APPENDIX E

MARINE MAMMAL PROTECTION ACT

LETTER OF AUTHORIZATION (LOA) APPLICATION

PORT EVERGLADES, FLORIDA PROJECT

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E INTRODUCTION TO THE MARINE MAMMAL PROTECTION ACT LETTER OF AUTHORIZATION APPLICATION

The Marine Mammal Protection Act (MMPA), and its implementing regulations, allows, upon request, the incidental take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. Incidental take is an unintentional, but not unexpected, "take". The MMPA requires that an incidental take authorization be obtained for the unintentional "take" of marine mammals. The MMPA requires the action agency to coordinate with the regulatory agencies to discuss potential impacts to any species covered under the Act. The Letter of Authorization or LOA application is expected to complete these requirements.

E.1 DETAILED DESCRIPTION OF THE SPECIFIC ACTIVITY OR CLASS OF ACTIVITIES THAT CAN BE EXPECTED TO RESULT IN INCIDENTAL TAKING OF MARINE MAMMALS

This section provides a detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals

The proposed Port Everglades Harbor Deepening and Widening Project is located within the cities of Hollywood, Dania Beach, and Fort Lauderdale, Broward County, Florida. This LOA application is for the proposed use of confined underwater blasting using conventional (high) explosives to remove rock in each of the project areas with the exception of the Environmentally Friendly Bulkhead (EFB) area (**Figure E-1**: Project Segments/Areas). In summary, project features include the following:

- increase the authorized depth of the Outer Entrance Channel (OEC) from 45 feet (ft.)(13.77 meters [m]) to 48 ft. (14.63 m) (resulting in an actual depth of up to 57 ft. due to engineering and safety requirements); widen the seaward end of the OEC from 500 ft. (152.40 m) to 800 ft. (243.84 m), and extend the channel 2,200 ft. (670.56 m) seaward;
- increase the authorized depth of the Inner Entrance Channel (IEC) from 42 ft. (12.80 m) to 48 ft. (14.63 m) (resulting in an actual depth of 50 ft.);
- increase the authorized depth of the Main Turning Basin (MTB) from 42 ft. (12.80 m) to 48 ft. (14.63 m) (resulting in an actual depth of 50 ft.);
- widen the rectangular shoal region (the Widener) by approximately 300 ft. (91.44 m) to the southeast of the MTB and deepen it to a new authorized depth of 48 ft. (14.63 m) (resulting in an actual depth of 50 ft.);
- widen the South Access Channel (SAC) in the proximity of berths 23 to 26, referred to as the knuckle, by about 250 ft. (76.2 m) and reconfigure the United State Coast Guard (USCG) facility, a General Navigation Feature, easterly on USCG property;
- shift the existing 400 ft. (121.92 m) wide SAC about 65 ft. (19.81 m) to the east from approximately berth 26 to the south end of berth 29 to provide a transition back from the expanded Widener area in the north to the existing federal channel limits to the south;
- increase the authorized depth of the SAC from 42 ft. (12.80 m) to 48 ft. (14.63 m) (from the area adjacent to berth 23 to the south end of berth 32) (resulting in an actual depth of 50 ft.);
- deepen the Turning Notch (TN), including an area currently being expanded and incorporated into the TN by the local sponsor, from 42 ft. (12.80 m) to 48 ft. (14.63 m) (resulting in an actual

depth of 50 ft.); widen the SAC to the east (across from the TN) by an additional 100 ft. (30.48 m) over a length of about 1,845 ft. (562.36 m); and widen the western edge of the SAC from near the south end of berth 29 to a width of up to approximately 130 ft. (39.62 m) at the north edge of the TN;

- conduct environmental mitigation;
- pre-treat rock substrates (using confined underwater blasting with conventional [high] explosives) as necessary and take appropriate measures to safeguard protected species during that process;
- dispose of dredged material east of the Port at the Port Everglades Harbor Ocean Dredged Material Disposal Site (ODMDS).

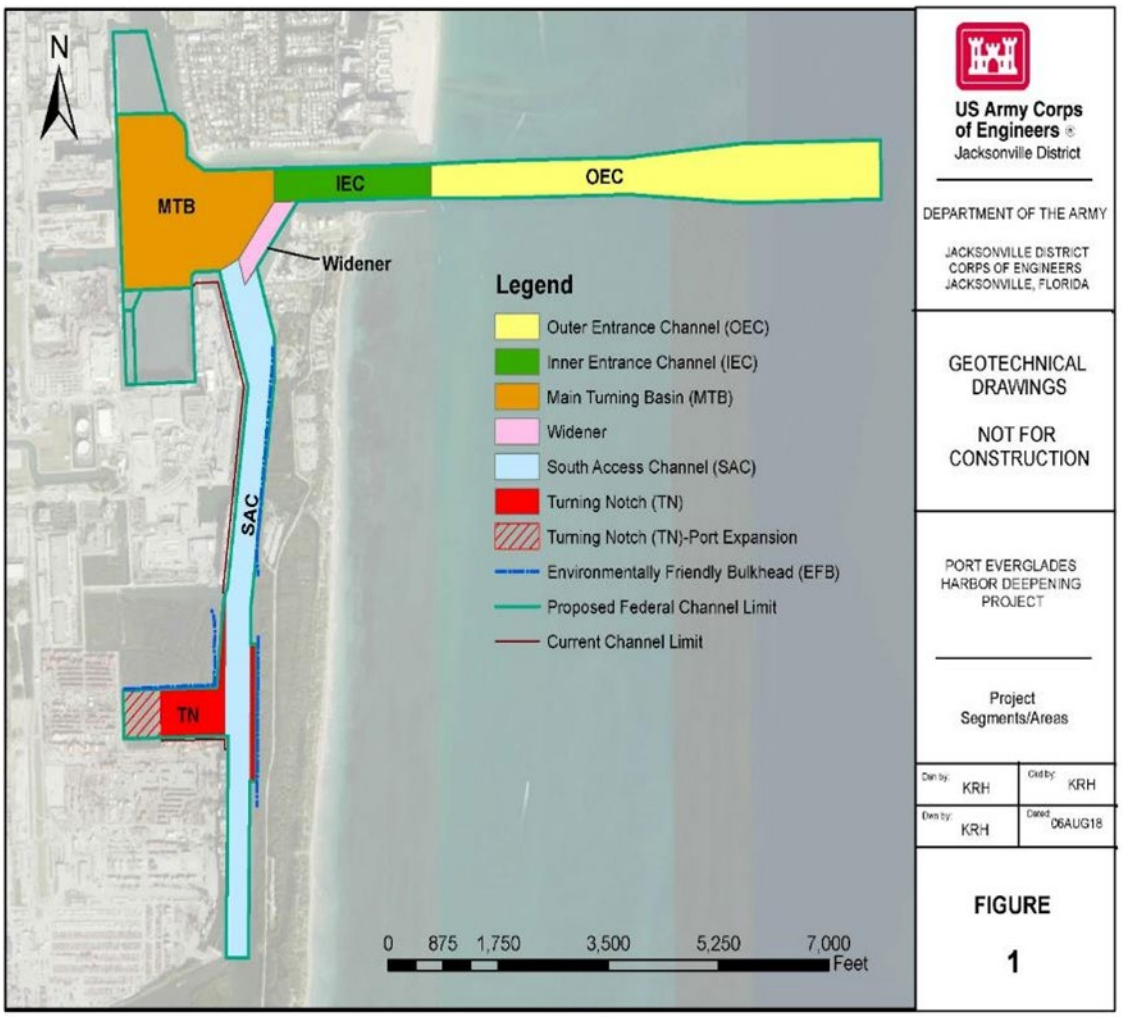

Figure E-1. Port Everglades Harbor Navigation (Deepening) Project, project segments/areas.

Environmental effects are currently being updated in a Supplemental Environmental Impact Statement (EIS) to address new information for effects to resources outside the preview of the Marine Mammal Protection Act (MMPA). All projects effects associated with marine mammals were evaluated and described within the project's original EIS. A Record of Decision for the proposed work was signed on January 29, 2016. The EIS provides a detailed explanation of project location as well as all aspects of project implementation. It is available online at the following website (scroll down and click on Broward County, and then scroll down to Port Everglades Feasibility Study and click on Final EIS):

http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/

To achieve the proposed deepening of Port Everglades, pretreatment of rock areas may be required using confined underwater blasting where dredging or other rock removal methods are unsuccessful due to the hardness and massiveness of the rock. For this LOA application, blasting is defined as the use of conventional (high) explosive materials to breakup rock substrate along the bottom and within the wideners/expansions of the project areas.

Duration of the blasting is dependent upon several 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 knowing the answers to these questions, an exact estimate of how many "blast days" will be required cannot be determined. However, it is anticipated that one-shot per day (a blast day) for 280 days, will be required to pre-treat the rock associated with this project. Blasting operations typically take place six days a week.

USACE has used core borings in conjunction with lab testing of rock samples in the dredge template to determine which areas are most likely to need blasting. The geology of the dredging project area generally consists of a thin, discontinuous layer of fine, poorly graded sand, silty sand, and sandy silt overlying limestone and sandstone bedrock ranging in hardness from soft to very hard. The limestone and sandstone rock include interbedded layers of fine, poorly graded sand. Approximately 49 percent of the removal volume within the dredge window consists of limestone and sandstone bedrock.

The rock within the dredge window does exhibit massive bedding (exceeding 3 feet in thickness) and very hard, well cemented zones in locations throughout the harbor. Contractors conducting work in the project area have reported Unconfined Compressive Strength values as high as 16,000 psi for rock within the MTB. Thick, massively bedded, high strength rock typically requires pre-treatment prior to dredging. Blasting is often used as a rock pre-treatment method due to its proven effectiveness in dredging projects.

Given the hardness and strength of the rock in the project area, blasting or other type(s) of rock pre-treatment will be required for the deepening project. Alternative rock pre-treatments can consist of utilizing rock breaking chisels driven by pneumatic, hydraulic, or vibratory hammers, or punch barges for mechanical breaking of the rock, which could be used for small areas. Alternative rock pre-treatments are prohibitively slow and cost prohibitive, compared to more efficient conventional confined blasting with high explosives. Rock removal will be required in each of the project areas shown on Figure 1, therefore, pre-treatment in any or all areas is likely. Based on historical dredging events and the most recent site-specific data, the project areas with the hardest and most massive rock include the following: the OEC; IEC; the MTB; the Widener; and the northern portion of the SAC. The location and extent of rock areas requiring pre-treatment will depend to a large degree on the type of equipment used to conduct the dredging operation (i.e. mechanical, hydraulic cutterhead). The selected contractor makes the

determination of the type of equipment used to conduct the dredging, which in turn determines the areas that require blasting. Blasting is not anticipated as a rock pre-treatment method for installation of the EFBs, located along the SAC.

Once a contractor has been selected, a more specific blasting plan will be prepared. However, as described in this document, certain restrictions shall be imposed on all blasting operations. Project specifications shall require that blasting be prohibited between November 15 and March 15. Blasting design criteria (further restrictions) shall also be implemented per **Table E-1**, and include no more than 280 blast events, maximum total charge weight per blast event for each project segment (i.e. SAC = 9,000 lbs [4082.31 kgs], etc.), maximum number of boreholes estimated per event (33-90), maximum individual charge weights per borehole (100 lbs [45.36 kgs], and total weight of high explosives per project area (i.e. OEC = 440000 lbs [199580.64kgs], etc.). A blast event is defined as the detonation of a delayed blast pattern consisting of 33 to 90 individual charges. Appropriate monitoring of protected species, including marine mammals, shall also be implemented.

Table E-1. Blasting Design Criteria

Project Area	Number of Blast Events Required	Pounds (lbs) of Explosives per Blast Event (Max)	Maximum Number of Boreholes per Event (estimated)	Maximum Pounds (lbs) of Explosive per Borehole	Total Weight of Explosives (Pounds/Kilograms)
OEC	88	5000 (2267.96)	50	100 (45.36)	440000 (199580.64)
IEC	19	2500 (1133.98)	33	100 (45.36)	47500 (21545.64)
MTB	103	3500 (1587.57)	50	100 (45.36)	360500 (163520.05)
Widener	10	5000 (2267.96)	50	100 (45.36)	50000 (22679.62)
SAC	50	9000 (4082.33)	90	100 (45.36)	450000 (204116.57)
Turning Notch	10	9000 (4082.33)	90	100 (45.36)	90000 (40823.31)
Totals =	**280**	--	--	--	1607700 (620332.93)

Given the blasting restrictions described above, specific charge weight and size of pattern are dependent upon the size and type of dredging equipment each contractor proposes to include in their contract bid. There is an inverse relationship between dredging equipment size (cutterhead size, horsepower behind the cutterhead, backhoe size) and the frequency, size and spacing of drill holes of individual detonation events. As the size of the equipment increases, the size and number of detonations decreases and the spacing between the individual holes increases. Vibration is also a limiting factor on charge size and hole spacing.

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. Drilling activities take place for a short 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 prior drilling events for the Miami Harbor deepening event (2005), dolphins were seen near the drill barge during drilling events and the USACE did not observe avoidance behavior. Although no measurements associated with noise from drilling small blast holes have been recorded, the USACE does not expect incidental harassment from drilling operations and is not requesting take associated with this activity.

More specific information will be made available to regulatory agencies after the contractor's blasting plan is prepared. Typically, each blast pattern is set up in a square or rectangle area divided into rows and columns (**Figure E-2** and **Figure E-4**). Blast patterns near bulkheads can consist of a single line (**Figure E-3**).

Since USACE does not have contract bids at this time and is required to have all authorizations and permits completed prior to release of the request for proposal, USACE cannot provide this information as part of the application. However, USACE must be in possession of a letter of authorization prior to advertising the contract, estimated to be January 2022, per the Competition in Contracting Act (CICA), and the Federal Acquisition Regulations (FAR).

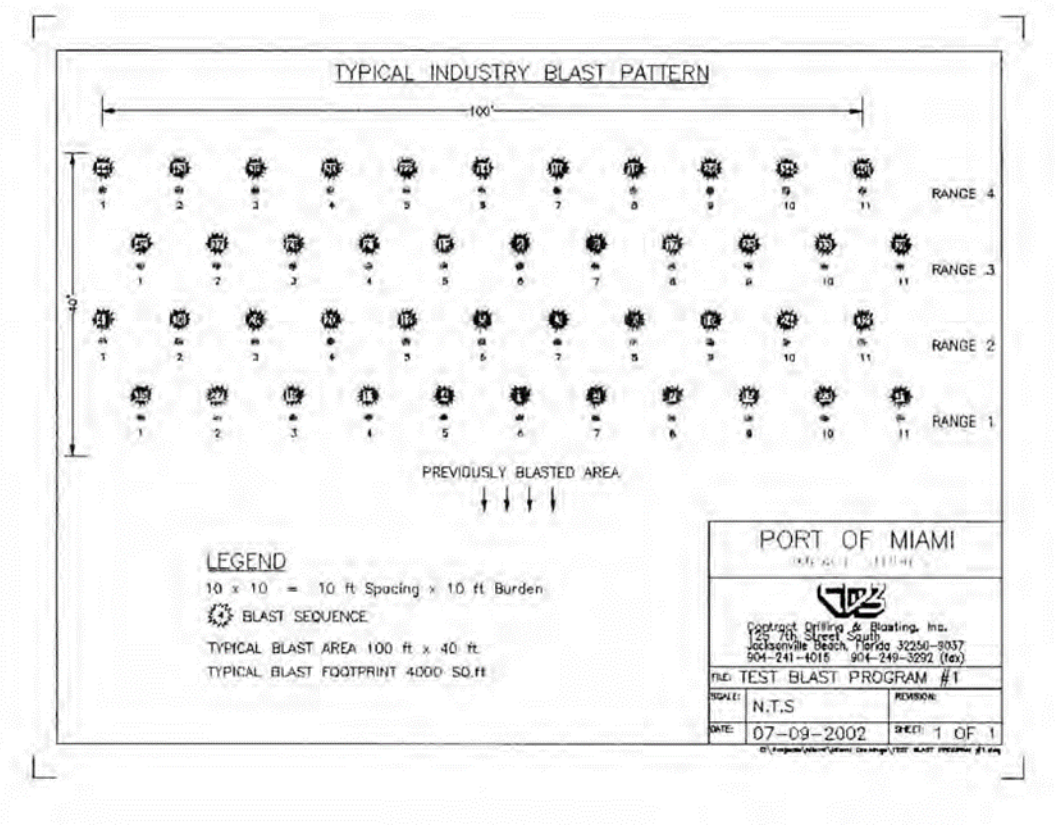

Figure E-2. Typical blast array – 10 holes x 10 holes; 100 feet (30.5 m) long by 40 feet (12.2 m) wide, 4,000 ft2 (1,219 m2) area per detonation.

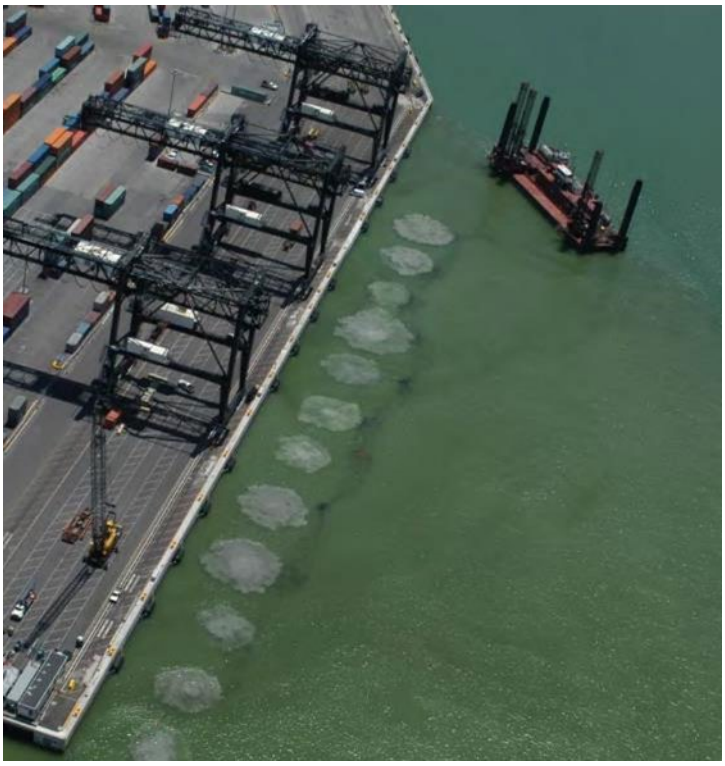

Figure E-3. Linear blast array along a bulkhead (Miami Harbor)

Figure E-4. Typical rectangular blast array (Miami Harbor)

In confined blasting, each charge is placed in a hole drilled in the rock approximately 5-10 ft. (1.5-3 m) deep; depending on how much rock/concrete needs to be pre-treated 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 E-5** and **Figure E-6**). USACE used this technique during the Miami Harbor Phase II project in 2005 in order to reduce pressure wave amplitude. National Marine Fisheries Service (NMFS) issued an incidental harassment authorization (IHA) for that operation on May 29, 2003 (and

renewed the IHA on April 19, 2005). For the Phase II project the stemming material was angular crushed rock. 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 Port Everglades Deepening Project, the specifications will be similar as those completed for the Miami Harbor Phase II project. Other types of stemming will be considered (either separately or combined with crushed rock) if they are documented to be as or more effective than crushed rock.

