

**The Protected Species Watch Program
For Blasting Activities In
San Juan Harbor
San Juan, Puerto Rico**

FINAL REPORT

**US Army Corps of Engineers
Project Number
DACW17-99-C-0060
San Juan Harbor Deepening Phase II**

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Summary

The port of San Juan is one of the busiest commercial ports in the Caribbean. The US Army Corps of Engineers initiated a channel deepening project for San Juan Harbor to accommodate the large container and cruise ships entering and leaving the harbor. As part of the deepening activities, the operations required blasting of the bedrock at the channel bottom to facilitate removal of solid material.

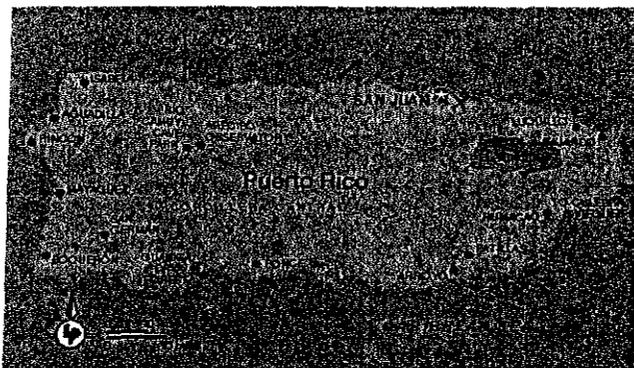


Figure 1. Location of San Juan, Puerto Rico.

At least three federally listed species, the Antillean Manatee (*Trichechus manatus*), the Loggerhead Turtle (*Caretta caretta*) and the Green Turtle (*Chelonia mydas*), as well as the protected bottlenose dolphin (*Tursiops truncatus*), routinely utilize the waters in and around San Juan Harbor. Protection of these species required both water craft and ground observers to be present during blasting operations.

A total of 38 blasting events took place between 16 July 2000 and 9 September 2000. There was only one blasting event per day between 16 and 30 July then two blasts per day thereafter except for 1 August and 27 August. No blasting took place between 1 August and 27 August due to weather conditions and drill barge maintenance.

Water craft surveys were conducted continuously from the top of a boat throughout the 2000' safety zone at least one hour prior to the scheduled blasting. Post blast surveys were conducted within the same vicinity for 1 hour after the blast until 4 September when the post blast surveys were reduced to ½ hour per the approval of the NMFS. Three stationary observers were used within the safety zone, one observer was stationed on Fort El Morro, one was stationed on the Drill Boat Apache, and the third was stationed either on the Dredge Alaska or on Isla de Cabras (Figure 2).

Observers reported any animal sightings to the primary observer and the sightings were recorded on maps and data sheets. All animals were tracked by the water craft observer until they were out of the safety zone or until 30 minutes after the last sighting. All animals were confirmed outside the safe zone before any blasting was authorized by the watch coordinator, and animals sighted near the safety radius after the blast were checked for normal behavior.

