part of the ACOE's Miami Harbor Phase II project, the ACOE monitored the confined blasting project and collected data on the pressures associated with confined blasts, while employing a formula to calculate buffer and exclusion zones that would protect marine mammals. Results from the pressure monitoring at Miami Harbor Phase II demonstrate that stemming each drill hole reduces the blast pressure entering the water (Nedwell and Thandavamoorthy, 1992; Hempen *et al*., 2005; Hempen *et al*., 2007).

The following standard conditions have been incorporated into the proposed project specifications to reduce the risk to marine mammals in the proposed project area. While this application is specific to bottlenose dolphins, these specifications are written for all protected species that may be in the proposed project area.

If confined blasting is proposed during the period of November 1 through March 31, significant operational delays should be expected due to the increased likelihood of manatees being present within the proposed project area. If possible, avoid scheduling proposed confined blasting during the period from November 1 through March 31. In the area where confined blasting could occur or any area where confined blasting is required to obtain channel design depth, the following marine mammal protective measures shall be employed, before, during, and after each confined blast:

(A) The USFWS and NMFS must review the contractor's approved Blasting Plan prior to any confined blasting activities. (Copies of this blasting plan shall be provided to FDEP and FWC as a matter of comity.) This confined blasting proposal must include information concerning a watch program and details of the blasting events. This information must be submitted at least 30 days prior to the proposed date of the confined blast(s) to the following addresses:

(1) FWC – ISM, 620 South Meridian Street, Mail Stop 6A, Tallahassee, FL 32399-1600 or ImperiledSpecies@myfwc.com.

(2) NMFS Office of Protected Resources, 1315 East-West Highway, Silver Spring, MD 20910.

(3) USFWS, 1339 20th Street, Vero Beach, Florida 32960-3559 or 6620 Southpoint Drive South, Suite 310, Jacksonville, FL 32216-0912 (project location dependent).

(4) NMFS Southeast Regional Office, Protected Species Management Branch, 263 13th Avenue South, St. Petersburg, FL 33701.

In addition to plan review, Dr. Allen Foley should be notified at the initiation and completion of all in-water blasting (allen.foley@myfwc.com).

(B) The contractor's blasting plan shall include at least the following information:

(1) A list of Protected Species Observers (PSOs), their qualifications, and positions for the watch, including a map depicting the proposed locations for boat or land-based PSOs. Qualified PSOs must have prior on-the-job experience observing for protected species during previous in-water blasting events where the blasting activities were similar in nature to this project.

(2) The amount of explosive charge proposed, the explosive charge's equivalency in TNT, how it will be executed (depth of drilling, stemming, in-water, etc.), a drawing depicting the placement of the charges, size of the exclusion zone, and how it will be marked (also depicted on a map), tide tables for the blasting event(s), and estimates of times and days for blasting events (with an understanding this is an estimate, and may change due to weather, equipment, etc.).

(C) For each explosive charge placed, four zones will be calculated, denoted on monitoring reports and provided to PSOs before each blast for incorporation in the watch plan for each planned detonation. All of the zones will be noted by buoys for each of the blasts. These zones are:

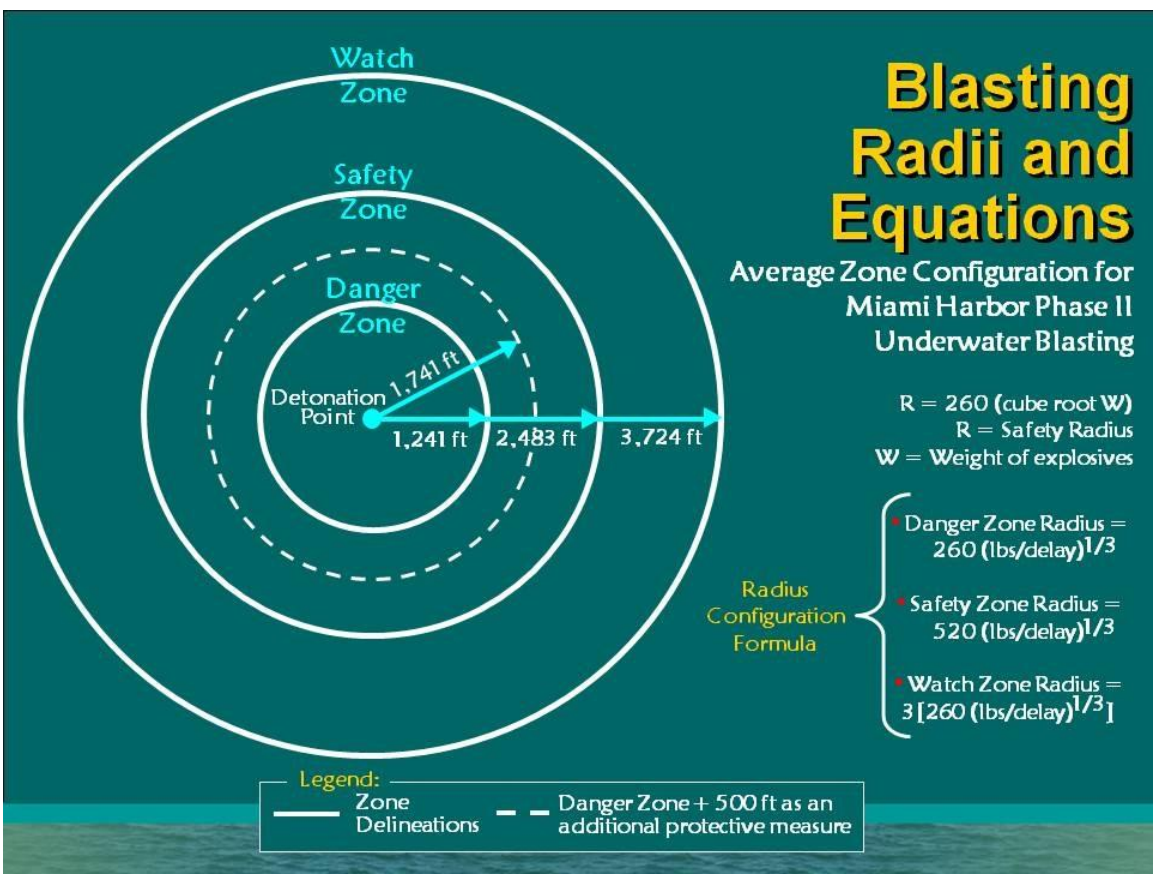

Figure 12 – (Figure 10 of the ACOE's IHA application) Average blast zone radii and equations from the 2005 project in Miami Harbor.

(1) Danger Zone: The danger zone radius is equal to 260 (79.25 m) times the cube root of the weight of the explosive charge in lbs per delay (equivalent weight of tetryl or TNT). The radius of the danger zone has been determined to be equal to or larger than the distance from the charge to a location where a marine mammal would experience Level B harassment.

Danger zone (ft) = 260 $(\text{lbs/delay})^{1/3}$

Danger Zone Development: The radius of the danger zone will be calculated to determine the maximum distance from the confined blast at which mortality to marine mammals is likely to occur. The danger zone was determined by the amount of explosives used within each delay (which can contain multiple boreholes). (The original basis of this calculation was to protect human U.S. Navy Seal divers from underwater detonations of underwater mines [Goertner, 1982]). Goertner's calculations were 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 1970's (Yelverton *et al*., 1973; Richmond *et al*., 1973). Additionally, 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; Young and O'Keefe, 1994) were also incorporated in this radius beyond its use by the Navy.

The U.S. Navy Dive Manual and the FWC Guidelines (2005) set the danger zone formula for an unconfined blast suspended in the water column, which is as follows:
$R = 260(W)^{1/3}$
Where:
R = radius of the danger zone in ft
W = weight of the explosive charge in lbs (tetryl or TNT)

This formula is conservative for the confined blasting being done by the ACOE in the Port of Miami since the blast will be confined with the rock and not suspended in the water column. The reduction of impact by confining the shots more than compensates for the presumed higher sensitivity of marine mammals. The ACOE and NMFS believes that the radius of the danger zone, coupled with a strong marine mammal monitoring and protection plan is a conservative approach to the protection of marine mammals in the action area.