All blast holes shall be stemmed. The Blaster-in-Charge or Blasting Specialist shall determine the thickness of stemming using blasting industry conventional stemming calculation. 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 subangular, hard stone chips without fines having an approximate diameter of 1/2-inch (1.3 cm) to 3/8-inch (1 cm). A barrier shall be placed between the stemming and explosive product, if necessary, to prevent the stemming from settling into the explosive product. Anything contradicting the effectiveness of stemming shall not extend through the stemming.

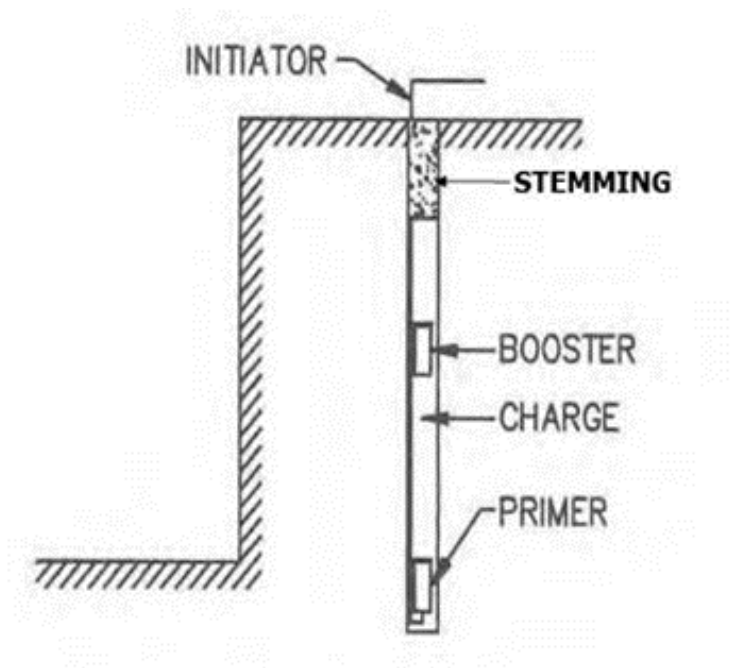

Figure E-5. Typical Drillhole configuration with stemming

Figure E-6. Stemming Material.

The length of stemming material will vary based on the length of the hole drilled, however minimum lengths will be included in the project specifications. Studies have shown that stemmed blasts have up to a 60-90% decrease in the strength of the pressure wave released, compared to open water blasts of the same charge weight (Nedwell and Thandavamoorthy 1992; Hempen et al. 2005; Hempen et al. 2007). However, unlike open water blasts (**Figure E-7**), very little peer-reviewed research exists on the effects that confined blasting can have on marine animals near the blast. The visual evidence from a typical confined blast is shown in **Figure E-8**. In the unlikely event of loss of confinement for the blasting, the pressure-wave exiting the rock mass to the water column through discontinuities in the rock (weak rock layer) could result in higher pressure-wave amplitudes in comparison to blasts properly absorbed by the rock mass. The logging of the blasting pattern boreholes during drilling typically allows for adjustments to the explosives packing and stemming design to avoid these issues with lack of confinement.

Figure E-7. Unconfined Blast of 7 lbs. (3.2 kg) of Explosives.

Figure E-8. Confined Blast of 3,000 lbs. (1,361 kg) Total Charge Weight of Explosives.

In confined underwater blasting, the detonation is generally conveyed from the drill barge to the primer and the charge itself by a non-electric initiation system. These systems are used to fire the blast from a distance which ensures human safety. These systems have a specific grain weight and they burn like a fuse. Time from activation to detonation is less than one second.

In addition to coordination with the agencies, any new scientific studies regarding the effects of blasting on marine mammals that may be in the area, will be incorporated into the design of the protection measures that will be employed in association with confined underwater blasting activities at Port Everglades. Any best new science and possible adaptive mitigation measures will be incorporated into any new LOA or IHA applications for this, and future, USACE blasting projects.

As part of these protective measures, USACE will develop four safety radii (**Figure E-9**) based on the use of an unconfined blast. The use of an unconfined blast in development of the safety radii for a confined blast will increase the protections afforded marine species in the area. These four zones are referred to as the "Danger zone" – which is the inner most zone, located closest to the blast; the "Exclusion Zone" – is the Danger zone + 500 feet to add an additional layer of conservatism to protect species in the project area; the "Safety zone" – which is the third zone and the "Watch zone" the outer most zone. All zones are noted in **Figure E-9**.

Danger Zone Development

The danger zone radius will be calculated to determine the maximum distance from the blast at which mortality to protected marine species is likely to occur. The danger zone was determined by the number of explosives used within each delay (which can contain multiple boreholes). The original basis of this calculation was to protect human 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 1970s (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 State of Florida has adopted this method for protection of marine mammals (particularly the endangered Florida manatee) within state waters (FWC, 2005) in the document entitled "May 2005 Guidelines for the Protection of Marine Mammals and Sea Turtles during the Use of Explosives in the Waters of the State of Florida."

The U.S. Navy Dive Manual and the FWC 2005 Guidelines set the danger zone formula for an unconfined blast suspended in the water column, which is as follows:

R = 260 (cube root w)

R = Danger zone radius

W = Weight of explosives

This formula is a conservative for the blasting being done in Port Everglades since the blast will be confined within 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 species. USACE believes that the danger zone radius, coupled with a strong protected species observation and protection plan is a conservative, but prudent, approach to the protection of marine wildlife species. Based on a review of this proposed method for the Miami Harbor phase II project, both NMFS (PRD and OPR) and FWS found these protective measures sufficient to protect marine mammals under their respective jurisdictions (NMFS, 2005; FWS 2002). This same approach will be fully implemented for the blasting requirements at Port Everglades.

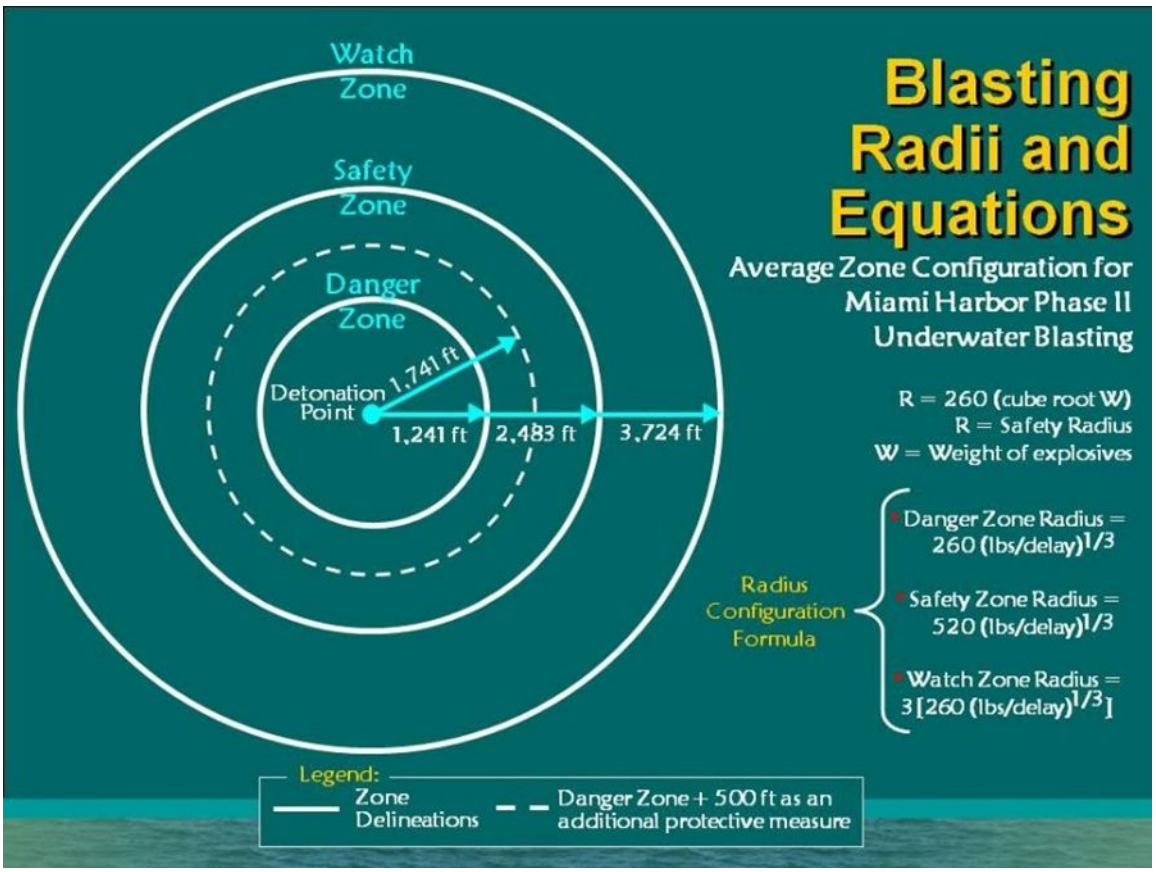

Figure E-9. Average Blast Zone Radii and Equations from Miami Harbor 2005 Project.

To estimate the maximum poundage of explosives that may be utilized for this project, USACE has reviewed previous blasting projects, one at San Juan Harbor, Puerto Rico in 2000 and Miami Harbor, Florida in 2005. The San Juan Harbor project's heaviest confined blast event was 375 lbs. (170.10 kg) per delay and in Miami it was 134 lbs. (60.78 kg) per delay. As stated earlier, the maximum weight of delays for the proposed Port Everglades deepening project will not exceed 100 lbs. (45.36 kg). A delay is defined as a distinct pause of predetermined time between detonation or initiation impulses, to permit the firing of explosive charges separately. Delay blasting is the practice of initiating individual explosive decks, boreholes, or rows of boreholes at predetermined time intervals using delay detonators, as compared to instantaneous blasting where all holes are fired essentially simultaneously.

Based upon industry standards and USACE Safety & Health Regulations, the blasting program may consist of the following:

- The weight of explosives to be used in each blast will be limited to the lowest kilograms (not to exceed 100 lbs. [45.36 kg]/delay) of explosives that can adequately break the rock;
- Drill patterns shall be restricted to a minimum of 8 ft. (2.44 m) separation from a loaded hole for this project;
- Hours of blasting are restricted from two hours after sunrise to one hour before sunset to allow for adequate observation of the project area for protected species, and will also be restricted to periods of good weather (blasting will not commence in rain, fog or otherwise poor weather conditions, and can only commence when the entire Level A Zone, Exclusion Zone, and Level B Zone are visible to observers);
- Selection of explosive products and their practical application method must address vibration and overpressure control for protection of existing structures and marine wildlife;
- Loaded blast holes will be individually delayed where larger blasts are broken into smaller blasts with a time break between them that will be determined by the contractor. Loaded blast holes will be individually delayed to reduce the maximum pounds (kilograms) per delay at point of detonation, which in turn will reduce the radius at which marine mammals may be injured or killed;
- 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 between delay detonations to stagger the blast pressures and prevent cumulative addition of pressures in the water will be determined by the contractor and will be in compliance with USACE regulations.

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

- Drill Boat Capabilities and Production Rates
- Ideal Drill Pattern for Typical Boreholes
- Acceptable Rock Breakage for Excavation
- Tolerable Vibration Level Emitted
- Directional Vibration
- Calibration of the Environment
- Sound Source Verification

The test blast program begins with a single range of individually delayed holes and progresses up to the maximum production blast intended for use. The test blast program will take place in the project area and will count toward the pre-treatment of material, since the blasts of the test blast program will be cracking rock. Test blasts will be included within the 280 total blast event limit. Each test blast is designed to establish limits of vibration and 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. Specifically, the test blast program will be used to determine the following:

- Distance between individual charges (minimum 8 ft. [2.44 m] requirement)
- Kilograms/Pounds Per Delay (not to exceed 100 lbs. [45.36 kg] per delay)
- Peak Particle Velocities (Threshold Limit Value TLV)
- Frequencies (TLV)
- Peak Vector Sum
- Overpressure

As part of the development of the protected species monitoring and mitigation protocols, which would be incorporated into the plans and specification for the project, USACE would continue to coordinate with the resource agencies to address concerns and potential impacts associated with the use of blasting as a construction technique

E.2 DATE(S) AND DURATION OF SUCH ACTIVITY AND THE SPECIFIC GEOGRAPHICAL REGION WHERE IT WILL OCCUR

Confined underwater blasting operations would be conducted from approximately October 2022 to December 2028, with the following restrictions. In accordance with Endangered Species Act-Section 7 consultation with the U.S. Fish and Wildlife Service, confined underwater blasting operations will be prohibited between November 15 and March 15 in order to avoid take of the West Indian Manatee (*Trichecus manatus*). During the blasting window, March 16 through November 14, the exact duration of blasting will be 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. Blasts shall be separated by an estimated minimum of 6 hours. When blasting operations are conducted, they will take place 24-hours a day, typically six days a week. The contractor may drill the blast pattern at night and then blast after at least two hours after sunrise (1-hour, plus one-hour of monitoring). Blasting activities normally will not take place on Sundays due to local ordinances.

The proposed confined underwater blasting activities may be performed within any of the project areas of Port Everglades except for the EFB located within Broward County, Florida (refer to **Figure E-1**). Coordinates for the approximate center of the MTB are 26° 05’ 34.76” N and 80° 07’ 05.44” W.

E.3 THE SPECIES AND NUMBERS OF MARINE MAMMALS UNDER NMFS JURISDICTION LIKELY TO BE FOUND WITHIN THE ACTIVITY AREA;

A number of cetaceans and a single species of sirenian may occur in the project area (see **Figure E-1**) as well as offshore of the southeast Florida coastline (see **Table E-2** below). The OEC extends 7,300 feet into the Atlantic Ocean, although the eastern most 200 feet of the authorized project does not require dredging. Species listed as endangered under the U.S. Endangered Species Act (ESA), includes the sei

(*Balaenoptera borealis*), fin (*Balaenoptera physalus*), blue (*Balaenoptera musculus*), North Atlantic right (*Eubalaena glacialis*), and sperm (*Physeter macrocephalus*) whales. 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; U.S. Fish and Wildlife Service jurisdiction). Table 2 presents information on the abundance, distribution, population status, and conservation status of species of marine mammals that may occur in the region of the proposed project area.

Table E-2. The habitat, occurrence, range, abundance, and conservation status of marine mammals that may occur in or near the proposed project area in the Atlantic Ocean off the U.S. southeast coast.

Species	Habitat	Occurrence in Proposed Project Area	Range in Atlantic Ocean	Stock Population Estimate [3]	ESA[1]	MMPA[2]
Mysticetes						
North Atlantic right whale (*Eubalaena glacialis*)	Pelagic, shelf and coastal	Uncommon	Canada to Florida	428 – Western North Atlantic stock	EN	S
Humpback whale (*Megaptera novaeangliae*)	Pelagic, nearshore waters, and banks	Rare	Canada to Caribbean	1,396 – Gulf of Maine stock	NL	NC
Minke whale (*Balaenoptera acutorostrata*)	Coastal, offshore	Rare	Arctic to Caribbean	4,202 – Canadian East Coast stock	NL	NC
Sei whale (*Balaenoptera borealis*)	Primarily offshore, pelagic	Rare	Canada to New Jersey	6,292 – Nova Scotia stock	EN	S
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	Rare	Canada to North Carolina	7,418 – Western North Atlantic stock	EN	S
Blue whale (*Balaenoptera musculus*)	Pelagic and coastal	Rare	Arctic to Florida	Unknown – Western North Atlantic stock	EN	S
Odontocetes						
Sperm whale (*Physeter macrocephalus*)	Pelagic, deep seas	Rare	Canada to Caribbean	4,349 – North Atlantic stock	EN	S
Dwarf sperm whale (*Kogia sima*)	Offshore, pelagic	Rare	Massachusetts to Florida	7,750 – Western North Atlantic stock	NL	NC
Pygmy sperm whale (*Kogia breviceps*)	Offshore, pelagic	Rare	Massachusetts to Florida	7,750 – Western North Atlantic stock	NL	NC
Cuvier's beaked whale (*Ziphius cavirostris*)	Pelagic, slope, canyons	Rare	Canada to Caribbean	5,744 – Western North Atlantic stock	NL	NC
Gervais' beaked whale (*Mesoplodon europaeus*)	Pelagic, slope, canyons	Rare	Canada to Florida	10,107 – Western North Atlantic stock	NL	NC
True's beaked whale (*Mesoplodon mirus*)	Pelagic, slope, canyons	Rare	Canada to Bahamas	10,107 – Western North Atlantic stock	NL	NC

Sowerby's beaked whale (*Mesoplodon bidens*)	Pelagic, slope, canyons	Rare	Canada to Florida	10,107 – Western North Atlantic stock	NL	NC
Blainville's beaked whale (*Mesoplodon densirostris*)	Pelagic, slope, canyons	Rare	Canada to Florida	10,107 – Western North Atlantic stock	NL	NC
Killer whale (*Orcinus orca*)	Widely distributed	Rare	Arctic to Caribbean	Unknown – Western North Atlantic stock	NL	NC
Short-finned pilot whale (*Globicephala macrorhynchus*)	Inshore and offshore	Rare	Massachusetts to Florida	28,924 – Western North Atlantic stock	NL	NC
Long-finned pilot whale (*Globicephala melas*)	Mostly pelagic	Rare	Canada to South Carolina	39,215 – Western North Atlantic stock	NL	NC
False killer whale (*Pseudorca crassidens*)	Pelagic	Rare	NA	1,791 – Western North Atlantic stock	NL	NC
Melon-headed whale (*Peponocephala electra*)	Pelagic	Rare	North Carolina to Florida	Unknown – Western North Atlantic stock	NL	NC
Pygmy killer whale (*Feresa attenuata*)	Pelagic	Rare	NA	Unknown – Western North Atlantic stock	NL	NC
Risso's dolphin (*Grampus griseus*)	Pelagic, shelf	Rare	Canada to Florida	35,493 – Western North Atlantic stock	NL	NC
Common bottlenose dolphin (*Tursiops truncatus*)	Offshore, inshore, coastal, and estuaries	Common	Canada to Florida	1,218 – Western North Atlantic Central Florida Coastal stock 172,825 – Western North Atlantic Offshore stock	NL	S
Rough-toothed dolphins (*Steno bredanensis*)	Pelagic	Rare	New Jersey to Florida	136 – Western North Atlantic stock	NL	NC
Fraser's dolphin (*Lagenodelphis hosei*)	Shelf and slope	Rare	North Carolina to Florida	Unknown – Western North Atlantic stock	NL	NC
Atlantic white-sided dolphin (*Lagenorhynchus acutus)* ()	Offshore, shelf	Rare	Maine to Gulf of St. Lawrence	93,233 – Western North Atlantic stock	NL	NC
Striped dolphin (*Stenella coeruleoalba*)	Coastal, shelf, slope	Rare	Massachusetts to Florida	67,0367 – Western North Atlantic stock	NL	NC
Pantropical spotted dolphin (*Stenella attenuata*)	Coastal, shelf, slope	Uncommon	Massachusetts to Florida	6,593 – Western North Atlantic stock	NL	NC
Atlantic spotted dolphin (*Stenella frontalis*)	Coastal to pelagic	Common	Massachusetts to Caribbean	39,921 – Western North Atlantic stock	NL	NC

Spinner dolphin (*Stenella longirostris*)	Mostly pelagic	Uncommon	Maine to Caribbean	4,102 – Western North Atlantic stock	NL	NC
Clymene dolphin (*Stenella clymene*)	Coastal, shelf, slope	Uncommon	North Carolina to Florida	4,237 – Western North Atlantic stock	NL	NC
Sirenians						
West Indian (Florida) manatee (*Trichechus manatus latirostris*)	Coastal, rivers, and estuaries	Common	Massachusetts to Florida to Texas	6,131** – Florida stock	T	S

[1] U.S. Endangered Species Act: EN = Endangered, T = Threatened, NL = Not listed.
[2] U.S. Marine Mammal Protection Act: S = Strategic, NC = Not classified.
[3] NMFS Marine Mammal Stock Assessment Reports.
**Florida Fish and Wildlife Conservation Commission 2018 Survey Data (U.S. Fish and Wildlife jurisdiction).