(2) Exclusion Zone: The exclusion zone radius is equal to the danger zone plus a buffer of 500 ft. Detonation will not occur if a marine mammal is known to be (or based on previous sightings, may be) within the exclusion zone.

Exclusion zone (ft) = danger zone + 500 ft

Exclusion Zone Development: The exclusion zone is not associated with any threshold of take under the MMPA. The exclusion zone was developed during consultations with the FWC during the 2005 to 2006 Phase II dredging and confined blasting project in

Miami Harbor. FWC requested a larger "no blast" radius due to the high number of manatees documented in the vicinity of the Port of Miami, particularly utilizing the Bill Sadowski Critical Wildlife Area directly south of the port and north of Virginia Key. The ACOE concurred with this request and added a second zone with an additional 500 ft radius above the calculated radius of the danger zone. To be consistent with the previous blasting activities at Miami Harbor, and since the confined blasting will take place in the same area, with the same concerns about the proximity of manatees to the blasting sites along Fisherman's Channel, the ACOE plans to maintain the exclusion zone.

(3) Safety Zone: The safety zone is equal to 520 (158.50 m) times the cube root of the weight of the explosive charge in lbs per delay (equivalent weight of tetryl or TNT).

Safety zone (ft; two times the size of the danger zone) = 520 $(\text{lbs/delay})^{1/3}$

<u>Safety Zone Development</u>: The safety zone is not associated with any threshold of take. The safety zone was developed to be an area of "heightened awareness" of protected species (e.g. dolphins, manatees, and sea turtles) entering the blast area, without triggering a shut-down. This area triggers individual specific monitoring of each individual or group of animals as they transit in, out, or through the designated zones.

(4) Watch Zone: The watch zone is three times the radius of the danger zone to ensure that animals entering or traveling close to the exclusion zone are sighted and appropriate actions can be implemented before or as the animal enters the any impact areas (i.e., a delay in blasting activities).

Watch zone (ft; three times the size of the Danger Zone) = 3 [260 $(\text{lbs/delay})^{1/3}$]

<u>Watch Zone Development</u>: The watch zone is not associated to any threshold of take. The watch zone is the area that can be typically covered by a small helicopter based on the blasting site, flight speed, flight height, and available fuel to ensure effective mitigation-monitoring of the proposed project area.

(D) The watch program shall begin at least one hour prior to the scheduled start of blasting to identify the possible presence of marine mammals. The watch program shall continue for at least 30 minutes (min) after detonations are complete.

(E) The watch program shall consist of a minimum of six PSOs. Each PSO shall be equipped with a two-way radio that shall be dedicated exclusively to the watch. Extra radios should be available in case of failures. All of the PSOs shall be in close communication with the blasting sub-contractor in order to halt the blast event if the need arises. If all PSOs do not have working radios and cannot contact the primary PSO and the blasting sub-contractor during the pre-blast watch, the blast shall be postponed until all PSOs are in radio contact. PSOs will also be equipped with polarized sunglasses, binoculars, a red flag for back-up visual communication, and a sighting log with a map to record sightings. All confined blasting events will be weather dependent. Climatic conditions must be suitable for optimal viewing conditions, to be determined by the PSOs.

(F) The watch program shall include a continuous aerial survey to be conducted by aircraft, as approved by the Federal Aviation Administration (FAA). The confined blasting event shall be halted if an animal(s) is sighted within the exclusion zone, within the five min before the explosives are scheduled to be detonated. An "all clear" signal must be obtained from the aerial PSO before the detonation can occur. The confined blasting event shall be halted immediately upon request of any of the PSOs. If animals are sighted, the blast event shall not take place until the animal(s) moves out of the exclusion zone under its own volition. Animals shall not be herded away or intentionally harassed into leaving. Specifically, the animals must not be intentionally approached by project watercraft or aircraft. If the animal(s) is not sighted a second time, the event may resume 30 min after the last sighting.