USACE has determined that blasting activities for the Port Everglades project will result in take of common bottlenose dolphins (Western North Atlantic Central Florida Coastal Stock). Although many other marine mammals may transit through the area offshore of Port Everglades, USACE does not believe the project will result in the taking of those species.

E.4 DESCRIPTION OF THE STATUS, DISTRIBUTION, AND SEASONAL DISTRIBUTION (WHEN APPLICABLE) OF THE AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS LIKELY TO BE AFFECTED BY SUCH ACTIVITIES

The most recent Stock Assessment Report (SAR) for Western North Atlantic Central Florida Coastal Stock of common bottlenose dolphins (NMFS 2019) was used in determining affected species populations. Note that all citations within this section of the application are included within the SAR.

E.4.1 STOCK DEFINITION AND GEOGRAPHIC RANGE

The recently updated SAR (NMFS 2019) provides the information herein for determining the current stock and geographic range of common bottlenose dolphins are found in estuarine, coastal, continental shelf, and oceanic waters of the western North Atlantic (wNA). Distinct morphological forms have been identified in offshore and coastal waters of the wNA off the U.S. East Coast: a smaller morphotype present in estuarine, coastal, and shelf waters from Florida to approximately Long Island, New York, and a larger, more robust morphotype present further offshore in deeper waters of the continental shelf and slope from Florida to Canada (Mead and Potter 1995). The two morphotypes also differ in parasite load and prey preferences (Mead and Potter 1995) and show significant genetic divergence at both mitochondrial and nuclear DNA markers (Hoelzel et al. 1998; Kingston and Rosel 2004; Kingston et al. 2009; Rosel et al. 2009). The level of genetic divergence is greater than that seen between some other dolphin species (Kingston and Rosel 2004; Kingston et al. 2009) suggesting the two morphotypes in the wNA may represent different subspecies or species. The larger morphotype makes up the wNA Offshore Stock of common bottlenose dolphins. Spatial distribution data (Kenney 1990; Garrison et al. 2017a), tag-telemetry studies (Garrison et al. 2017b), photo-identification (photo-ID) studies (e.g., Zolman 2002; Speakman et al. 2006; Stolen et al. 2007; Mazzoil et al. 2008), and genetic studies (Caldwell 2001; Rosel

et al. 2009; Litz et al. 2012) indicate that the coastal morphotype comprises multiple stocks distributed in coastal and estuarine waters of the wNA. The Central Florida Coastal Stock is one such stock.

Common bottlenose dolphins are found in coastal waters south of Cape Hatteras, North Carolina, to southern Florida year-round (Blaylock and Hoggard 1994; Garrison and Yeung 2001; Garrison et al. 2016; Mazzoil et al. 2016; Caldwell 2016). Significant genetic differentiation was observed between animals sampled in coastal waters of Georgia and those sampled in the Jacksonville, Florida, area (Rosel et al. 2009) indicative of demographic independence between animals sampled in these two coastal regions. Similarly, genetic analyses of dolphins sampled in coastal and estuarine waters near the Indian River Lagoon, Florida, revealed significant differentiation (Richards et al. 2013). Photo-ID studies in both Jacksonville and in central Florida near the Indian River Lagoon also distinguished between dolphins that used coastal waters and those using estuarine waters (Mazzoil et al. 2011; Caldwell 2016) indicating the presence of demographically independent coastal and estuarine stocks along the Florida coast.

The Central Florida Coastal Stock is delimited as the dolphins of the coastal morphotype inhabiting coastal waters from the shoreline to the 200-m isobath from 29.4°N south to the western end of Vaca Key (~24.7°N, 81.1°W) where the stock boundary for the Florida Keys Stock begins. There has been little study of bottlenose dolphin stock structure in coastal waters of central and southern Florida, and both the northern and southern boundaries for this stock are provisional as the spatial extent of this stock is poorly understood. The boundaries are derived from the first delimitation of coastal stocks in 2002 (Waring et al. 2002) when the original single, coast-wide coastal stock suggested by Scott et al. (1988) was broken into seven management units (Waring et al. 2002). The offshore boundary was determined based on a combined genetic and logistic regression analysis that incorporated depth, latitude, and distance from shore to model the probability that a particular bottlenose dolphin group seen in coastal waters south of Cape Hatteras was of the coastal morphotype (Garrison et al. 2017a). Dolphins of the coastal morphotype were identified in waters out to 97 m depth. The logistic regression predicted that the majority of the coastal morphotype inhabits waters 0–20 m in depth and that the density of the coastal morphotype declines with increasing depth (Garrison et al. 2017a). South of Cape Hatteras in waters less than 20 m depth, 70% of the bottlenose dolphins were predicted to be of the coastal morphotype and fewer than 10% of the animals present beyond 35 m depth were predicted to be of the coastal morphotype (Garrison et al. 2017a). These spatial patterns may not apply as well to the Central Florida Coastal Stock, however, 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.

It is plausible this stock contains multiple demographically independent populations because its range crosses a known biogeographic break at Cape Canaveral, Florida (Pelc et al. 2009), and appropriate coastal habitat is limited in southern Florida between West Palm Beach and Miami where the Gulf Stream comes close to shore. The lack of appropriate habitat in this region could serve as a barrier between members of this stock that inhabit coastal waters from Vaca Key eastward to approximately Miami, Florida, and those inhabiting coastal waters north of West Palm Beach where the shelf widens again. There is no firm boundary defining the offshore extent of this stock and it overlaps to some degree with the Offshore Stock (Garrison et al. 2017a). This spatiotemporal overlap complicates the ability to definitively identify the offshore extent for the stock and the assignment of human-caused dolphin mortalities to stock at certain times of the year.

E.4.2 POPULATION SIZE

The best available abundance estimate for the Central Florida Coastal Stock of common bottlenose dolphins in the western North Atlantic is 1,218 (CV=0.35; Garrison et al. 2017a). This estimate is derived from aerial surveys conducted during the summer of 2016 covering coastal and shelf waters from Florida to New Jersey.

Keith (1999-2003) performed the most recent surveys of this stock within Port Everglades. Boat based surveys were conducted from May 1, 1999 to April 31, 2003. Their study area (1.81 km2) consisted of the Intracoastal Waterway (ICW) from just north of the Las Olas Boulevard bridge south to the Dania Beach Boulevard bridge, bounded on the west by the docks and seawalls of the Port and extending up the Dania Cut-off Canal to the U.S. 1 bridge, and bounded on the east by the barrier islands making up Fort Lauderdale Beach north of the Port Entrance, and John U. Lloyd State Park south of the Port Entrance. The northern part of the study area (Las Olas bridge to 17th Ave. bridge), is surrounded by a highly urbanized series of artificial islands with numerous homes and villas. The central part of the study area (17th Ave. Bridge to the Dania Cut-off Canal) is surrounded by the industrialized port, and the southern part of the study area (Dania Cut-off Canal to Dania Beach Boulevard Bridge) is surrounded by a relatively undisturbed wetland. As was stated within their 2000 annual report, their boat-based survey transect wound or meandered through the study area. USACE assumes that survey transects covered the entire study area during each survey event. Their survey data is summarized in **Table E-3**.

Table E-3. Common bottlenose dolphin survey data collected from May 1, 1999 to April 31, 2003 within the Port Everglades project area (Keith 2003).

Year	Number of Surveys	Number of Dolphins	Group Size	Average number of Dolphins/Survey**
1999-2000	19	31	1-14	1.63
2000-2001	22	0	0	0
2001-2002	23	3	NA	0.13
2002-2003	27	0	0	0

* One definitive and two possible sightings were noted
**Calculated by USACE
N/A, Not available

As stated in **Table E-3**, Keith's 2000 report indicated group size ranged from 1-14. Assuming the numbers in his report indicates a single group, group size was 12, 4, 1 and 14 from 1999-2000 (no group sizes were provided in the 2001-2002 report). Data obtained from the Florida Fish and Wildlife Conservation Commission (FWC) indicates that during manatee surveys within Port Everglades, they opportunistically observed two groups of dolphins from 2013-2014 (2 and 8 animals) and from 2014-2015, they observed 3 groups of dolphins (3, 3 and 2 animals). FWC did not necessarily record all dolphin sightings so it is not possible to determine whether other dolphins were observed or present but not recorded. Adding the group data from the FWC to Keith's data, (12+4+1+14+2+8+3+3+2) ÷ 9, produces an average group size of 5.4 animals.

E.4.3 MINIMUM POPULATION ESTIMATE

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. The best estimate for the Central Florida Coastal Stock is

1,218 (CV=0.35). The resulting minimum population estimate is 913. Present data are insufficient to calculate minimum population estimate for the Port Everglades stock of bottlenose dolphins.

E.4.4 CURRENT POPULATION TREND

Available surveys allow a limited analysis of trend in population size for coastal stocks of common bottlenose dolphins. A standardized analytical approach accounting for variation in survey execution and environmental conditions was used to derive unbiased abundance estimates for each survey (Garrison et al. 2017a). A weighted generalized linear model was used to evaluate trends in population size by stock using abundance estimates from surveys conducted in the summers of 2002, 2004, 2010, 2011, and 2016. Abundance estimates were weighted by the inverse of their standard error, which reduces the influence of less certain estimates (Neter et al. 1983). Stock was treated as a fixed factor, and surveys were grouped into three periods to test for long term trends in population size: 2002–2004, 2010–2011, and 2016. Period was also included as a fixed factor in the model along with the interaction between stock and period. Contrasts were specified to test for differences in abundance between periods for each stock (Garrison et al. 2017a). For the Central Florida Coastal Stock, the resulting mean abundance estimate for 2002–2004 was 2,108 (CV=0.99), and that for 2010–2011 was 6,777 (CV=0.63). There was no significant difference between these estimates and the estimate of 1,218 (CV=0.35) for 2016. There is limited power to detect a significant change given the high CV of the estimates, interannual variability in spatial distribution and stock abundance between 2002 and 2004, and the availability of only one recent survey (Garrison et al. 2017a).

E.4.5 CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the wNA coastal morphotype. The maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations likely do not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow et al. 1995).

E.4.6 POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of the minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997; Wade 1998). The minimum population size of the Central Florida Coastal Stock of common bottlenose dolphins is 913. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.5 because this stock is depleted. PBR for this stock of common bottlenose dolphins is 9.1.

E.4.7 STATUS OF STOCKS

Common bottlenose dolphins in the western North Atlantic are not listed as threatened or endangered under the Endangered Species Act, but the Central Florida Coastal Stock is a strategic stock due to its designation as depleted under the MMPA. From 1995 to 2001, NMFS recognized only the western North Atlantic Coastal Stock of bottlenose dolphins in the western North Atlantic, and this stock was listed as depleted as a result of a unexplained mortality event (UME) in 1988–1989 (64 FR 17789, April 6, 1993). The stock structure was revised in 2008, 2009, and 2010, to recognize resident estuarine stocks and migratory and resident coastal stocks. The Central Florida Coastal Stock retains the depleted designation as a result of its origin from the western North Atlantic Coastal Stock. This stock is presumed to be below

optimum sustainable population (OSP) due to its designation as depleted. PBR for the Central Florida Coastal Stock is 9.1, so the zero-mortality rate goal, 10% of PBR, is 0.9. The documented total mean annual human-caused mortality for this stock for 2011–2015 was 0.4. However, this estimate is biased low for the following reasons: 1) there are several commercial fisheries operating within this stock's boundaries that have little to no observer coverage, and 2) the estimate incorporates a count of verified human-caused deaths and serious injuries and should be considered a minimum (NMFS 2016). Given these biases and uncertainties, there is insufficient information to determine whether or not the total fishery-related mortality and serious injury is approaching a zero mortality and serious injury rate. The impact to this stock of the 2013–2015 mid-Atlantic and the 2008 Indian River Lagoon UMEs is unknown. Analysis of trends in abundance suggests a possible decline in stock size between 2010–2011, and 2016; however, there is limited power to evaluate trends given uncertainty in stock distribution, lack of precision in abundance estimates, and a limited number of surveys.

E.5 TYPE OF INCIDENTAL TAKING AUTHORIZATION THAT IS BEING REQUESTED (I.E., TAKES BY HARASSMENT ONLY; TAKES BY HARASSMENT, INJURY AND/OR DEATH) AND THE METHOD OF INCIDENTAL TAKING

USACE is requesting authorization of incidental taking of common bottlenose dolphins (mid-frequency cetacean) by behavior harassment, Temporary Threshold Shift (TTS), Level B take, caused by proposed confined underwater blasting operations. The USACE expects that a five-year LOA would be required and an additional one-year IHA may be necessary to complete this project, due to the anticipated six-year project duration. NMFS dual criteria for determination of take are included below.

USACE, Jacksonville District, has not documented any incidental take of dolphins associated with dredging activities. However, there is a growing international awareness of the potential adverse influence of anthropogenic sounds to aquatic life (e.g., UN 2018). Relatedly there is a growing interest in the potential ecological risks of exposure to underwater sound (i.e., probability of adverse biological effects; NRC 2005). In this regard, there has been effort to discern the biological consequences of activities emanating predominantly low-frequency continuous sounds (e.g., commercial shipping, dredging, offshore energy production), due to the overlap with the hearing frequencies of many aquatic species (e.g., fish, marine mammals; WODA 2013; Redfern et al. 2017; NMFS 2018a). There is a growing body of information on underwater sounds related to the 4 major types of dredges (cutter suction dredge, trailing suction hopper dredge, grab dredge, and backhoe dredge. Studies indicate that underwater sounds from dredging are highly variable, are spatially dynamic, dependent on activity type (i.e., excavation, transit, placement, and pumping) and site-specific conditions (e.g., substrate type, bathymetry). In general, dredging produces predominately low-frequency sounds, which are typically continuous and nonimpulsive. As described by McQueen (McQueen, Sudel, et. al. 2020), there is a high degree of uncertainty with risk associated with dredging operations given the lack of data regarding the responses of organisms to low-frequency non-impulsive sounds (Southall et al. 2007, 2019; Popper et al. 2014; NMFS 2018a). The port expansion project case study therein demonstrates benefits of a transparent and repeatable process to estimate and communicate hazards and risks. The development of a screening-level assessment relied upon publicly available sound exposure modeling tools (i.e., NMFS [2018] user spreadsheet and numerical modeling equations) and published biological effects thresholds for marine mammals and fish.

From February 21, 2018 to the time of this application, USACE contractors (marine animal observers) have been collecting common bottlenose dolphin behavior data in the vicinity of mechanical (clamshell and backhoe) and hydraulic (hopper and/or cutter-suction) dredging operations associated with dredging within the Jacksonville Harbor, lower St. Johns River. Common bottlenose dolphins have been observed

on 86 separate occasions. A total of 246 adult and 11 calf sightings have been recorded (additional observations are being recorded). On all occasions, except for one, dredging operations did not alter the bearing of the dolphins. They were observed transiting through the project area and, on occasion, were observed in the near vicinity, fewer than 10 m to 150 m or greater, of the dredge (including adults with calves). On the one occasion where the dolphins turned back and did not transit through the project area, the group appeared to be feeding approximately 75 m off of the starboard bow of the clamshell dredge and then transited out of the project area in the same direction that they came. The reason the dolphins transited out of the project area in the same direction that they came is unclear, but the reasons were probably unrelated to dredging operations since they were observed feeding in the near vicinity of the dredge and, during all other observations, dolphins (including adults with calves) transited through the project area and appeared to be undisturbed by dredging operations. NMFS' current criteria for determination of take are included in **Table E-4**.

Table E-4. NMFS criteria for determination of take (Mid-frequency cetaceans only including common bottlenose dolphin).

Group	Species	Behavior		Slight Injury			Mortality
		Behavioral for multiple detonations	TTS[1]	PTS[2]	Gastro-intestinal Tract	Lung	
Mid-frequency Cetaceans	Most Delphinids, medium and large toothed whales	165 dB SEL[3]	170 dB SEL or 224 dB peak SPL[4]	185 dB SEL or 230 dB peak SPL	243 dB SPL	$I=103M^{1/3}(1+D/10.1)^{1/6}$ Where: M=animal mass (kg) D=animal depth (m)	$I=65.8M^{1/3}(1+D/10.1)^{1/6}$ Where: M=animal mass (kg) D=animal depth (m)

1 Temporary Threshold Shift (TTS)
2 Permanent Threshold Shift (PTS)
3 Sound Exposure Level (SEL)
4 Sound Pressure Level (SPL)

E.6 BY AGE, SEX, AND REPRODUCTIVE CONDITION (IF POSSIBLE), THE NUMBER OF MARINE MAMMALS (BY SPECIES) THAT MAY BE TAKEN BY EACH TYPE OF TAKING IDENTIFIED IN PARAGRAPH (A)(5) OF THIS SECTION, AND THE NUMBER OF TIMES SUCH TAKINGS BY EACH TYPE OF TAKING ARE LIKELY TO OCCUR

As previously stated, Keith (1999-2003) performed the most recent surveys of common bottlenose dolphins occurring within Port Everglades. Boat based surveys were conducted from 1999-2003 within their Port Everglades study area (1.81 km2). Although Keith's data is limited and the true density populations are unknown, this is the only know source of information regarding bottlenose dolphins in the vicinity of Port Everglades. Given the limited information available, USACE calculates a density of 0.24 dolphins/km2 within the inner channels, turning basins, wideners, and other inner harbor areas of Port Everglades. Dolphin density (i.e. number of dolphins per square kilometer) is used in the determination of take levels. Equations for determining this density are provided as follows:

Survey Years 1999-2000: 31 dolphins ÷ 19 surveys = 1.63 dolphins/survey
1.63 dolphins/survey ÷ 1.81 km^2 = 0.90 dolphins/km^2

Survey Years 2000-2001: 0 (zero) dolphins observed during 22 surveys

Survey Years 2001-2002: 3 dolphins ÷ 23 surveys = 0.13 dolphins/survey
0.13 dolphins/survey ÷ 1.81 km^2 = 0.07 dolphins/km^2

Survey Years 2002-2003: 0 (zero) dolphins observed during 27 surveys

Survey Years 1999-2003: (0.90 dolphins/km^2 + 0 dolphins/km^2 + 0.07 dolphins/km^2 + 0 dolphins/km^2) ÷ 4 = 0.24 dolphins/km^2

Per the recommendation of the NMFS, USACE used the Atlantic Marine Assessment Program for Protected Species (AMAPPS) Marine Mammal Model Viewer, an online tool capable of providing densities for marine mammals in certain locations, to determine the density of common bottlenose dolphins within the OEC of Port Everglades. This tool provided an estimate of 0.22 dolphins/km^2 within the footprint of the OEC.