(G) An actual delay in blasting shall occur when a marine mammal is detected within the exclusion zone at the point where the blast countdown reaches the T-minus five min. At that time, if an animal is in or near the safety zone, the countdown is put on hold until the zone is completely clear of marine mammals and all 30 min sighting holds have expired. Animal movements into the safety zone prior to that point are monitored closely, but do not necessarily stop the countdown. The exception to this would be stationary animals that do not appear to be moving out of the area or animals that begin moving into the safety zone late in the countdown. For these cases, holds on the T-minus 15 minutes may be called to keep the shipping channel open and minimize the impact on the Port of Miami operations.

(H) The PSOs and contractors shall evaluate any problems encountered during blasting events and logistical solutions shall be presented during blasting events and logistical solutions shall be presented to the Contracting Officer. Corrections to the watch shall be made prior to the next blasting event. If any one of the aforementioned conditions is not met prior to or during the blasting, the watch PSOs shall have the authority to terminate the blasting event, until resolution can be reached with the Contracting Officer. The Contracting Officer will contact FWC, USFWS, and NMFS.

(I) If an injured or dead marine mammal is sighted after the confined blast event, the PSOs on watch shall contact the ACOE and the ACOE will then contact the proper Federal and/or state natural resource agencies.

The PSOs shall maintain contact with the injured or dead marine mammal until authorities have arrived. Blasting shall be postponed until consultations are reinitiated and completed, and determinations can be made of the cause of injury or mortality. If blasting injuries are documented, all demolition activities shall cease. The ACOE will then submit a revised blasting plan to USFWS and NMFS for review with copies provided to FWC and FLDEP as a matter of comity.

(J) Within 30 days after completion of all blasting events, the primary PSO shall submit a report the ACOE, who will provide it to the USFWS, NMFS, FWC, and FLDEP providing a description of the event, number and location of animals seen and what actions were taken when animals were seen. Any problems associated with the event and suggestions for improvements shall also be documented in the report.

Monitoring for Mitigation

The ACOE will rely upon the same monitoring protocol developed for the Port of Miami project in 2005 (Barkaszi, 2005) and published in Jordan *et al*. (2007), which can be found online at: http://www.nmfs.noaa.gov/pr/permits/incidental.htm. The monitoring protocol is summarized here:

A watch plan will be formulated based on the required monitoring radii and optimal observation locations. The watch plan will consist of at least five PSOs including at least one aerial PSO, two boat-based PSOs, and two PSOs stationed on the drill barge (see Figures 13, 14, 15, and 16 of the ACOE's IHA application). This watch plan will be consistent with the program that was utilized successfully at Miami Harbor in 2005. The sixth PSO will be placed in the most optimal observation location (boat, barge, or aircraft) on a day-by-day basis depending on the location of the blast and the placement of dredging equipment. This process will ensure complete coverage of the four 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).

Figure 13 – (Figure 13 of the ACOE's IHA application) Typical helicopter with aerial observer.

Figure 14 – (Figure 14 of the ACOE's IHA application) View of typical altitude of helicopter during aerial observer operations.

Figure 15 – (Figure 15 of the ACOE's IHA application) Typical vessel for boat-based observer operations.

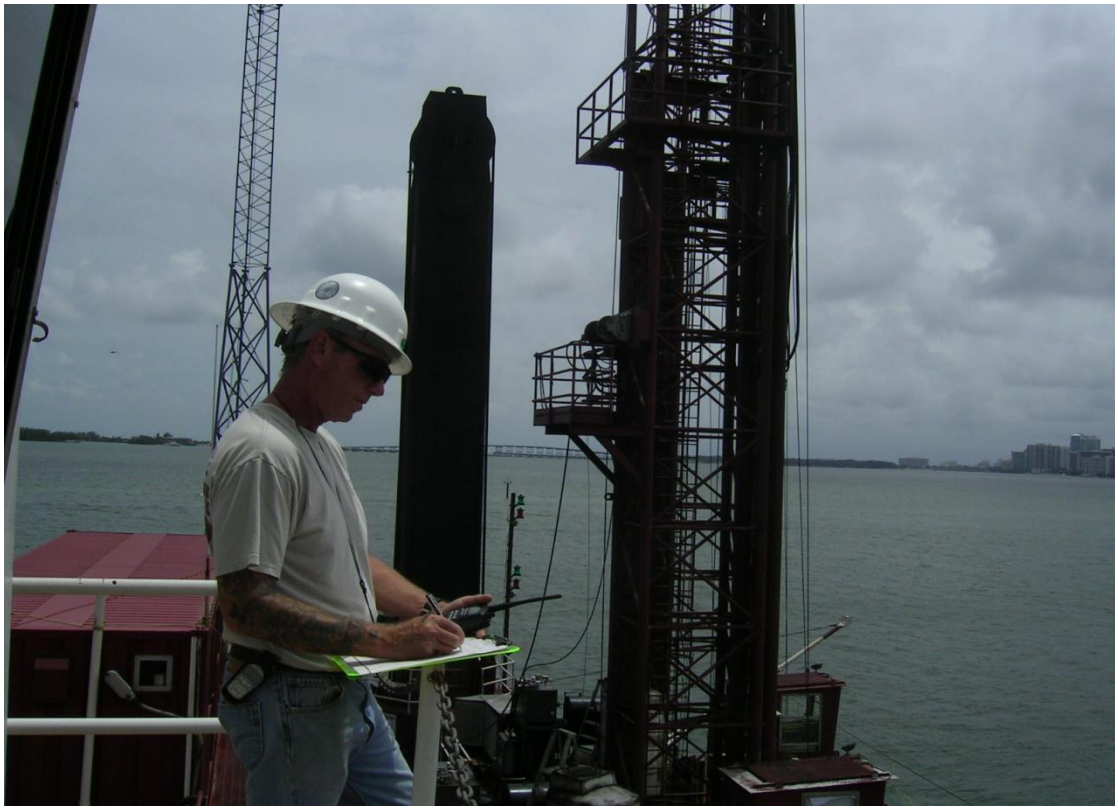

Figure 16 – (Figure 16 of the ACOE's IHA application) Observer on drill barge.

The aerial PSO will fly in a turbine engine helicopter (bell jet ranger) with the doors removed. This provided maximum visibility of the watch and safety zones as well as exceptional maneuverability and the needed flexibility for continual surveillance without fuel stops or down time, minimization of delays due to weather or visibility and the ability to deliver post-blast assistance. Additionally, at least six commercial helicopter, small Cessna, and ultra-light companies operate on Key Biscayne, immediately south of the Port of Miami and offer "flight-seeing" operations over downtown Miami, Bayfront, and the Port of Miami. Recreational use of ultra-lights launching from Key Biscayne is also common in the area, as are overflights of commercial seaplanes, jet aircraft, and helicopters. The proposed action area being monitored is a high traffic area, surrounded by an urban environment where animals are potentially exposed to multiple overflights daily. ACOE conferred with Mary Jo Barkaszi, owner and chief PSO of ECOES, Inc., a protected species monitoring company with 25 years experience, and has worked on the last five blasting events involving marine mammal concerns for the ACOE throughout the country. All of these blasting events had bottlenose dolphins commonly occur in the project area. Ms. Barkaszi states that in her experience, she has not observed bottlenose dolphins diving or fleeing the area because a helicopter is hovering nearby at 500 ft (pers. comm., September 12, 2011). During monitoring events, the helicopter hovers at 500 ft above the watch zone and only drops below that level when helping to confirm identification of something small in the water, like a sea turtle. The ACOE and NMFS do not expect the incidental take of bottlenose dolphins, by Level B harassment, from helicopter-based monitoring of the blasting operations and the ACOE is not requesting take.

Boat-based PSOs are placed on one of two vessels, both of which have attached platforms that place the PSOs eyes at least 10 ft (3 m) above the water surface enabling optimal visibility of the water from the vessels. The boat-based PSOs cover the safety zone where waters are deep enough to safely operate the boats without any impacts to seagrass resources. The shallow seagrass beds south of the proposed project site relegate the PSO boats mainly to the channel east and west of the blast zone. At no time are any of the PSO boats allowed in shallow areas where propellers could potentially impact the fragile seagrass.