USACE has estimated the number of blasting events required for each of the Port Everglades project areas (**Table E-5**).

Table E-5. Estimated number of blast events for each of the Port Everglades project segments/areas.:

Project Segments/Areas	Number of Estimated Blast Events
OEC	88
IEC	19
MTB	103
Widener	10
SAC	50
Turning Notch	10
Total	**280**

Although the sequencing of construction and dredging duration necessary within each segment is not yet known, USACE anticipates some project segments will take greater than one and potentially multiple years to complete. Since the number of blasting events, duration of construction, and dolphin density varies for some project areas, USACE has calculated separate take levels for each project segment below **(Table E-6**).

Table E-6 presents the estimated Level A (mortality, lung injury, and PTS) and Level B behavior TTS take of common bottlenose dolphins resulting from confined underwater blasting operations within each of the Port Everglades project segments/areas. Figures 9-14 depict representative Level A (PTS) and Level B take zones for each project segment/area for the proposed maximum charge weights (note that some very small take polygons are not represented in some figures but are represented in the take calculations). The distances (m), or Level A and B radii around each blast, indicate how far from the blast site each level of take would occur. Impulse radii were calculated using algorithms specifically developed for confined underwater blasting operations provided by NMFS and calculated by the U.S. Army Engineer Research and Development Center (ERDC) (see Attachment B; spreadsheet results also included). The code calculates the total explosive energy from all charges through a summation of the individual energy emanating from each charge as a function of temporal and spatial separation of charges. Acoustical transmission loss is assumed to occur through cylindrical spreading. The Sound Exposure Level (SEL) of the first detonation and each subsequent detonation is summed and transmission loss of acoustic energy due to cylindrical spreading is subtracted from the total SEL. Ultimately, the distance where the received level falls to the desired SEL is calculated by spherical spreading of the total SEL. However, NMFS and USACE agree that acoustic energy emanating from the detonation point would rapidly decrease as the energy moves through severe bends or turns in channels and creeks. Under these conditions, sound energy exceeding a 45-degree angle, or a 45-degree cone shape, would not result in Level B take.

Level A and B take zones (km2) were calculated using the radii. Note that some blasting radii are wholly contained within the water column. These areas therefore are circular in shape and not truncated by land. However, some of the larger blasting radii extend beyond the project area shorelines. In these cases, the Level A and B take zones form an irregular polygon shape that are constrained by the shoreline. The areas of these irregular polygon shapes were determined with computer software (Google Earth Pro). All blasting drawings/electronic (kmz) files shall be provided upon request.

Blasting patterns would be comprised of maximum individual charge weights of 100 lbs. (45.36 kg)/delay and a maximum of 103 blast events (MTB). For example, the MTB is expected to require 50 boreholes with no greater than 100 lbs. per borehole and 3500 lbs. of explosives/event for 103 separate events (103 blasting events * 3500 lbs./event = 360,500 lbs. of explosives required). For Level A take zones consisting of lung injury and mortality, the zones of the peak impulse are based on the maximum weight of a single charge in a blasting pattern. While for Level B take zones, the distances are based on cumulative SELs from the total weight of the charges in a blasting pattern. Level A take, a form of harassment, includes mortality as well as permanent injury (PTS). It assumes no implementation of monitoring and mitigation measures. However, USACE shall monitor blasting operations and implement protective measures. Most notably, blasting shall not be conducted if common bottlenose dolphins (or any other protected species, i.e. manatee or sea turtle) are present within mortality or serious injury zones. Therefore, no take resulting in serious injury or mortality of dolphins should occur. Level B take includes TTS changes in behavior and is detailed below within the take summary request.

Take Summary Request

A maximum of 280 blast events are anticipated to occur over a period of approximately six years, within six distinct construction areas of Port Everglades, as detailed within this LOA. Using the Western North Atlantic Central Florida Coastal Stock abundance estimate (N=1,218), the density of common bottlenose dolphins occurring within the project footprint (N=0.22 dolphins/km^2, OEC and 0.24 dolphins/km^2 all other areas), as well as the maximum charge weight of 9,000 lbs./blast array, the USACE is requesting Level B TTS take for up to 6.49 bottlenose dolphins per blast (refer to **Table E-6**). A maximum of 782 bottlenose dolphin takes, by way of behavioral TTS, have been calculated over the entire construction duration (approximately six years) and would be necessary to complete the Port Everglades Navigation Improvement Project. However, due to the protective measures of confined blasts, implementation of the Danger and Exclusion Zones, as well as an extensive observer-based monitoring program, the USACE does not anticipate Level A take in the form of harassment causing serious injury or mortality of common bottlenose dolphins. Since the population is estimated at 1,218 dolphins and construction duration would take place over multiple years, this take level indicated that fewer than 33% of the population would be subjected to TTS harassment (Level B take) in any given year

Table E-6. Level A and Level B Take Estimates Per Event for common bottlenose dolphins (Western North Atlantic Central Florida Coastal Stock) for all project segments/areas, Port Everglades Harbor Deepening Project.

Port Everglades Stock Take Estimates						
		Behavior		**Serious Injury**		**Mortality**
Maximum Charge Weight (lbs & kg) for the Largest Blasting Array		**Level B TTS SEL**	**Level A PTS SEL**	**Gastro-intestinal Tract**	**Lung**	**Mortality**
OEC 5000 lbs (2268 kg)		**170 dB**	**185 dB**	**243 dB**	**max at 10.7 m depth**	**Max at 4.9 m depth**
	distance (m)	3544.6	630.3	732	77.7	38.9
	area (km^2)	*29.48*	*1.25*	*1.67*	*0.02*	*.005*
*maximum take per event (0.22/km^2)*area*		*6.49*	*0.28*	*0.3674*	*0.0044*	*0.0011*
		Level B TTS SEL	**Level A PTS SEL**	**Gastro-intestinal Tract**	**Lung**	**Mortality**
IEC 2500 lbs (1134 kg)		**170 dB**	**185 dB**	**243 dB**	**max at 11.7 m depth**	**max at 5.2 m depth**
	distance (m)	3435.2	610.9	732	77.2	38.5
	area (km^2)	*8.88*	*0.41*	*1.67*	*0.02*	*.005*
*maximum take per event (0.24/km^2)*area*		*2.13*	*0.10*	*0.4008*	*0.0048*	*0.0012*
MTB 5000 lbs (2268 kg)						
	distance (m)	3544.6	630.3	732	77.2	38.5
	area (km^2)	*5.51*	*0.81*	*1.67*	*0.02*	*.005*
*maximum take per event (0.24/km^2)*area*		*1.32*	*0.194*	*0.4008*	*0.0048*	*0.0012*
Widener 5000 lbs (2268 kg)						
	distance (m)	3544.6	630.3	732	77.2	38.5
	area (km^2)	*7.49*	*0.64*	*1.67*	*0.02*	*.005*

*maximum take per event (0.24/km^2)*area*		*1.7976*	*0.1536*	*0.4008*	*0.0048*	*0.0012*
SAC 9000 lbs (4082 kg)						
	distance (m)	3693.3	656.77	732	77.2	38.5
	area (km^2)	*0.83*	*0.170*	*1.67*	*0.02*	*.005*
*maximum take per event (0.24/km^2)*area*		*0.1992*	*0.0408*	*0.4008*	*0.0048*	*0.0012*
Turning Notch 9000 lbs (4082 kg)						
	distance (m)	3693.3	656.77	732	77.2	38.5
	area (km^2)	*2.61*	*0.15*	*1.67*	*0.02*	*.005*
*maximum take per event (0.24/km^2)*area*		*0.6264*	*0.036*	*0.4008*	*0.0048*	*0.0012*

* For Level A take zones consisting of lung injury and mortality the zones of the peak impulse are based on the maximum weight of a single charge in a blasting pattern, while for Level B take zones, the distances are based on cumulative SELs from the total weight of the charges in a blasting pattern.
* For Level A take zones consisting of lung injury and mortality the zones of the peak impulse are based on the maximum weight of a single charge in a blasting pattern, while for Level B take zones, the distances are based on cumulative SELs from the total weight of the charges in a blasting pattern.

Figure E-10. Common bottlenose dolphin example take areas for maximum combined charge weight of 5,000 lbs. (2267.96 kg) for OEC, Port Everglades Harbor Deepening Project. All other forms of Level A take (i.e. lung injury and mortality) have smaller radii than the Permanent Threshold Shift (PTS) Zone.

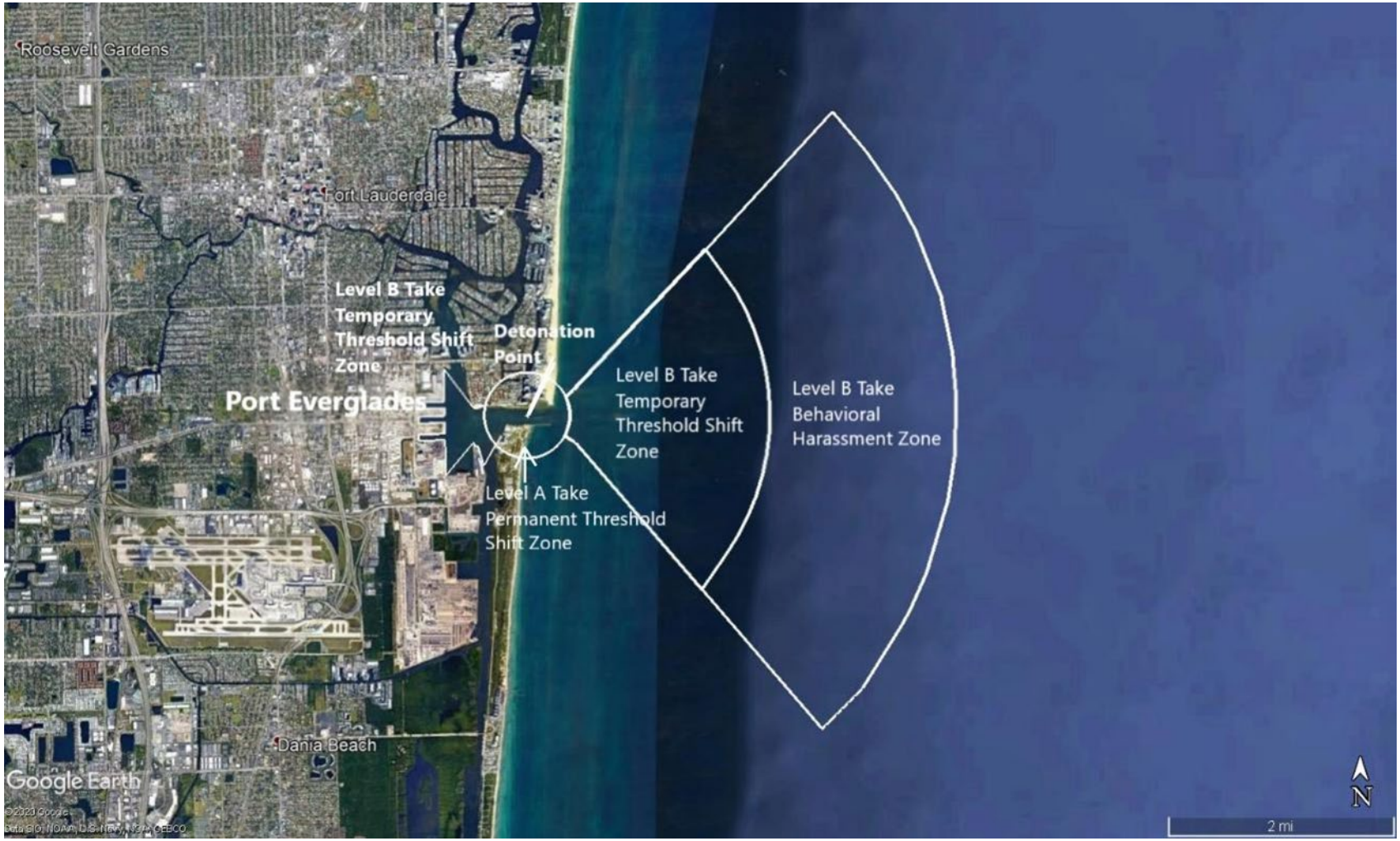

Figure E-11. Common bottlenose dolphin example take areas for maximum combined charge weight of 2,500 lbs. (1,133.98 kg) for IEC, Port Everglades Harbor Deepening Project. All other forms of Level A take (i.e. lung injury and mortality) have smaller radii than the Permanent Threshold Shift (PTS) Zone

Figure E-12. Common bottlenose dolphin example take areas for maximum combined charge weight of 5,000 lbs. (2267.96 kg) for MTB, Port Everglades Harbor Deepening Project. All other forms of Level A take (i.e. lung injury and mortality) have smaller radii than the Permanent Threshold Shift (PTS) Zone.

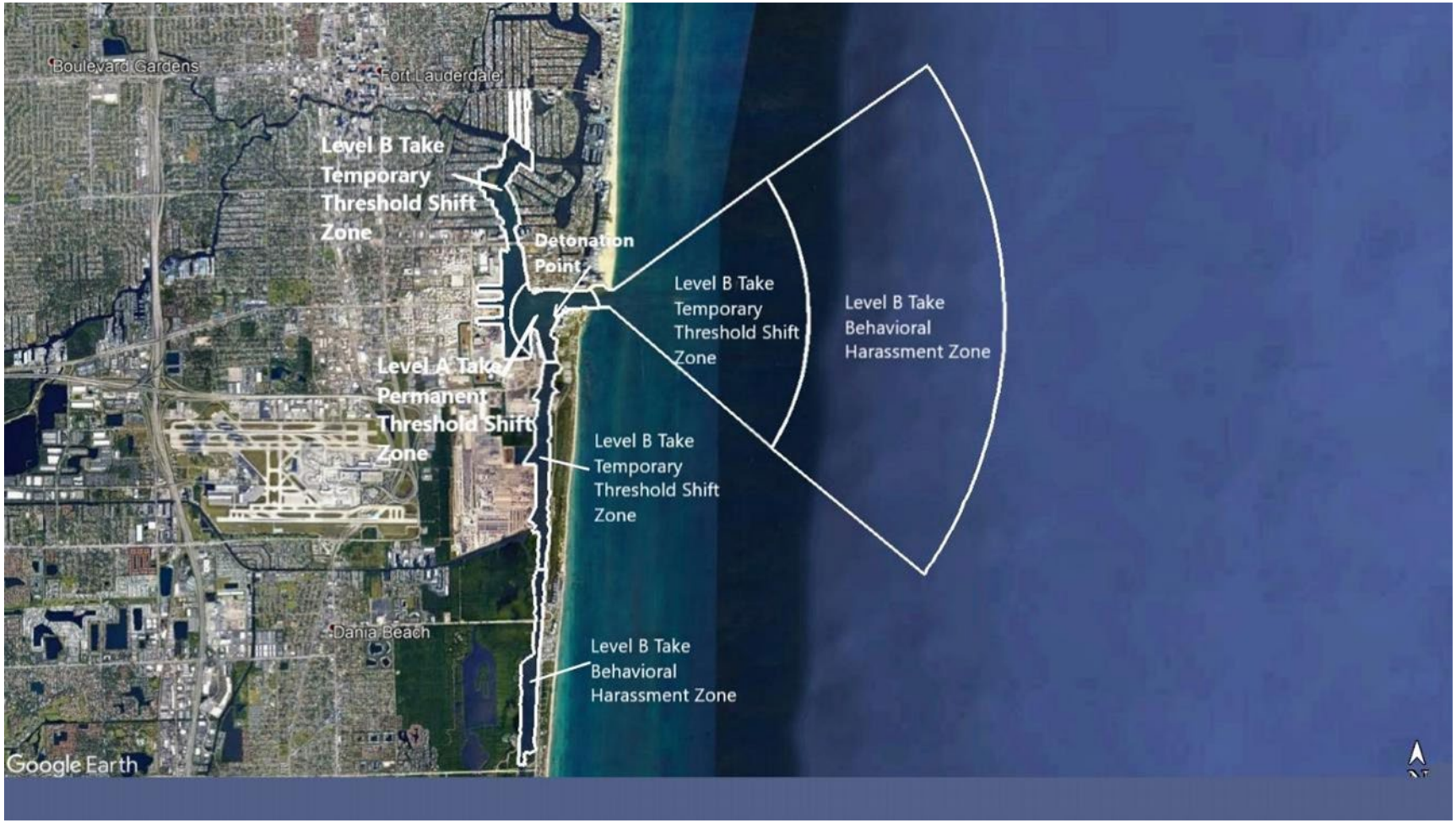

Figure E-13. Common bottlenose dolphin example take areas for maximum combined charge weight of 5,000 lbs. (2,267.96 kg) for Widener, Port Everglades Harbor Deepening Project. All other forms of Level A take (i.e. lung injury and mortality) have smaller radii than the Permanent Threshold Shift (PTS) Zone.