At times, turbidity in the water may be high and visibility through the water column may be reduced so that animals are not seen below the surface as they should be under normal conditions. This may be more common on an ebb tide or with a sustained south wind. However, animals surfacing in these conditions are still routinely sighted from the air and from the boats, thus the overall PSO program is not compromised, only the degree to which animals were tracked below the surface. Adjustments to the program are made accordingly so that all protected species are confirmed out of the safety zone prior to the T-minus five min, just as they are under normal visual conditions. The waters within the proposed project area are exceptional for observation so that the decreased visibility below the surface during turbid conditions make the waters more typical of other port facilities where PSO programs are also effective throughout the U.S., for example New York and Boston harbors, where this monitoring method has also been employed.

All PSOs are equipped with marine-band VHF radios, maps of the blast zone, polarized sunglasses, and appropriate data sheets. Communications among PSOs and with the blaster is of critical importance to the success of the watch plan. The aerial-based PSO is in contact with vessel and drill barge-based PSOs and the drill barge with regular 15 min radio checks throughout the watch period. Constant tracking of animals spotted by any PSO is possible due to the amount and type of PSO coverage and the excellent communications plan. Watch hours are restricted to between two hours after sunrise and one hour before sunset. The watch begins at least one hour prior to the scheduled blast and is continuous throughout the blast. Watch continues for at least 30 min post blast at which time any animals that were seen prior to the blast are visually re-located whenever possible and all PSOs in boats and in the aircraft assisted in cleaning up any blast debris.

If any marine mammals are spotted during the watch, the PSO notifies the aerial-based PSO and/or the other PSOs via radio. The animals is located by the aerial-based PSO to determine its range and bearing from the blast array. Initial locations and all subsequent re-acquisitions are plotted on maps. Animals within or approaching the safety zone are tracked by the aerial and boat-based PSOs until they exited the safety zone. Anytime animals are sighted near the safety zone, the drill barge is alerted as to the animal's proximity and some indication of any potential delays it might cause.

If any animal(s) is sighted inside the safety zone and not re-acquired, no blasting is authorized until at least 30 minutes has elapsed since the last sighting of that animal(s). The PSOs on watch will continue the countdown up until the T-minus five minute point. At this time, the aerial-based PSO confirms that all animals are outside the safety zone and that all holds have expired prior to clearing the drill barge for the T-minus five min notice. A fish scare charge will be fired

at T-minus five min and T-minus one min to minimize effects of the blast on fish that may be in the same area of the blast array by scaring them from the blast area.

4.5 MONITORING AND REPORTING MEASURES

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking." NMFS implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for IHAs must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the action area.

The ACOE will be conducting a study on fish kill associated with confined underwater blasting that will provide information on the effects of confined underwater blasting on prey species for dolphins in the proposed project area. This study will determine the minimum distance from the blast array, based on charge weight, at which fish will not be killed, or injured (the "lethal dose of zero" distance) by confined underwater blasting. Similar studies have been completed for open water (unconfined) blasts as cited by Hempen and Keevin (1995), Keevin *et al*. (1995a, 1995b, and 1997), and Keevin (1998), but no such studies have been conducted for confined underwater blasting. This data will be useful for future confined blasting projects where pisciverous marine mammals are found, since it will allow resource managers to assess the impacts of the blasting activities on marine mammal prey, where species composition and density data have been collected for that project.

Additionally, ACOE will provide sighting data for each blast to researchers at NMFS Southeast Fisheries Science Center's marine mammal program and any other researchers working on dolphins in the project area to add to their database of animal usage of the proposed project area. The ACOE will rely upon the same monitoring protocol developed for the Port of Miami project in 2005 (Barkaszi, 2005) and published in Jordan *et al*. (2007).

The ACOE plans to coordinate monitoring with the appropriate Federal and state resource agencies, and will provide copies of all relevant monitoring reports prepared by their contractors. After completion of all detonation and dredging events, the ACOE will submit a summary report to regulatory agencies.

Within 30 days after completion of all proposed blasting events, the lead PSO shall submit a report to the ACOE, who will provide it to NMFS. The report will contain the PSO's logs (including names and positions during the blasting events), provide a description of the events, environmental conditions, number and location of animals sighted, the behavioral observations of the marine mammals, and what actions were taken when animals were sighted in the action area of the proposed project. Any problems associated with the even and suggestions for improvements shall also be documented in the report. A draft final report must be submitted to NMFS within 90 days after the conclusion of the proposed blasting activities. The report would include a summary of the information gathered pursuant to the monitoring requirements set forth in the IHA, including dates and times of detonations as well as pre- and post-blasting monitoring observations. A final report must be submitted to NMFS within 30 days after receiving

comments from NMFS on the draft final report. If no comments are received from NMFS, the draft final report will be considered to be the final report.

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this IHA, such as an injury, serious injury or mortality, ACOE will immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation, Office of Protected Resources, NMFS at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov, and the NMFS Southeast Region Marine Mammal Stranding Network at 877-433-8299 (Blair.Mase@noaa.gov and Erin.Fougeres@noaa.gov) (Florida Marine Mammal Stranding Hotline at 888-404-3922). The report must include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Description of the incident;
- Status of all noise-generating source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with ACOE to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. ACOE may not resume their activities until notified by NMFS via letter or email, or telephone.

In the event that ACOE discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), ACOE will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov, and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299) and/or by email to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fougeres@noaa.gov). The report must include the same information identified in the paragraph above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with ACOE to determine whether modifications in the activities are appropriate.

In the event that ACOE discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), ACOE will report the incident to the Chief of the Permits and Conservation

Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Howard.Goldstein@noaa.gov, and the NMFS Southeast Region Marine Mammal Stranding Network (877-433-8299), and/or by email to the Southeast Regional Stranding Coordinator (Blair.Mase@noaa.gov) and Southeast Regional Stranding Program Administrator (Erin.Fougeres@noaa.gov), within 24 hours of discovery. ACOE will provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network.

4.6 ***ENCOURAGING AND COORDINATING RESEARCH***

The ACOE will coordinate monitoring with the appropriate Federal and state resource agencies, including NMFS Office of Protected Resources and NMFS SERO Protected Resources Division, and will provide copies of any monitoring reports prepared by the contractors.

4.7 CUMULATIVE IMPACTS

According to CEQ regulations, cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR §1508.7). Cumulative effects analysis in a document prepared for purposes of the NEPA should consider potential cumulative environmental impacts. Cumulative impacts may occur when there is a relationship between a proposed action and other actions expected to occur in a similar location or during a similar time period. This relationship may or may not be obvious. Actions overlapping within close proximity to the proposed action can reasonably be expected to have more potential for cumulative effects on "shared resources" than actions that may be geographically separated. Similarly, actions that coincide temporally will tend to offer a higher potential for cumulative effects.

Cumulative effects refer to the impacts on the environment that result from a combination of past, present, and reasonably foreseeable future projects and human activities. Past, present, and reasonably foreseeable future activities that are likely to affect the human environment in southeastern Florida include dredging, construction and demolition activities, shipping, commercial fishing, recreational fishing and boating, and military readiness activities. The following summary describes ongoing and proposed activities in southeastern Florida that may contribute to cumulative adverse impacts to the biological and physical environment.

ACOE's FEIS (2004) includes an in-depth analysis on the cumulative impacts in the action area on historic and cultural resources, specifically past activities (1970 to present), Port Expansion Project of 1980, Channel Deepening Project of 1991, current navigational improvements, direct and indirect natural resource impacts, future natural resource impacts, and other minor activities in the action area and that section is incorporated here by reference.