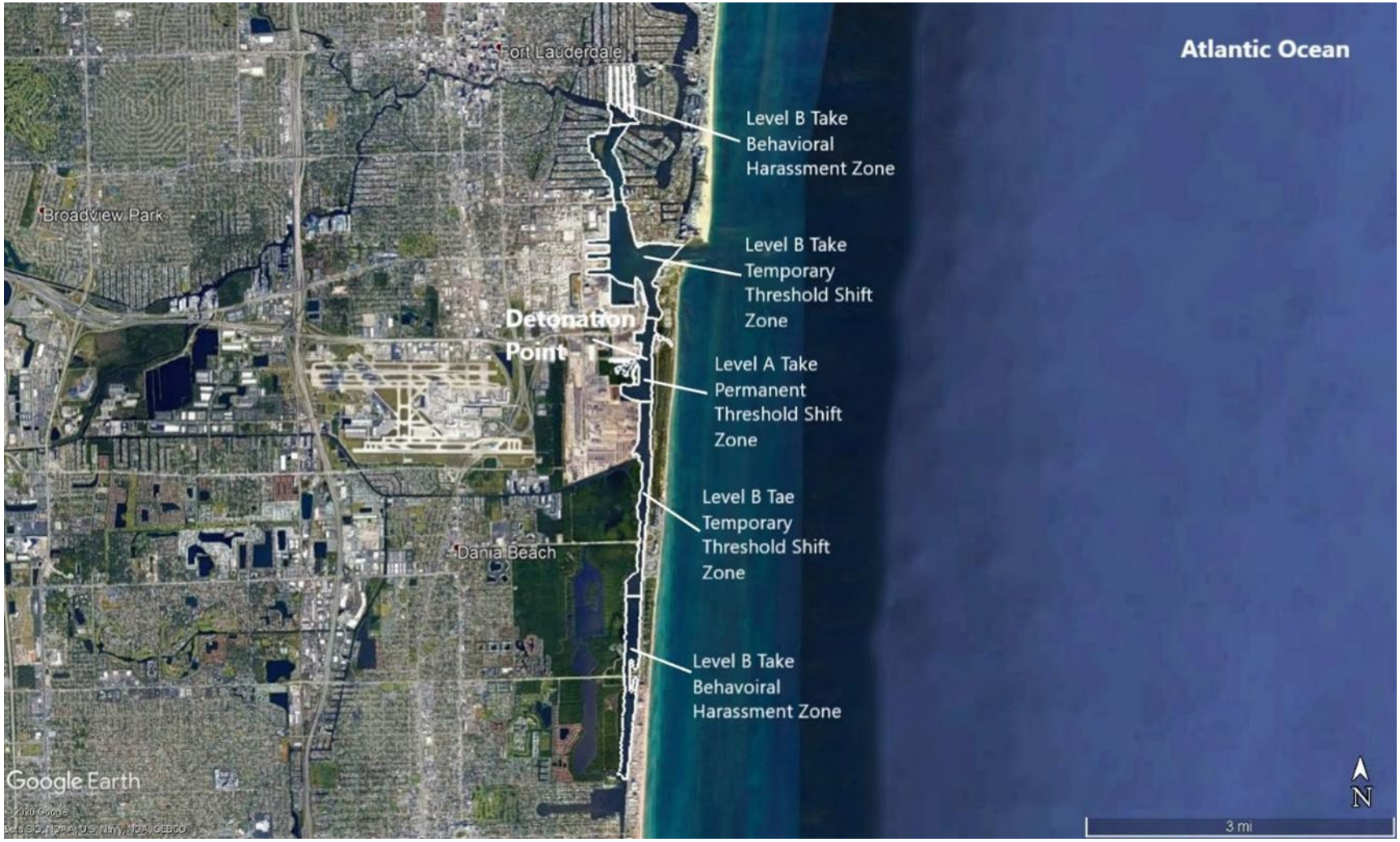

Figure E-14. Common bottlenose dolphin example take areas for maximum combined charge weight of 9,000 lbs. (4,082 kg) for SAC, Port Everglades Harbor Deepening Project. All other forms of Level A take (i.e. lung injury and mortality) have smaller radii than the Permanent Threshold Shift (PTS) Zone.

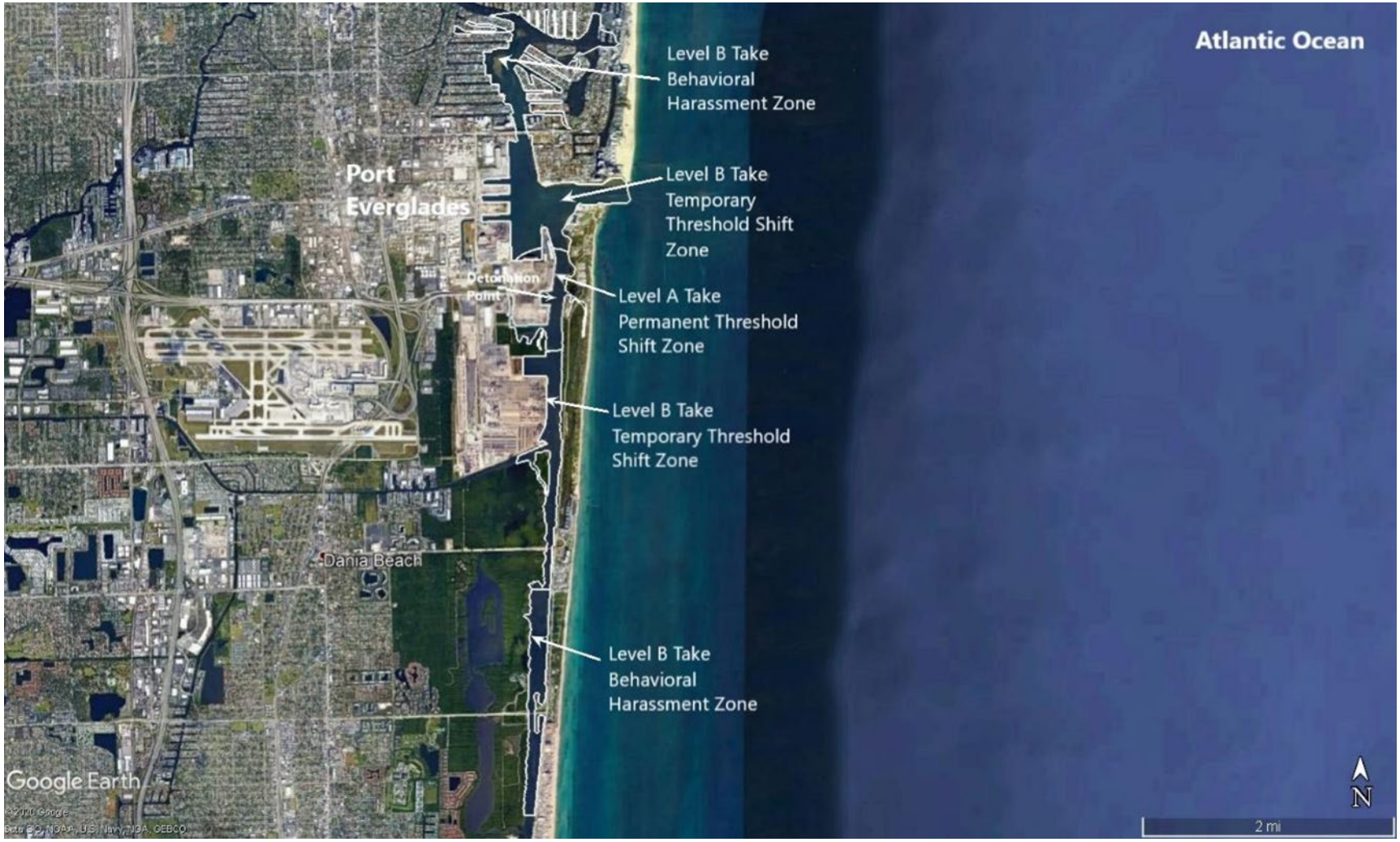

Figure E-15. Common bottlenose dolphin example take areas for maximum combined charge weight of 9,000 lbs. (4,082 kg) for Turning Notch, Port Everglades Harbor Deepening Project. All other forms of Level A take (i.e. lung injury and mortality) have smaller radii than the Permanent Threshold Shift (PTS) Zone.

Table E-7. Summary of estimated Level B take of common bottlenose dolphins resulting from proposed blasting operations, Port Everglades Harbor Deepening Project.

Project Segments and Total Maximum Charge Weights/Pattern	Level B Take/Blast Event			Blast Events/Project Segment	Cumulative Level B Take[1]
	Behavior SEL 165 dB	TTS SEL 170 dB	Combined Level B Take		
OEC					
5000 lbs (2267.96 kg)	--	6.49	6.49	88	571.12
IEC					
2500 lbs (1133.98 kg)	--	2.13	2.13	19	40.47
MTB					
3500 lbs (1587.57 kg)	--	1.32	1.32	103	135.96
Widener					
5000 lbs (2267.96 kg)	--	1.79	1.79	10	17.9
SAC					
9000 lbs (4082.33 kg)	--	0.20	0.20	50	9.95
Turning Notch					
9000 lbs (4082.33 kg)	--	0.63	0.63	10	6.264
			Totals=	**280**	**781.66**

Notes:
[1]Cumulative Level B Take only includes Temporary Threshold Shift (TTS SEL) take if 1 Blast per Day is conducted per NMFS guidance (No expected Behavioral SEL Take assumed for 1 Blast per Day).
[1]Cumulative Take represents a conservative estimate of each project segment. Blast events per segment are likely to occur over multiple years.
[2]Dolphin Stock Population Size = 1,218 (Garrison et al. 2017a)

E.7 THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE SPECIES OR STOCK

Given limited data availability, USACE is unable to determine but assumes dolphins in the area utilize Port Everglades as habitat for socializing, feeding, resting, etc. The use of blasting to expand the port may have an effect on dolphins that are in close proximity to any blasts fired to crack rock. Although there have been very few sightings of dolphins in the boundaries of the port, or in Broward County inland waters, it is likely that any effect on dolphins outside of the proposed safety radius will be in the form of a TTS. Both the pressure and noise associated with blasting can injure marine mammals.

In general, potential impacts to marine mammals from explosive detonations could include both lethal and non-lethal injury, as well as TTS and behavioral harassment. In the absence of monitoring and mitigation, marine mammals may 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 gas bubbles in the intestines. Effects are 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 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 provided the thresholds and criteria utilized for predicting impact analyses from the use of explosives in the notice of the proposed IHA (79 FR 6545, February 4, 2014). As part of the U.S. Navy’s training and testing activities in the Atlantic Fleet Training and Testing Study Area (AFTT) final rule, NMFS updated the thresholds and criteria utilized for predicting impact analyses from the use of explosives (see **Table E-4**). A detailed explanation of how these thresholds were derived is provided in the AFTT Environmental Impact Statement/Overseas Environmental Impact Statement (DEIS/OEIS) Criteria and Thresholds Technical Report (http://aftteis.com/DocumentsandReferences/AFTTDocuments/SupportingTechnicalDocuments.aspx) and summarized in Chapter 6 of the U.S. Navy’s AFTT Letter of Authorization application (http://www.nmfs.noaa.gov/pr/permits/incidental/military.htm).

Utilizing data from rock-contained blasts such as those at Miami Harbor in 2005, USACE has been able to estimate potential effects on protected species. These data can be correlated to the data from work completed for the Navy by the Woods Hole Oceanographic Institute (WHOI) (Ketten 2004), and USACE during the construction at Miami Harbor in 2005 (Hempen et al, 2007; Jordan et al. 2007) concerning blasting impacts to marine mammals. These data indicate that impacts from explosives can produce lethal and non-lethal injury as well as incidental harassment. The pressure wave from the blast is the most causative factor in injuries because it affects the air cavities in the lungs and intestines. The extent of lethal effects is proportional to the animal’s mass, i.e., the smaller the animal, the more lethal the effects (Ketten 2004); therefore, all data are based on the lowest possible affected mammal weight (infant dolphin). Non-lethal injuries include tympanic membrane rupture; however, given that dolphin’s behavior relies heavily on sound, the non-lethal nature of such an injury is questionable in the long-term. For that reason, it is important to use a limit where no non-lethal tympanic membrane damage occurs. Based on the WHOI and USACE Miami Harbor test data, the level of pressure impulse where no lethal and no non-lethal

injuries occur is reported to be 10-12 pounds per square inch of pressure in the smallest species and 20-25 psi for larger species.

Studies by Finneran et al. (2000) showed that TTS and PTS in marine mammals were used to evaluate explosion impacts. Since marine mammals are highly acoustic, such physiological impacts should be considered when assessing harmful impacts. While many of these impacts are not lethal and this study has shown that the impacts tend not to be cumulative, significant changes in behavior could constitute a "take" under the MMPA. The primary potential impact to the common bottlenose dolphins occurring in the Port Everglades action area from proposed confined underwater blasting is Level B harassment, in the form of TTS, incidental to noise generated by explosives. USACE believes the proposed monitoring and mitigation measures will preclude the possibility of Level A take (permanent injury or mortality) and minimize behavioral impacts in the case of these activities.

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 µPa2 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 recently 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 Port Everglades project, 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.

Level B harassment can also include behavioral modifications resulting from repeated noise exposures (below TTS) to the same animals (usually resident) over a relatively short period of times. Since repetitive blast events per day are not anticipated, behavioral harassment SEL is not expected to be an impact to marine mammals with this project.

Several impulsive noise exposure studies have also been conducted without measurable (behavioral) TTS. Finneran et al. (2000) exposed dolphins to single impulses from an "explosion simulator" (maximum unweighted SEL = 179 dB re 1 µPa2s, peak SPL = 217 dB re 1 µPa) and Finneran et al. (2015) exposed three dolphins to sequences of 10 impulses from a seismic airgun (maximum unweighted cumulative SEL = 193 to 195 dB re 1 µPa2s, peak SPL =196 to 210 dB re 1 µPa) without measurable TTS.

As previously described in Section 1 of this application, the USACE is proposing to utilize a series of protective radii to monitor protected species locations in relation to the blast array. Two of these are particularly important to this application. The Danger Zone is where the USACE has determined the potential for Level B harassment to occur, and the Exclusion zone is the point that if an animal crosses and enters that zone that the blast will be delayed until the animal leaves the zone of its own volition. The Exclusion zone is outside the area where the USACE has determined that Level B harassment will occur, so if the monitoring works as expected and no detonation occurs when an animal is inside of the Exclusion zone, no take should occur. However, to be conservative, the USACE has calculated the potential exists for Level B harassment and is pursuing a LOA.

E.8 THE ANTICIPATED IMPACT OF THE ACTIVITY ON THE AVAILABILITY OF THE SPECIES OR STOCKS OF MARINE MAMMALS FOR SUBSISTENCE USES

There is no subsistence use of marine mammals in or near Port Everglades.

E.9 THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE HABITAT OF THE MARINE MAMMAL POPULATIONS, AND THE LIKELIHOOD OF RESTORATION OF THE AFFECTED HABITAT

The bottom of the Port Everglades channel is comprised of previously dredged rock and unconsolidated sediment. Apart from deepening the channel, the physical nature of the habitat is not expected to significantly change and should continue to be utilized by dolphins.

Various types of dredging equipment are anticipated to be utilized during the Port Everglades deepening project and may include mechanical (clamshell and/or backhoe) and hydraulic (hopper and/or cutter-suction) dredges. Dredge pipelines are likely to cross navigation channels. Any such crossing would require that the pipeline remain anchored along the bottom to the maximum extent practicable. Placement of the pipeline along the bottom should allow dolphins to transit through the project area.

Blasting within the project area will be limited both spatially and temporally. Explosives utilized are water soluble and non-toxic. If for some reason, a charge is unable to be fired and must be left in the drillhole, it is designed to breakdown as it is made of water soluble ammonium nitrate in a fluid gel format. Each drill hole also has a booster with detonator and detonation cord. Most of the cord is recovered onto the drill barge by pulling it back onboard the drill barge after the blast event. Small amounts of detonation cord can remain in the water after the blast has taken place and will be recovered by small vessels with scoop nets. Any material left in the drill hole after the blast will be recovered through the dredging process, after the blasting when the dredge excavates the fractured rock material.

A water quality certification pursuant to Section 401 of the Clean Water Act will be obtained from the State of Florida, prior to awarding contract(s) for dredging Port Everglades. Temporary, minor and localized impacts to water quality are expected during dredging, however, environmental best management protective measures will be employed during all phases of the project. Dissolved oxygen concentrations may temporarily decrease in the material disposal plume. Chemically reduced inorganic compounds associated with particles sinking through the upper water column may be oxidized, causing a transient increase in the chemical oxygen demand. Oxidation of labile organic material may consequently reduce dissolved oxygen concentrations in the water. However, because the water column is well oxygenated, offsite impacts are not expected and any onsite impacts should be of short duration. Plumes of suspended sediments would result in increases in turbidity levels, suspended particulate concentrations, and decreased light transmittance. These effects will be dissipated by natural dispersion, mixing, and eventual sinking of particles. Based on dispersion modeling conducted for the Port Everglades Harbor ODMDS, any temporary perturbations in water quality resulting from disposal of dredged material would be reduced to ambient or undetectable levels within a short distance of the release point (USEPA 2004)."

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

By utilizing the confined blasting technique that was used and studied at Miami Harbor in 2005, the blasting will result in the maximum pressures from the confined shot being significantly lower than open-

water shot pressures at the same charge weight. Radiation of the wave energy into rock reduces the available energy to reach the water column (Hempen et al. 2007). The pressures entering the water column are well below those pressures that typically propagate away from open-water (unconfined by solid media that may radiate the energy away with less harm) charges relative to charge weight per delay.

In addition to reducing the pressure wave by confining the blasts in rock, by putting in place a series of protective zones around the blast array and monitoring the area for the presence of protected species, USACE does not believe that any marine mammals will be injured or killed by the blasting activities. Hempen et al. (2007) also demonstrate that the pressure data collected at Miami Harbor showed that using the zones previously described, the pressures associated with the blasts return to background levels (1-2 psi) at the margin of the danger zone. This means that any animal located inside the safety zone, but outside the danger zone would not be exposed to any additional pressure effects from a confined blast (Hempen et al. 2007, Jordan et al 2007). However, to ensure that the project was being very conservative in estimation of effects to listed species, USACE assumed that the proposed action may harass manatees by causing a TTS. As a result of this assumption, USACE consulted with USFWS under the ESA and MMPA for potential effect to the species. As part of the consultation, USACE agreed not to conduct blasting operations during the winter months (November 15 to March 15) when manatee populations are expected to be at their highest concentration in the action area. More detailed information concerning the impacts associated with the project is available in the FEIS' Biological Assessment submitted to the USFWS that is included in Appendix F and can be found under Broward County at:

https://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/

E.10 THE ANTICIPATED IMPACT OF THE LOSS OR MODIFICATION OF THE HABITAT ON THE MARINE MAMMAL POPULATIONS INVOLVED

The anticipated modification of the habitat by channel deepening is not expected to significantly affect common bottlenose dolphins. Historically, Port Everglades is manmade and has been previously deepened and maintenance dredged.

With regard to prey species (mainly fish), a small number of fish are expected to be impacted by the project. Based on the results of the 2005 blasting project at Miami Harbor, the blasting consisted of 40 blast events, with a total charge weight of 301 lbs. to 4,646 lbs. per event, over a 38-day time frame. Twenty-three of these blasts were monitored (57.5%) by the state and had injured and dead fishes collected after the all clear was given. Noting that the "all-clear" is normally at least 2-3 minutes after the shot is fired is important, since seagulls and frigate birds quickly learned to approach the blast site and swoop in to eat some of the stunned, injured and dead fish floating on the surface. State biologists and volunteers collected the carcasses of floating fish (it should be noted that not all dead fish float after a blast, and due to safety concerns, no plans exist to put divers on the bottom of the channel in the blast zone to collect those non-floating carcasses). The fish were described to the lowest taxonomic level possible (usually species) and the injury types were categorized.

A summary of that data shows that 24 different genera were collected during the Miami Harbor blasting. The species with the highest abundance were white grunts (*Haemulon plumieri*) (N=51); scrawled cowfish (*Lactophrys quadricornis*) (N=43) and Pygmy filefish (*Monocanthus setifer*) (N=30). Total fish collected during the 23 blasts was N=288 or an average of 12.5 fish per blast (range 3 to 38). In observation of the three blasts with the greatest number of fishes killed (Table 9) and reviewing the maximum charge weight

per delay for the Miami Harbor project, it appears that there is no direct correlation between charge weight and fishes killed that can be determined from such a small sample. Reviewing the 23 blasts where dead and injured fish were collected after the all clear signal was given, no discernible 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 (see the Aug 10, 2005 blast for example; a much smaller charge weight resulted in a relatively high fish kill due to the closeness of a bulkhead).

Table E-8. Confined Blast Maximum Charge Weight and Number of Observed Fish Killed

Date	Max Charge Wt/delay (kg; lbs.)	Fish killed
7/26/2005	38.55 kg; 85 lbs.	38
7/25/2005	50.80 kg; 112 lbs.	35
8/10/2005	7.71 kg; 17 lbs.	28

In the past, to reduce the potential for fish to be injured or killed by the blasting, USACE has allowed, and the resource agencies have requested, that blasting contractors utilize a small, unconfined explosive charge, usually a 1 lb. (0.45 kg) charge weight, detonated about 30 seconds before the main blast to drive fish away from a blasting zone. It is assumed that noise or pressure generated by the small charge will drive fish from the immediate area, thereby reducing impacts from the larger and potentially more-damaging blast. Blasting companies use this method as a “good faith effort” to reduce potential impacts to aquatic resources. The explosives industry recommends firing a “warning shot” to frighten fish out of the area before seismic exploration work is begun (Anonymous 1978 in Keevin et al. 1997).

There is limited data available on the effectiveness of fish scare charges at 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, largemouth bass; channel catfish and flathead catfish, equipping each fish with an internal radio tag to allow the fishes movements before and after the scare charge to be tracked. Fish movement was compared with a predicted Lethal Dose 0% mortality distance for an open water shot (no confinement) for a variety of charge weights. Largemouth bass showed little response to repelling charges and none would have moved from the kill zone calculated for any explosive size. Only one of the flathead catfish and two of the channel catfish would have moved to a safe distance for any blast. This means that only 11% of the fish used in the study would have survived the blasts. These results call into question the true effectiveness of this minimization methodology; however, some argue that based on the monetary value of fish (American Fishery Society 1992 in Keevin et al. 1997) including high value commercial or recreational species found in southeastern Florida like Port Everglades, the low cost associated with repelling charge use would be offset if only a few fish were moved from the kill zone (Keevin et al.1997).

To calculate the potential loss of prey species from the project area as an impact of blasting, USACE used a 12.5 fish/blast kill estimate based on the Miami Harbor 2005 blasting, and multiplied it by the 40 shots – reaching a total estimate of floating fish killed in the 2005 Miami project of 500 fish. As stated previously, not all carcasses float to the surface and there is no way to estimate how many carcasses did not float. However, it can be determined that at Miami Phase II, the minimum estimated fish kill for the entire project, was 500 fish.

Using the 12.5 fish killed/detonation estimate and the maximum 280 blasting events or detonations for the project – the minimum number of fish expected to be killed by the Port Everglades deepening project is 3,500 fish over the estimated 6-year project duration.

E.11 THE AVAILABILITY AND FEASIBILITY (ECONOMIC AND TECHNOLOGICAL) OF EQUIPMENT, METHODS, AND MANNER OF CONDUCTING SUCH ACTIVITY OR OTHER MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACT UPON THE AFFECTED SPECIES OR STOCKS, THEIR HABITAT, AND ON THEIR AVAILABILITY FOR SUBSISTENCE USES, PAYING PARTICULAR ATTENTION TO ROOKERIES, MATING GROUNDS, AND AREAS OF SIMILAR SIGNIFICANCE

USACE has been collecting data for more than ten years concerning the effects of confined blasting projects on marine mammals. This effort began in the early 1990s when USACE contracted with Dr. Calvin Konya (Precision Blasting Services) to review previous USACE blasting projects, recommendations of Florida Fish and Wildlife Conservation Commission (FWC) (then known as the Florida Department of Natural Resources) and the USFWS.

As previously discussed, as part of the Miami Harbor Phase II project, USACE monitored the blasting project and collected data on the pressures associated with confined underwater blasts, while employing a formula to calculate zones that would be protective of protected species. Results from the pressure monitoring at 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 conditions shall be incorporated into the project specifications to reduce the risk to marine mammals within the project area. While this application is specific to common bottlenose dolphins, these specifications are written for all protected species that may be in the project area.

a. Blasting operations will only be conducted from March 16 through November 14.

b. The contractor's approved blasting plan shall be provided to the appropriate agencies including NMFS for review at least 30 days prior to work. This blasting proposal must include information concerning a watch program and details of the blasting events and will be submitted to the following entities.

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

    2) NMFS-PR1, 1315 East West Highway, Silver Spring, MD 20910

    3) U.S. Fish and Wildlife Service; 1339 20th Street; Vero Beach, FL 32960-3559 OR 6620 Southpoint Drive, South; Suite 310, Jacksonville, FL 32216-0912 (Project location dependent)

    4) NMFS-SERO-Protected Species Management Branch, 263 13th Ave South, St. Petersburg, FL 33701

    In addition to plan review, Ms. Laura Engleby, NMFS Southeast Region Marine Mammal Branch Chief (email:nmfs.ser.research.notification@noaa.gov) and Dr. Allen Foley, FWC (email: allen.foley@myfwc.com) shall be notified at the initiation and completion of all in-water blasting.

c. The plan shall include, but not be limited to, the following information:

    1) A list of the 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 marine species (such as dolphins, manatees, marine turtles, etc.) 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 safety radius 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.). Certain blasting restrictions will be imposed including the criteria in Table 1 including the following: a total of 280 blast events, maximum total charge weight per blast event for each project segment (i.e. OEC = 5000 lbs [2,267.96 kgs], etc. refer to Table 1), maximum number of boreholes per event (33-90), maximum individual charge weights per borehole 100 lbs (45.36 kgs), and total weight of high explosives per project area (i.e. OEC = 440,000 lbs [199,580.64 kgs], etc. refer to Table 1).

d. For each explosive charge placed, protective zones will be calculated (Danger Zone, Exclusion Zone, Safety Zone and Watch Zone), denoted on monitoring reports and provided to protected species observers before each blast for incorporation in the watch plan for each planned detonation. All zones will be marked by buoys for each of the blasts. These zones are:

1) Danger Zone (Level A Take Zone): The Level A Take Zone is equal to the radius of the PTS Injury Zone. As shown in Table 6, as well as Figures 9 through 14. All other forms of Level A take have smaller radii than the PTS injury zone. Detonation shall not occur if a protected species is known to be (or based on previous sightings, may be) within the Level A take Zone;

2) Exclusion Zone: Danger Zone (Level A Take Zone) + 152.4 m (500 ft.) Detonation will not occur if a protected species is known to be (or based on previous sightings, may be) within the Exclusion Zone.

3) Safety Zone: Equal to 520 ft (158.50 m) X cube root of weight of explosives in lbs per delay (equivalent weight of TNT).

4) Watch Zone (Level B Take Zone): The Level B Take Zone extends from the Safety Zone to the Behavior Zone radius. Detonation shall not occur if a protected species is known to be (or based on previous sightings, may be) within the Level B Take Zone.

Examples of these zones are provided in **Figure E-16**.

e. The watch program shall consist of a minimum of six PSOs with a designated lead PSO. Each PSO shall be equipped with a two-way radio that shall be dedicated exclusively to the watch. Extra radios shall be available in case of failures. All the PSOs shall be in close communication with the blasting subcontractor in order to halt the blast event if the need arises. If all PSOs do not have working radios and cannot contact the primary observer and the blasting subcontractor 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 backup visual communication, and a sighting log with a map to record sightings.

f. The watch program shall begin at least one hour prior to the scheduled start of blasting to determine the possible presence of protected species. The watch program shall continue until at least one hour after detonations are complete.

g. The hours of blasting shall be restricted from two hours after sunrise to one hour before sunset to ensure adequate observation of marine mammals in the project area. All blasting events will be weather dependent. Climatic conditions must be suitable for adequate viewing conditions. Blasting will not commence in rain, fog or otherwise poor weather conditions, and can only

commence when the entire Level A Take Zone, Exclusion Zone, and Level B Take Zone are visible to PSOs.

h. The watch program shall include a continuous aerial survey to be conducted by aircraft, as approved by the Federal Aviation Administration. The blasting event shall be halted if an animal is spotted approaching or within the Exclusion Zone. An "all-clear" signal must be obtained from the aerial PSO before detonation can occur. Note that all PSOs must give the “all-clear” signal before blasting can commence. The 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 moves out of the Exclusion Zone under its own volition. Animals shall not be herded away or harassed into leaving. Specifically, the animals must not be intentionally approached by project watercraft. Blasting may only commence when 30 minutes has passed without an animal being sighted within or approaching the Exclusion Zone or Level A Take Zone.

i. After each blast, the PSOs and contractors shall meet and evaluate any problems encountered 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 (a through f, above) is not met prior to or during the blasting, the contractor as advised by the PSOs shall have the authority to terminate the blasting event, until resolution can be reached with the Contracting Officer.

j. If an injured or dead protected species is sighted after the blast event, the contractor shall contact USACE and the resource agencies at the following phone numbers:

   1) FWC through the Manatee Hotline: 1-888-404-FWCC and 850-922-4300 (manatees).

   2) USFWS Jacksonville: 904-731-3336 (manatees)

   3) NMFS SERO-PRD: 772-570-5312 (sea turtles, sturgeon, and sawfish)

   4) NMFS- Emergency Stranding Hotline – 1-877-433-8299

k. PSOs shall maintain contact with the injured or dead protected species to the greatest extent practical until authorities arrive. Blasting shall be postponed until consultations are completed and determinations can be made of the cause of injury or mortality. If blasting injuries are documented, all demolition activities shall cease. USACE will then submit a revised plan to FWC, NMFS and USFWS for review.

l. Within 30 days after completion of all blasting events, the lead PSO shall submit a report to USACE, who will provide it to FWC, NMFS and USFWS 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.

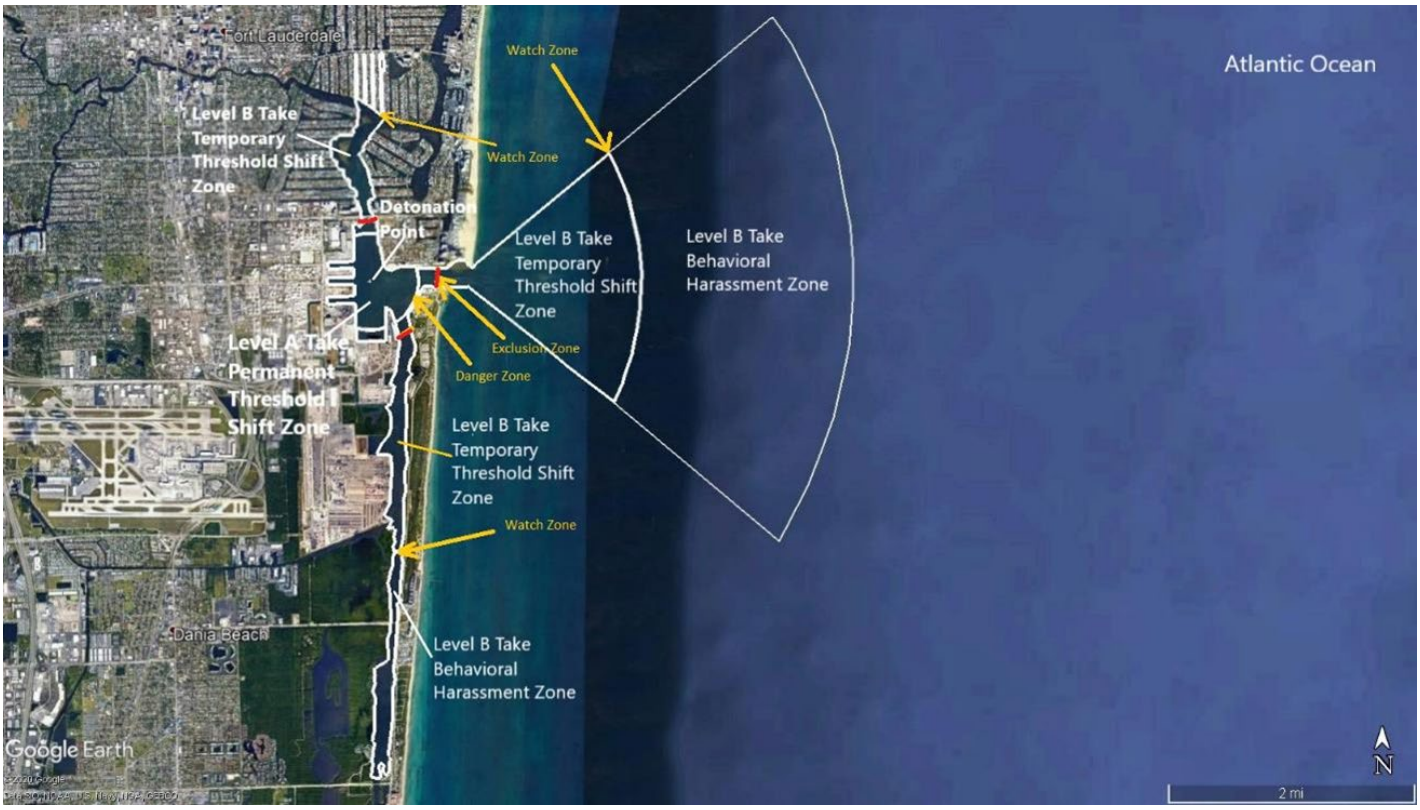

Figure E-16. Danger Zone (Level A Take Zone), Exclusion Zone, and Watch Zone (Level B Take Zone) Middle Turning Basin, Port Everglades

E.11.1 Required Monitoring Protocol During Blast Events

With some exceptions, USACE 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. A summary of that protocol is provided as follows:

A watch plan will be formulated based on the required monitoring radii or polygon and optimal observation locations. The watch plan will be similar to the program that was utilized successfully at Miami Harbor in 2005 and for this project will consist of at least six PSOs including at least one (1) aerial PSO, two (2) boat-based PSOs, and two (2) PSOs stationed on the drill barge (Figures 15, 16, 17, and 18). The 6th 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. There shall also be one lead PSO. This process will insure complete coverage of the three zones as well as any critical areas. The watch will begin at least one hour prior to each blast and continue for one hour after each blast.

Figure E-17. Typical observer helicopter.

Figure E-18. View of typical altitude of aerial observer operations.

Figure E-19. Typical vessel for boat-based observer.

Figure E-20. Observer on Drill Barge.

The aerial PSO will fly in a helicopter with doors removed at an average height of 500 ft. (152.4 m). The helicopter will drop lower if they need to identify something in the water. This will provide maximum

visibility of all zones as well as exceptional maneuverability and the needed flexibility for continual surveillance without fuel stops or down time, and the ability to deliver post-blast assistance. The area being monitored is a high traffic area, surrounded by an urban environment where animals are potentially exposed to multiple overflights daily. USACE conferred with Ms. Mary Jo Barkaszi, owner and chief PSO of Continental Shelf Associates International, a protected species monitoring company with 25+ years of experience and has worked on multiple marine mammals/blasting events for USACE throughout the country. All of these projects had common bottlenose dolphins in the work area. Ms. Barkaszi stated that in her experience, she has not observed common bottlenose dolphins diving or fleeing the area because a helicopter is hovering nearby at 500 ft. (152.4 m; personal communication, 2011). During monitoring events, the helicopter hovers at 500 ft. (152.4 m) 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. USACE does not expect incidental harassment associated with helicopter-based monitoring of the blasting activities and is not requesting take associated with helicopter-based monitoring.

Boat-based PSOs will be placed on vessels with viewing platforms. The boat PSOs will cover the Level B Take Zone where waters are deep enough to safely operate the vessel.

The natural visibility of the water is expected to be poor so that animals will not be seen below the surface. As previously stated, blasting cannot commence until the entire Level A Take Zone, Exclusion Zone, and Level B Take Zone are visible to monitors, and should not commence in rain, fog, or other adverse weather conditions. However, animals surfacing in these turbid conditions are still routinely spotted from the air and from the boats, thus the overall PSO program is not compromised, only the degree to which animals are tracked below the surface. PSOs must confirm that all protected species are out of the Exclusion Zone and the Level A Take Zone for 30 minutes before blasting can commence, just as they are under normal visual conditions.

All PSOs will be 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 critical to the success of the watch plan. The aerial PSO will be in contact with vessel and drill-barge based PSOs as well as the drill barge crew with regular 15-minute radio checks throughout the watch period. Constant tracking of animals spotted by any PSO will be possible due to the amount and type of observer coverage and the communications plan. Watch hours will be restricted to between two hours after sunrise and one hour before sunset. The watch will begin at least one hour prior to the scheduled blast and is continuous throughout the blast. Watch continues for at least one-hour 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 protected species are spotted during the watch, the PSO will notify the lead PSO, aerial PSO, blasting personnel, and/or the other PSOs via radio. The animal will be located by the aerial PSO to determine its range and bearing from the blast pattern. Initial locations and all subsequent observations will be plotted on maps. Animals within or approaching the Exclusion Zone will be tracked by the aerial and boat based PSOs until they exit the Exclusion Zone. As stated earlier, animals that exit the Exclusion Zone and enter the Level B Take Zone will also be monitored. The animal's heading shall be monitored continuously until it is confirmed beyond the Level B Take Zone. Anytime animals are spotted near the Exclusion Zone, the drill barge and lead PSO will be alerted as to the animal's proximity and some indication of any potential delays it might cause.

If an animal is spotted inside the Exclusion Zone and not re-observed, no blasting will be authorized until at least 30 minutes has elapsed since the last sighting of that animal. The watch will continue its countdown up until the T-minus five (5) minute point. At this time, the aerial PSO will confirm that all animals are outside the Exclusion Zone and that all holds have expired prior to clearing the drill barge for the T-minus five (5) minute notice. A fish scare charge will be fired at T-minus five (5) minutes and T-minus one (1) minute to minimize effects of the blast on fish that may be in the area of the blast array by scaring them from the blast area.