The Port of Miami provides commercial and recreational resources for the residents of southeastern Florida and is therefore subjected to anthropogenic disturbance. These include recreational and commercial vessel traffic, and coastal construction and development. As

described in Richardson *et al*. (1995), marine mammals are likely habituated and tolerant to a certain degree of anthropogenic disturbance, including noise. The ACOE project is not likely to add an increment of disturbance which would cumulatively, when combined with other actions, result in significant adverse impacts to marine mammals.

4.7.1 Current Related Projects in Action Area

Issuance of IHAs to the ACOE is not related to other actions with individually insignificant, but cumulatively significant impacts.

4.7.2 Reasonably Foreseeable Future Actions

Other than the renewal of the ACOE's IHA by NMFS, there are currently no reasonably foreseeable projects planned for this portion of the Port of Miami under NMFS authority that are not currently ongoing. NMFS is unaware of any foreseeable future actions in the project area. Any future authorizations will have to undergo the same permitting process, and NMFS will take the ACOES's Miami Harbor Deepening Project into consideration in its analyses under the MMPA, ESA, and NEPA. Any foreseeable future actions that the ACOE are aware of in the proposed action area are described in the ACOE's FEIS, incorporated here by reference.

As a result of this environmental review, NMFS has determined that the issuance of IHAs to take small numbers of marine mammals by Level B harassment incidental to the ACOE's confined blasting operations in the Port of Miami will not significantly affect the quality of the human environment.

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CHAPTER 6 LITERATURE CITED

Hempen, G.L., T.M. Keevin, and H.J. Ruben. 2005. Underwater blast pressures from confined rock removal shots: The Kill Van Kull Deepening Project. Pp. 91-100. In: Proceedings of the Thirty-first Annual Conference on Explosives and Blasting Technique, Volume 1, Orlando, Florida. International Society of Explosive Engineers, Cleveland, OH.

Hempen, G.L., T.M. Keevin, and T.L. Jordan. 2007. Underwater blast pressures from a confined rock removal during the Miami Harbor Deepening Project. International Society of Explosives Engineers. 2007G Volume 1: 1-12.

Jordan, T.L., K.R. Hollingshead, M.J. Barkaszi. 2007. Port of Miami Project – Protecting marine species during underwater blasting. International Society of Explosives Engineers. 2007G Volume 1: 1-10.

Keevin, T.M. and G.L. Hempen. 1997. The environmental effects of underwater explosions with methods to mitigate impacts. U.S. Army Corps of Engineers.

National Marine Fisheries Service. 2003. Small Takes of Marine Mammals Incidental to Specified Activities; Port of Miami Construction Project (Phase II). *Federal Register*: May 29, 2003, 68 FR 32016.

National Marine Fisheries Service. 2005. Taking Marine Mammals Incidental to Specified Activities; Port of Miami Construction Project (Phase II). *Federal Register*: April 25, 2005, 70 FR 21174.

National Marine Fisheries Service. 2009. Stock Assessment Report for Bottlenose Dolphin (*Tursiops truncatus*) Biscayne Bay Stock. [available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/ao2009dobn-bb.pdf].

National Marine Fisheries Service. 2010. Stock Assessment Report for Bottlenose Dolphin (*Tursiops truncatus truncatus*) Western North Atlantic Central Florida Coastal Stock. [available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/ao2010dobn-wnacfc.pdf].

National Marine Fisheries Service. 2011. Takes of Marine Mammals During Specified Activities; Blasting Operations by the U.S. Army Corps of Engineers During the Port of Miami Construction Project in Miami, FL. *Federal Register*: November 18, 2011, 76 FR 71517

Nedwell, J.R. and T.S. Thandavamoorthy. 1992. The waterborne pressure wave from buried explosive charges: an experimental investigation. Applied Acoustics. 37: 1014.

Richardson W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. San Diego: Academic Press. 576 p.

U.S. Army Corps of Engineers, Jacksonville District. 2004. Final General Reevaluation Report and Environmental Impact Statement on the Miami Harbor Navigation Study, Miami-Dade County, Florida.

U.S. Army Corps of Engineers, Jacksonville District. 2011. Application for an Incidental Harassment Authorization from the National Marine Fisheries Service for the Miami Harbor Deepening Project.