An actual postponement in blasting will only occur when a protected species is located within or is approaching the Exclusion Zone at the point where the blast countdown reaches the T-minus five (5) minutes. At that time, if an animal is in or near the Exclusion Zone, the countdown is put on hold until the Exclusion Zone is completely clear of protected species and all 30-minute sighting holds have expired

E.12 WHERE THE PROPOSED ACTIVITY WOULD TAKE PLACE IN OR NEAR A TRADITIONAL ARCTIC SUBSISTENCE HUNTING AREA AND/OR MAY AFFECT THE AVAILABILITY OF A SPECIES OR STOCK OF MARINE MAMMAL FOR ARCTIC SUBSISTENCE USES, THE APPLICANT MUST SUBMIT EITHER A "PLAN OF COOPERATION" OR INFORMATION THAT IDENTIFIES WHAT MEASURES HAVE BEEN TAKEN AND/OR WILL BE TAKEN TO MINIMIZE ANY ADVERSE EFFECTS ON THE AVAILABILITY OF MARINE MAMMALS FOR SUBSISTENCE USES

N/A – the project will not take place in or near a traditional Arctic subsistence hunting area, nor will it affect availability of a species or stock of marine mammal for Arctic subsistence uses.

E.13 THE SUGGESTED MEANS OF ACCOMPLISHING THE NECESSARY MONITORING AND REPORTING THAT WILL RESULT IN INCREASED KNOWLEDGE OF THE SPECIES, THE LEVEL OF TAKING OR IMPACTS ON POPULATIONS OF MARINE MAMMALS THAT ARE EXPECTED TO BE PRESENT WHILE CONDUCTING ACTIVITIES AND SUGGESTED MEANS OF MINIMIZING BURDENS BY COORDINATING SUCH REPORTING REQUIREMENTS WITH OTHER SCHEMES ALREADY APPLICABLE TO PERSONS CONDUCTING SUCH ACTIVITY. MONITORING PLANS SHOULD INCLUDE A DESCRIPTION OF THE SURVEY TECHNIQUES THAT WOULD BE USED TO DETERMINE THE MOVEMENT AND ACTIVITY OF MARINE MAMMALS NEAR THE ACTIVITY SITE(S) INCLUDING MIGRATION AND OTHER HABITAT USES, SUCH AS FEEDING. GUIDELINES FOR DEVELOPING A SITE-SPECIFIC MONITORING PLAN MAY BE OBTAINED BY WRITING TO THE DIRECTOR, OFFICE OF PROTECTED RESOURCES

A hydroacoustic monitoring plan (plan) shall be developed in coordination with NMFS. The plan will describe the hydroacoustic measurement methods and analytical methods as well as the data to be reported. The plan will stipulate the sampling rate of the recording devices and will ensure the necessary frequencies (10 Hz - 40 kHz) and pressure signals (at least 1 MHz) are recorded. The plan will stipulate the type of hydrophone and/or pressure gauge proposed for use and will ensure it is appropriate for collecting measurements of underwater detonations as well as ambient measurements in the far field (i.e., low vs high sensitivity). A copy of the plan shall be presented to NMFS HQ Permits and Conservation Division (PRI) for review at least 30 days prior to blasting activities. As part of the hydroacoustic monitoring, recording devices will be placed in the near field and sufficiently in the far field (and away from shipping lanes to the maximum extent practical) to collect relevant data. The plan shall describe analytical methods used, and must specify that pressure signals will be analyzed using appropriate signal processing methods and applicable equations; the various impulse metrics should be calculated using time series data;

cumulative sound exposure levels (SELcum) will be calculated using a linear summation of acoustic intensity; and weighted cumulative sound exposure thresholds will be used to estimate the various ranges. Finally, the data to be reported as part of the plan will include the appropriate metrics (i.e., impulse in Pa-sec or psi-msec, peak should pressure levels, SELcum) for entire blast event, and appropriate statistics (i.e., median, mean, minimum, and maximum), relevant information pertaining to the blast event (i.e., number of delays per blast event, total net explosive weight of each blast event, sediment characteristics/types, hydrophone and/or pressure gauge depths and distances to the closest and farthest delay, water depth, power spectral data) will be specified in the plan in order to be reviewed and approved by NMFS.

The Contractor shall use hydrophones and/or pressure gauges to record the SEL and SPL associated with three blasting events for each project segment/area conducted (18 total). The Contractor shall also record the associated work (including borehole drilling and fish scare charges) as separate recordings. The Contractor shall provide nearby hydrophone and/or pressure gauge records of drilling operation of 30 minutes over three early contract periods at least 18 hours apart. The Contractor shall provide hydrophone and/or pressure gauge or transducer records within the contract area of three continuous 10-minute quiet periods over three early contract periods at least 18 hours apart or prior to the contractor's full mobilization to the site, and 10 close approaches of varied vessel sizes. Information to be provided as both an Excel file and recording for each hydrophone (.wav file) shall include:

- GPS location of the hydrophone aboard the vessel. The hydrophone shall be located outside of the range that would cause clipping (overloading of the hydrophone, causing the absolute peaks to be lost).
- Water depth to the sediment/rock bottom. The hydrophone and/or pressure gauge shall be placed at the shallower of 9.84 ft., or 9 ft., 10 inches (3 m) depth or the mid-water column depth.
- Information provided by the Blasting Contractor regarding the blast pattern or drilling. The minimum data shall include, as appropriate for blast shots or drilling; the date, time and blast number of the shot; the average water depth of the shot pattern or the average depth to sediment/rock at the nearest five shot holes closest to the hydrophone location; GPS location of the closest shot hole in the blast pattern to the hydrophone and/or pressure gauge; the maximum charge weight per delay of the shot pattern in pounds of explosives; and the largest charge weight per delay of the closest delay sequence to the hydrophone and/or pressure gauge.

E.14 SUGGESTED MEANS OF LEARNING OF, ENCOURAGING, AND COORDINATING RESEARCH OPPORTUNITIES, PLANS, AND ACTIVITIES RELATING TO REDUCING SUCH INCIDENTAL TAKING AND EVALUATING ITS EFFECTS

USACE will coordinate monitoring with the appropriate federal and state resource agencies, including NMFS-OPR (HQ) and NMFS-PRD (SERO), and will provide copies of any monitoring reports prepared by the contractors

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E.16 ATTACHMENT A - NOVA SOUTHEASTERN UNIVERSITY OCEANOGRAPHIC CENTER MARINE MAMMALS ANNUAL SURVEY REPORTS 1999 - 2003

NOVA SOUTHEASTERN UNIVERSITY
Oceanographic Center

RECEIVED
SEP 29 2003
By Dei-Loged 2W 9/29/03

September 19, 2003

Chief, Permits Division
F/PR1
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Springs, MD 20910-3226

TO WHOM IT MAY CONCERN:

This letter serves as my Annual Report of Activities for the period 1 May 2002 to 31 April 2003, as authorized under Letter of Confirmation No. 942-1497 issued to Edward O. Keith. The Letter of Confirmation authorized Level B harassment of four species of small cetaceans in and around Port Everglades, FL, in the course of vessel surveys, behavioral observations, and photographic identification.

In the course of the past year, a total of 27 surveys were conducted, with a total of 0 bottlenose dolphins seen. This is a decrease from the 3 probable dolphin sightings last year (2001-2002), but is equal to our results on 2000-2001, and reflects a continued reduction from the number of dolphins seen during our 1999-2000 effort, which was 31. It is not clear why this reduction is occurring, but it is our intention to continue these surveys until 31 March 2004, as authorized by the Letter of Confirmation, in order to determine longer term trends in dolphin populations in this area, if any.

It is my intention to apply for another permit during the Spring of 2004, so that we may continue this long-term study for another five years. Although we haven't had much success sighting dolphins, we feel that it is important to continue our survey efforts in order to document the infrequent use of Port Everglades by dolphins when it occurs.

Please do not hesitate to contact me should further information be necessary. Thank you.

Sincerely,

Edward O. Keith, Ph.D.
Associate Professor

8000 North Ocean Drive • Dania Beach, Florida 33004-3078 • (954) 262-3600
Fax (954) 262-4098

NOVA SOUTHEASTERN UNIVERSITY

26 June 2002

JUL 3 2002

Chief, Permits Division
F/PR1
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Springs, MD 20910-3226

TO WHOM IT MAY CONCERN:

This letter serves as my Annual Report of Activities for the period 1 May 2001 to 31 April 2002, as authorized under Letter of Confirmation No. 942-1497 issued to Edward O. Keith. The Letter of Confirmation authorized Level B harassment of four species of small cetaceans in and around Port Everglades, FL, in the course of vessel surveys, behavioral observations, and photographic identification.

In the course of the past year, a total of 23 surveys were conducted, with a total of 1 bottlenose dolphins seen definitively, with 2 more probable sightings, for a total of 3. These observations were made on 25 February 2002, and represent the first sightings made since 21 January 2000. This represents an increase from our 2000-2001 effort, which resulted in no sightings, but represents a continued reduction from the number of dolphins seen during our 1999-2000 effort, which was 31. It is not clear why this reduction is occurring, but it is our intention to continue these surveys until 31 March 2004, as authorized by the Letter of Confirmation, in order to determine longer term trends in dolphin populations in this area, if any.

During the past year we also sighted 43 manatees in our study area. These sightings were made incidental to our project and involved no harassment of these animals, as we adhere to the FWS West Indian manatee approach guidelines. We have been in contact with the Fish and Wildlife Service office in Jacksonville, FL, regarding our project, and have been assured that as long as our observations are made on an opportunistic basis, no permit is required.

Please do not hesitate to contact me should further information be necessary. Thank you.

annual
5/1/01 – 4/30/02
23 surveys
3 individuals
* takes
? more info

Sincerely,

Edward O. Keith, Ph.D.
Associate Professor

OCEANOGRAPHIC CENTER
8000 North Ocean Drive • Dania Beach, Florida 33004-3078 • (954) 262-3600 • Fax (954) 262-4098

NOVA SOUTHEASTERN UNIVERSITY

RECEIVED JUL 2 2001

26 June 2001

Chief
Permits Division
F/PR1
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Springs, MD 20910-3226

TO WHOM IT MAY CONCERN:

This letter serves as my Annual Report of Activities for the period 1 May 2000 to 1 May 2001, as authorized under Letter of Confirmation No. 942-1497 issued to Edward O. Keith. The Letter of Confirmation authorized Level B harassment of four species of small cetaceans in and around Port Everglades, FL, in the course of vessel surveys, behavioral observations, and photographic identification.

In the course of the past year, a total of 22 surveys were conducted, with a total of 0 bottlenose dolphins seen. This represents a reduction from the number of dolphins seen during our first year of effort, which was 31. It is not clear why this reduction occured, but it is our intention to continue these surveys for a period of 5 years, as authorized by the Letter of Confirmation, in order to determine longer term trends in dolphin populations in this area, if any.

Please do not hesitate to contact me should d further information be necessary. Thank you.

Sincerely,

Edward O. Keith, Ph.D.
Associate Professor

OCEANOGRAPHIC CENTER
8000 North Ocean Drive • Dania Beach, Florida 33004-3078 • (954) 262-3600 • Fax (954) 262-4098

NOVA SOUTHEASTERN UNIVERSITY

5 May 2000

RECEIVED MAY 11 2000

Chief
Permits Division
F/PR1
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Springs, MD 20910-3226

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Enclosed with the letter is my Annual Report of Activities for the period 1 May 1999 to 1 May 2000, as authorized under Letter of Confirmation No. 942-1497 issued to Edward O. Keith. This letter authorized Level B harassment of four species of small cetaceans in and around Port Everglades, FL, in the course of vessel surveys, behavioral observations, and photographic identification.

In the course of the past year, a total of 19 surveys were conducted, with a total of 31 bottlenose dolphins seen. It is difficult to say whether this is a normal number of dolphins for this area, due to the relatively short period of time surveys have been conducted. It is our intention to continue these surveys for a period of 5 years, as authorized by the Letter of Confirmation, in order to determine longer term trends in dolphin populations in this area, if any.

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ANNUAL REPORT OF ACTIVITIES

Letter of Confirmation No: 942-1497
Edward O. Keith, Ph.D.

INTRODUCTION

All of my photographic identification studies have taken place in and around Port Everglades, Florida, which was established as a deep water harbor in 1927 and has since grown to become one of the largest ports in the southeastern United States, with annual operating revenues of more than $66 million and total waterborne commerce exceeding 23 million tons. More than 5,300 ships call at Port Everglades in a year, creating a significant potential for harmful interactions with marine mammals. There is also a large electricity generating plant at Port Everglades, which discharges large amounts of warm water on a continuous basis, and which attracts large numbers of Florida manatees (*Trichechus manatus latirostris*) during the cold-weather months. In order to assess the degree of utilization of Port Everglades by manatees and small cetaceans, including bottlenose dolphins (*Tursiops truncatus*), Atlantic spotted dolphins (*Stenella frontalis*), dwarf sperm whales (*Kogia simus*) and pygmy sperm whales (*Kogia breviceps*) boat-based surveys of the Port have been conducted. Although the focus was to be on bottlenose dolphins, there was the possibility that the other species might be sighted, and so they were included in the permit application.

STUDY AREA

The Port Everglades study area lies on the southeastern coast of the Florida peninsula within the cities of Fort Lauderdale, Dania Beach, and Hollywood, FL, and includes some areas of unincorporated Broward County as well. Its name is somewhat misleading since Port Everglades is not a part of the much larger inland ecosystem known as the Florida Everglades. Port Everglades' jurisdiction encompasses a total of 2,190 acres (887 hectares) which includes 1,742 acres (705 hectares) of upland and 448 acres (181 hectares) of submerged land, centered on 26°, 5', 31'' N latitude and 80°, 4 ', 46'' W longitude .

The study area itself consists of the intracoastal waterway (ICW) from just north of the Las Olas Boulevard bridge south to the Dania Beach Boulevard bridge, bounded on the west by the docks and seawalls of the Port and extending up the Dania Cut-off Canal to the U.S. 1 bridge, and bounded on the east by the barrier islands making up Fort Lauderdale Beach north of the Port entrance, and John U. Lloyd State Park south of the Port Entrance (Figure 1). The northern part of the study area (Las Olas bridge to 17th Ave. bridge), is surrounded by a highly urbanized series of artificial islands with numerous expensive homes and villas. The central part of the study area (17th Ave. bridge to the Dania Cut-off Canal) is surrounded by the industrialized port, and the southern part of the study area (Dania Cut-off Canal to Dania Beach Boulevard bridge) is surrounded by a relatively undisturbed wetland. The majority of boat-based dolphin sightings have been in the southern part of the study area. Weather permitting, surveys sometimes included the reefs about one mile east of the barrier islands.

MATERIALS AND METHODS

Surveys were started on 26 May 1999, and have continued to the present. Surveys were intermittent during the summer of 1999, and then became more regular (every other week) during the fall of 1999 and winter-spring 2000. Surveys are conducted from a 22 foot Boston Whaler (R.V. Lucy Foreman) powered by a 200 hp outboard motor. R.V. Lucy is equipped with a depth sounder, VHF radio, and a portable GPS unit is brought on every survey. Photographic equipment includes a Canon EOS 35 mm camera with a 25-80 mm zoom lens and a 100-400 mm zoom lens as well as a Kodak Mavica digital camera. Kodachrome KR 135-36 ASA 64 film is used. This study was authorized by Letter of Confirmation N0. 942-1497 from the National Marine Fisheries Service (NMFS) dated 23 March 1999. On 1 May 1999, the Nova Southeastern University Oceanographic Center, located in Dania Beach, FL, initiated the photographic identification project and a population survey .

The transect line winds through the study area, generally within the ICW due to shallows and mud banks in some areas. Every time a dolphin, or group of dolphins, is sighted, it is approached and photographed. GPS and map locations, time, depth, tide, sea state, and weather are recorded. Transect data sheets are stored in a dedicated file cabinet, and archived on a spreadsheet database. The developed slides are sorted, labeled, and matched to the survey data sheets. The best photograph of the dorsal fin is added to the catalog, along with all associated data. Some photographs are included in the NOAA/SEFSC South Florida Bottlenose Dolphin Cooperative Photo-ID Project web site (http://199.242.231.186/photoid/BISCAYNEBAY.HTM). In addition, these results are to be presented at the XXV Reunión Internacional para el Estudio de los Mamíferos Marinos de la Sociedad Mexicana para el Estudio de los Mamíferos Marinos (the Mexican Marine Mammal Society XXV Annual Meeting) in La Paz, B.C.S., Mexico, 8-11 May 2000.

RESULTS

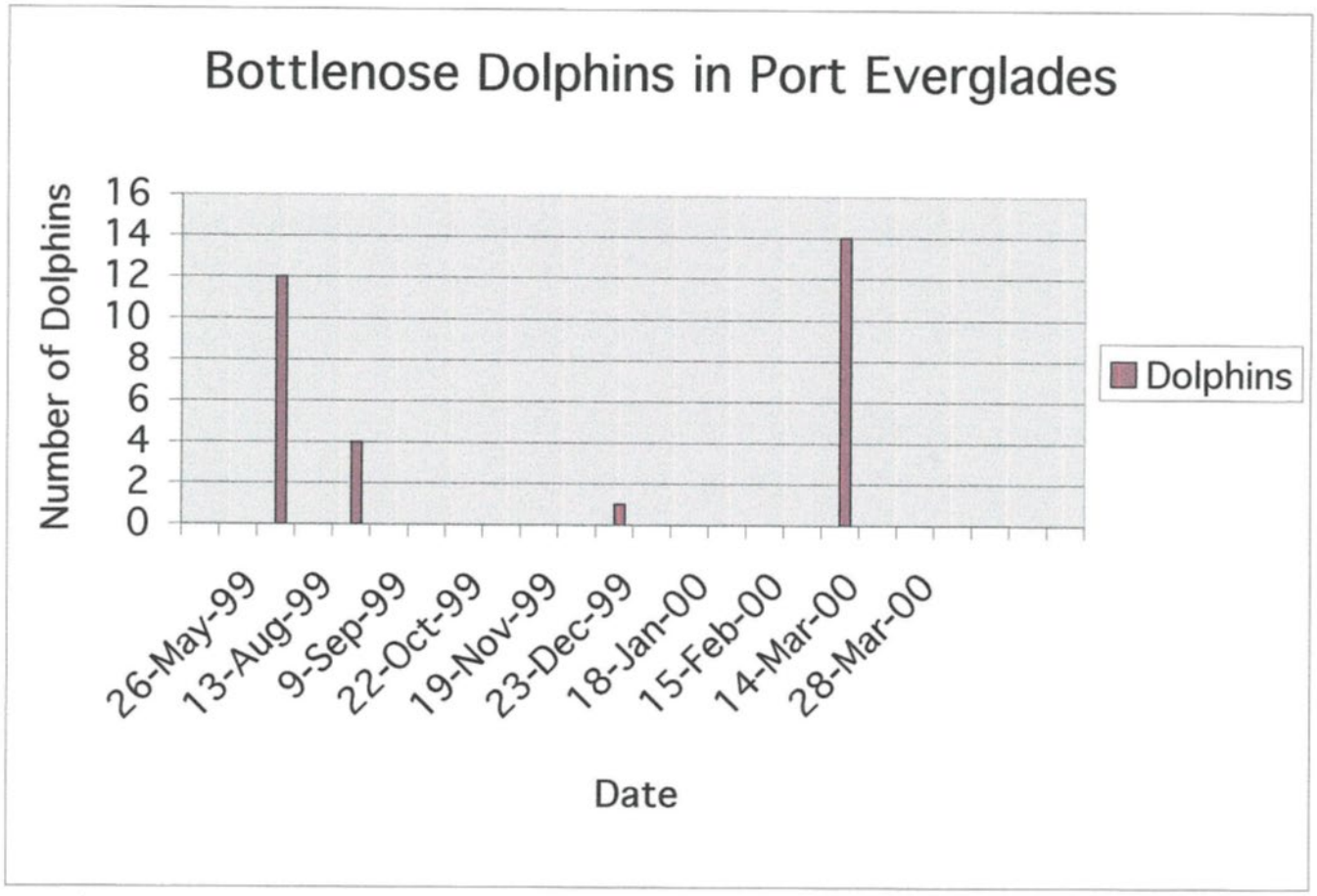
During the first year of this effort, a total of 19 surveys were made, with a total of 31 bottlenose dolphins seen, for a mean of 1.84 dolphins per survey (SD = 6.27, VAR = 39.3, CV = 0.16, 95% CI = –0.98-4.66). These groups ranged in size from 1 to 14 dolphins, with a mean of 7.0 (SD = 5.66, VAR = 23.0, CV = 0.18, 95% CI = 2.04-11.7). Additionally, during the same surveys, a total of 61 manatees were observed, for a mean of 3.21 manatees per survey (SD = 5.81, VAR = 33.7, CV = 0.17, 95% CI = 0.31-6.03). Figure 1 shows the seasonal distribution of bottlenose dolphins and Figure 2 shows the season distribution of manatees. Manatee numbers have been the greatest during the winter months. Because most of my sightings of bottlenose dolphins were at a distance from the boat, it is difficult to determine if they changed their behavior due to our presence. Even when I approached them more closely, they did not seem to change what they were doing in any appreciable way. However, these are subjective interpretations, and so I must state that at maximum, all 31 dolphins seen were harassed. as defined the the Marine Mammal Protection Act as ammended.

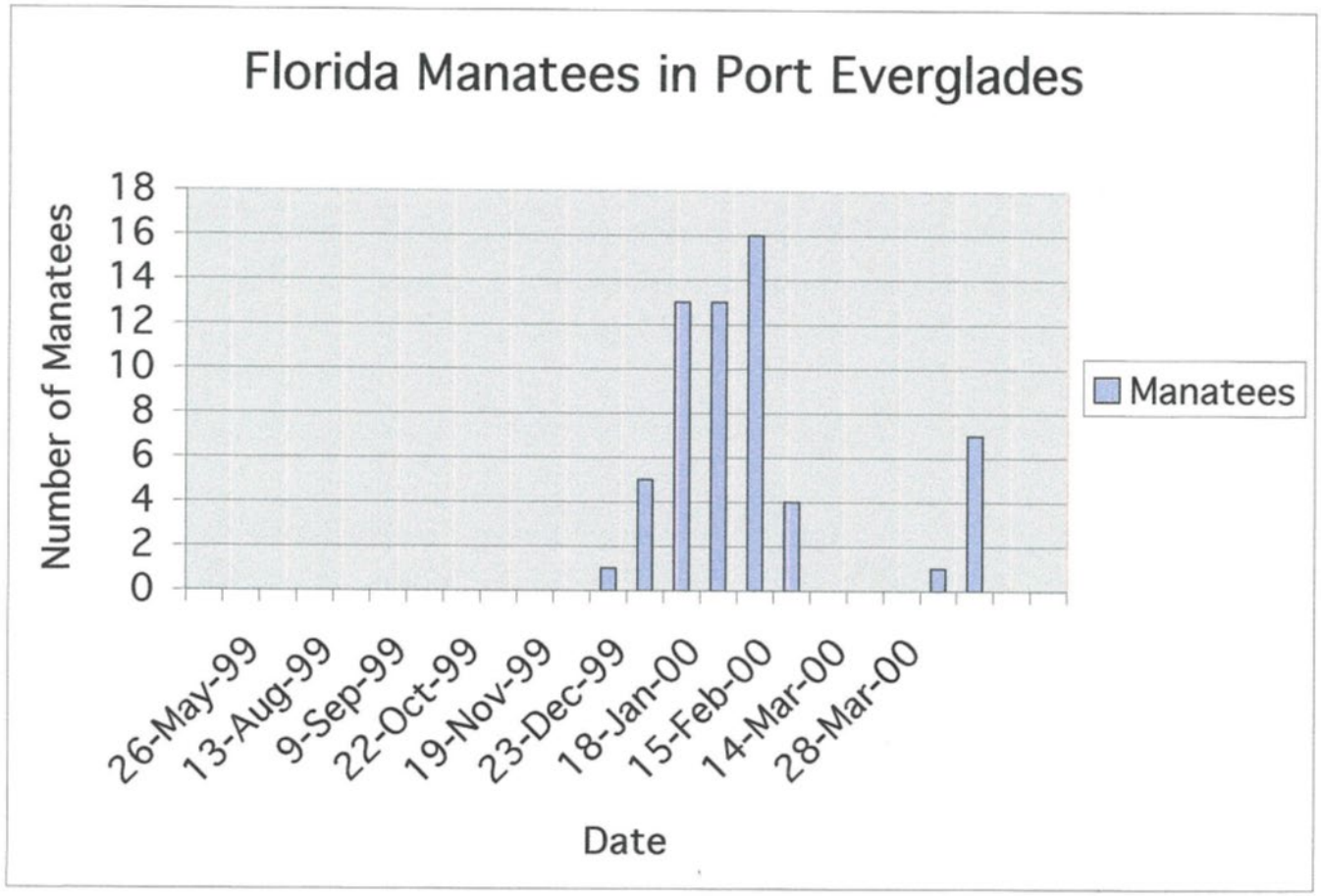
DISCUSSION

The results of my boat-based surveys are similar to those of Contillo, et. al. (1997) and Litz, et. al. 1996) in Biscayne Bay, Florida, just south of my study area. Contillo, et. al. (1997) reported a mean group size of 5.0, while Litz, et. al. reported a group size of 5.15. Since CVs and data were not reported, statistical comparisons with these results could not be made. These results contrast with those of Irvine, et. al. (1981) in Sarasota Bay, Florida, where an average of 4.8 dolphins/group (SE = 0.16) were reported. Boat-based surveys of bottlenose dolphin abundance in the eastern Pacific Ocean near San Diego, CA, found an average number of dolphins per survey of 26.8 (SD = 22.30), and an average group size of 19.8 (range 2-90, SD = 18.4) (Defran and Weller 1999).

Other studies of bottlenose dolphin group size in this region have found similar results, with Hansen (1986) reporting an average group size of 6.43 (SD = 7.60, 95% CI = 5.46-7.40) in offshore Atlantic waters near the Florida Keys, and Odell (1979) reporting an average of 2.98 animals /group (95% CI = 2.88-3.08) in Whitewater Bay, a shall inshore body of water in Everglades National Park. Odell (1979) also report an average group size of 9.57 animals/group (95% CI = 8.78-10.36) in Biscayne Bay, and Leatherwood (1979) reported an average of 8.2 dolphins/group (95% CI = 7.71-8.69) in the Indian and Banana Rivers, which are some distance north of our study area. There are no significant differences between the Florida Keys Atlantic waters data of McClellan, et. al. (2000) and those of Hansen (1986), McClellan 1986), Odell (1979) Whitewater Bay data, or Leatherwood (1979) ($P > 0.05$). However, there are significant differences between the Florida Bay data of McClellan, et. al. (2000) and the Biscayne Bay data of Odell (1979), and those of Leatherwood (1979) ($P < 0.0001$). These results are summarized in McClellan, et. al. (2000). Odell (1979) suggested that these differences might be due to differences in food abundance, environmental complexity, or pollution, which is certainly important in the Port Everglades study area.

My results suggest relatively low bottlenose dolphin numbers in the Port Everglades area. In contrast, Port Everglades is heavily used by Florida manatees, and significant potential for deleterious human/vessel interactions exist for this endangered species. It may be that climatic, oceanographic, or other factors cause bottlenose dolphin numbers to vary over a period of years in this area, and thus a continued effort is needed to develop baseline information about the presence of this species in the Port Everglades area.


Bottlenose Dolphins in Port Everglades
Number of Dolphins
16
14
12
10
8
6
4
2
0
26-May-99
13-Aug-99
9-Sep-99
22-Oct-99
19-Nov-99
23-Dec-99
18-Jan-00
15-Feb-00
14-Mar-00
28-Mar-00
Date
Dolphins


Florida Manatees in Port Everglades
Number of Manatees
18
16
14
12
10
8
6
4
2
0
26-May-99
13-Aug-99
9-Sep-99
22-Oct-99
19-Nov-99
23-Dec-99
18-Jan-00
15-Feb-00
14-Mar-00
28-Mar-00
Date
Manatees

E.17 ATTACHMENT B - U.S. ARMY CORPS OF ENGINEERS RESEARCH AND DEVELOPMENT CENTER COMPUTATIONS AND MATLAB SPREADSHEETS

Computation of maximum range to impulse

The goal is to determine the maximum possible range to impulse to be used for determination of take for underwater blasting operations.

E.17.1 Pressure

The pressure wave profile with respect to time at a remote point is given by:

$$P(t) = P_{max} e^{\frac{-t}{\theta}} \tag{1}$$

where P_{max} is the peak pressure, t is time after the shock wave arrives at the point, and ϑ is the decay constant.

It is recommended in (EM 110-2-3800 2018) to use the empirically fit peak pressure equation developed by Hempen et al. (Hempen, Keevin and Jordan 2007) as an upper bound for untested sites. The equation is:

$$P_{max} = 5460 \left(\frac{W^{\frac{1}{3}}}{R} \right)^{1.23} \tag{2}$$

where P_{max} is peak pressure in pounds per square inch (*psi*), W is the maximum borehole charge weight in pounds (*lb*), which is based on the maximum single charge in a delayed blast pattern, and R is the range to the mammal in feet (*ft*). For this equation, the range is the slant range to the mammal as depicted in **Figure E-21**.

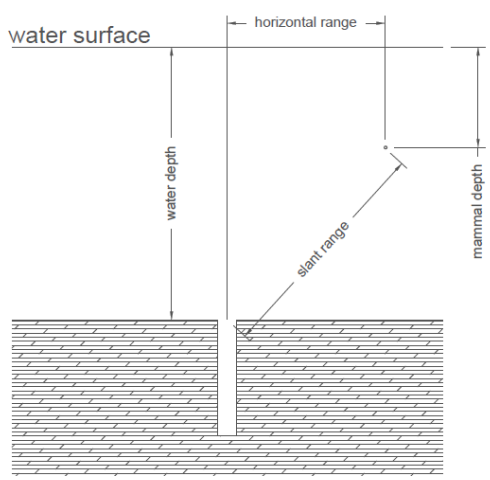


Figure E-21. Ranges and depths defined

It is assumed that the pressure wave decays exponentially similar to open water detonations and the decay constant for pressure is defined as ϑ, which is an empirically fit equation validated by Arons (Arons 1954) for use at long ranges.

$$\theta = 0.0583W^{\frac{1}{3}}\left(\frac{W^{\frac{1}{3}}}{R}\right)^{-0.22} \quad (3)$$

Both *W* and *R* units are as previously defined in equation (2) and ϑ is expressed in milliseconds (*ms*)

E.17.2 Impulse

The impulse that is required to affect a mammal is provided by the appropriate equations, which the National Marine Fisheries Services (NMFS) endorses at the time of the application. Currently, the criteria presented in (U.S. Navy June 2017) is applicable and are shown in **Table E-9.**

Table E-9. Criteria to quantitatively assess non-auditory injury due to underwater explosions.

Impact Assessment Criterion	*Threshold*
Mortality - Impulse	$144M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Injury - Impulse	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Injury - Peak Pressure	243 dB re 1 μPa peak

Where M is animal mass (kg) and D is animal depth (m).

The impulse is found by integrating the pressure with respect to time.

$$I = \int_0^t P(t)dt \quad (4)$$

Substituting equations (2) and (3) into (4) and solving, we get:

$$I = Pmax * \theta(1 - e^{\frac{-t}{\theta}}) \quad (5)$$

The only new variable introduced is the integration time (*t*). The maximum integration time is found when the shock wave reflects as a tensile wave at the water surface and interacts with the direct shock wave (Shuler 1968) at the depth of the mammal. This period of time is known as the "cutoff time" and is easy found from the detonation depth, range and the depth of the mammal.

$$t_s = \frac{1}{c}\left(\sqrt{(d_c + d_m)^2 + R^2} - \sqrt{(d_c - d_m)^2 + R^2}\right) \text{ (Qin, Casper and Babina 2016)} \quad (6)$$

where t_s is the surface wave cutoff time (*ms*), *c* is the speed of sound of water in (*ms*), d_c is the depth of charge (*ft*), d_m is the depth of the mammal (*ft*) and *R* is the horizontal range (*ft*) as depicted in Figure 1. Note that in order to have consistent units the pressure in equation (5) must be in (*psf*). Figure 3 shows an example of the pressure time history for the case when a 100 lb borehole charge at a bottom depth of 12.8 m, and mammal depth of 1 m. The inset plot shows the same pressure curve with the surface reflected tensile wave interacting at 0.4365 ms.

Figure E-23 illustrates the influence of both, the impulse increase with increasing depth and the effect of the pressure cutoff on the maximum range. **Figure E-24** has the mortality maximum range curve for the 12.8 m bottom depth versus water depth and includes the pressure time histories with cutoff applied for 1, 5 and 12 m depths. The impulse for each case is the area under the solid portion of the curve. It

should be noted that this example illustration is calculated using the old NMFS criteria (U.S. Army Corps of Engineers 2020), not the new Navy criteria.

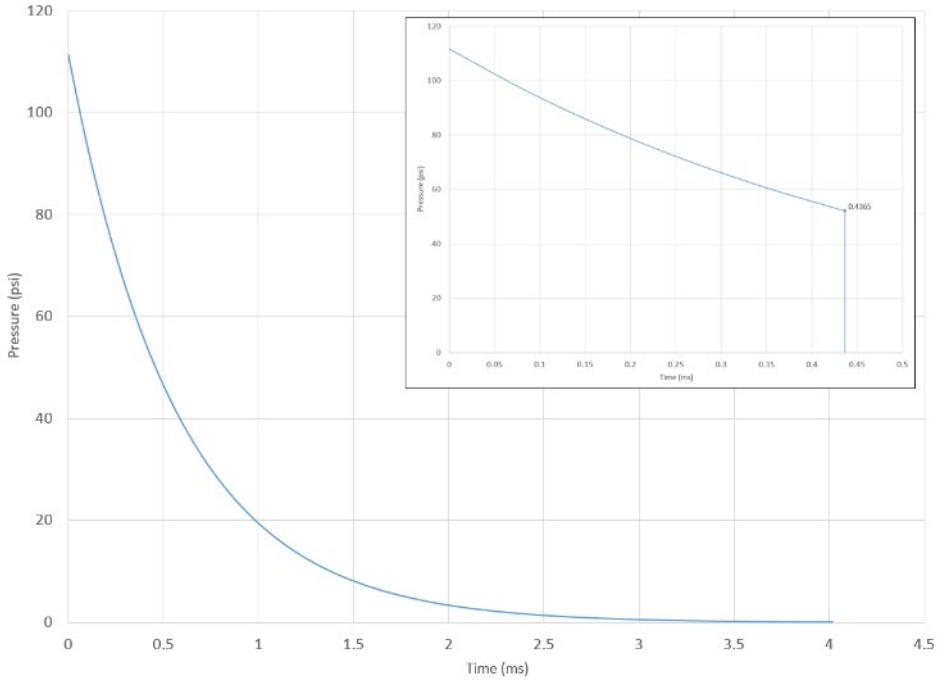


Figure E-22. Pressure time history curve

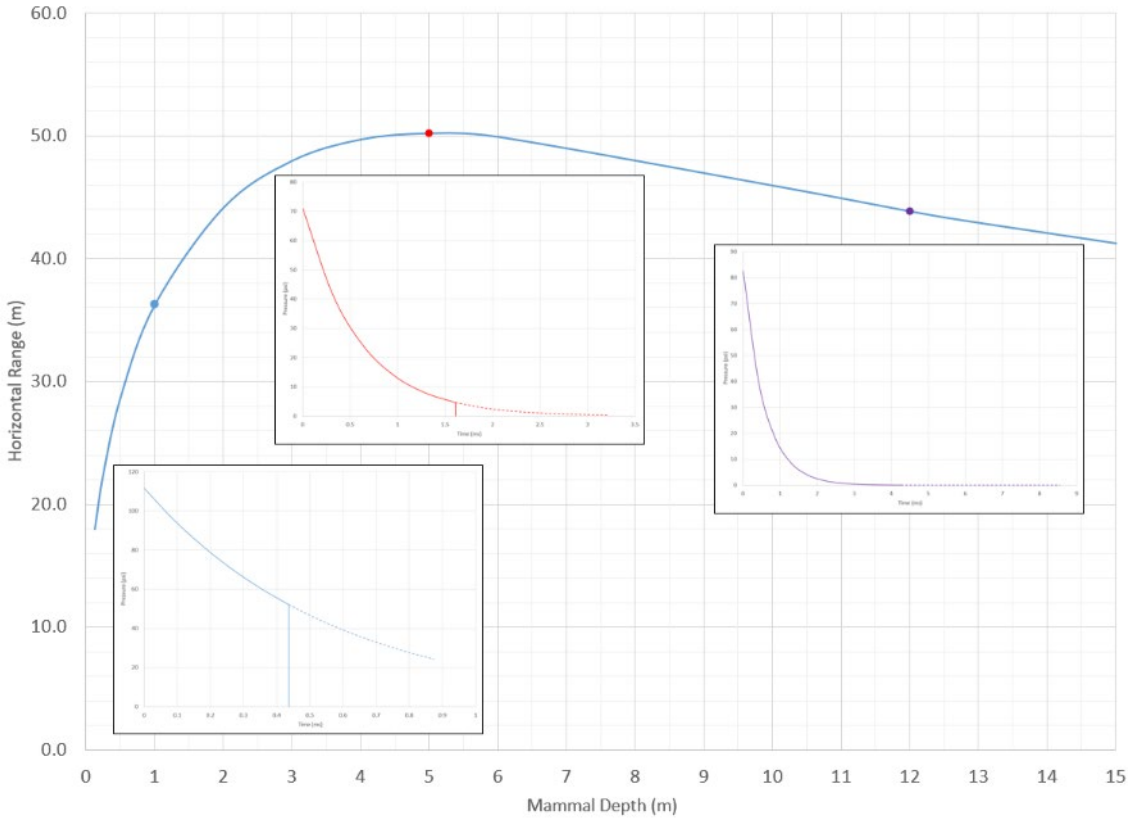


Figure E-23. Mortality horizontal range curve with pressure time history curves for 1, 5, and 12m.

E.17.3 References

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EM 110-2-3800. 2018. Blasting for Rock Excavations. US Army Corps of Engineers.

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Matlab spreadsheets shall be made available upon request.