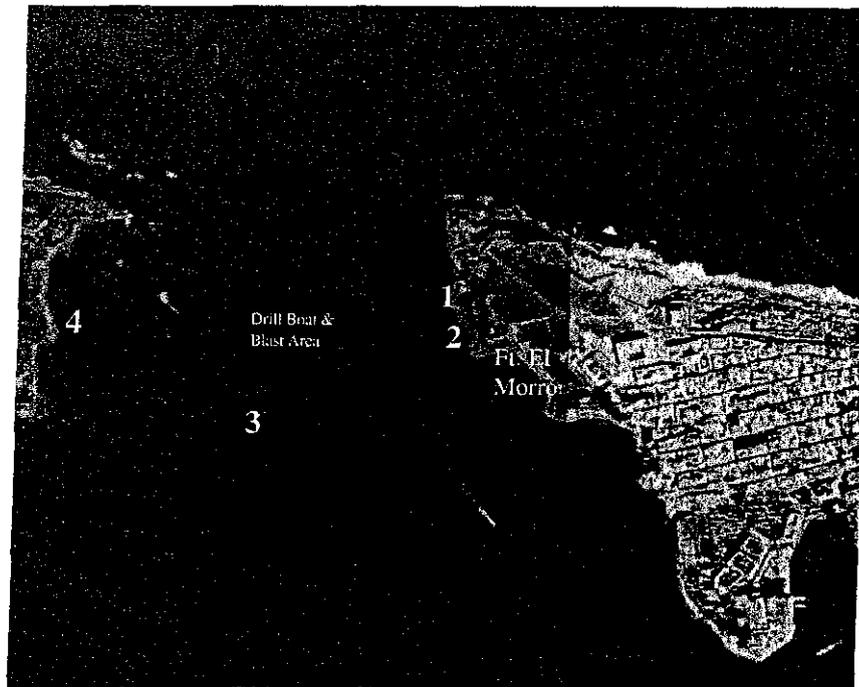


Figure 2. Locations of Stationary Observers: 1 & 2 are locations of Ft. El Morro observer; 3 is the location of the Alaska observer; 4 is the location of the Isla De Cabras observer. There was also an observer located on the Drill Boat. Positions changed slightly as the blast arrays changed location.

During the course of the blasting, there was a total of 27 sightings of marine turtles, 10 manatee sightings and two bottlenose dolphin sightings.

Pre-blast sightings of animals included 6 manatees, 13 marine turtles and 2 bottlenose dolphins. All these animals exhibited normal behavior and left the danger zone on their own volition. There were 18 post-blast sightings of animals (14 marine turtles and 4 manatees). Most of these sightings were close to 30 minutes after the blast. All animals were at least 2000' from the blast site when observed and showed no signs of distress. No protected species were observed to be injured or dead after any blasting events.

METHODS

Blasting Operations

Blasting operations were conducted by Contract Drilling & Blasting, Inc. (CDB), and Great Lakes Dredge & Dock Inc., (GLD&D). Blasting operations followed protocol provided by the National Marine Fisheries Service Division of Protected Species and the US Fish and Wildlife Service. This protocol required that detonations take place during daylight hours. Weather conditions such as wind, and sea state were also taken into account by the watch coordinator to insure that visibility was not compromised.

A total of 38 blasting events took place between 16 July 2000 and 9 September 2000. There was only one blasting event per day between 16 and 30 July then two blasts per day thereafter except for 1 August and 27 August. No blasting took place between 1 August and 27 August due to weather conditions and drill barge maintenance. A detailed description of the blasting operations can be found in the CDB Marine Wildlife Safety Plan, Appendix A.

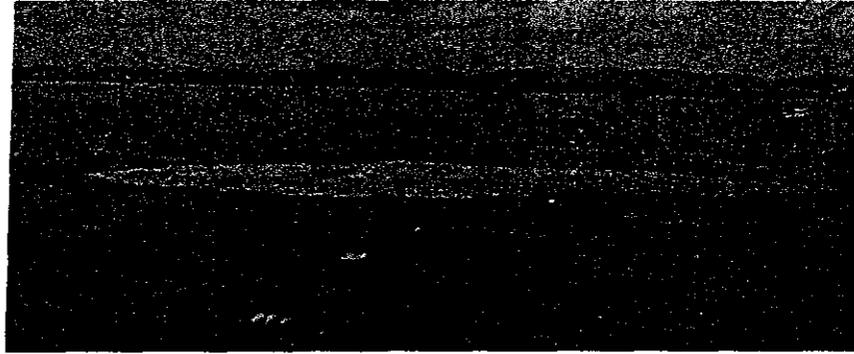


Figure 3. Typical blast as seen from the Drill Boat

A safety zone around the blast site was established to ensure the safety of protected marine species. This safety zone had to be clear of all protected species before blasting could be initiated. The safety area was calculated using the following formula:

$$r = 260 (\text{cube root } w)$$

Where:

- r = safe distance radius, 260 is the blast overpressure
- w = weight of explosives.

The anticipated maximum pounds of explosives per delay for the San Juan Harbor blasting was approximately 375 lbs.; calculating to a safety radius of 1,875 ft. This radius was further modified to 2000 ft., for an added margin of safety. This 2000 ft zone covered all ingress and egress points for species to be entering the area (Figure 4).

Fish scare charges were deployed from the drill boat prior to blasting. Due to the amount of open water habitat 3 scare charges were deployed prior to each blast event. The first charge was set at the 15 minutes-to-blast warning, the second was set at the 5 minutes-to-blast warning and the final was set at the 30 seconds-to-blast warning. The first charge was used to initiate some early movement from any

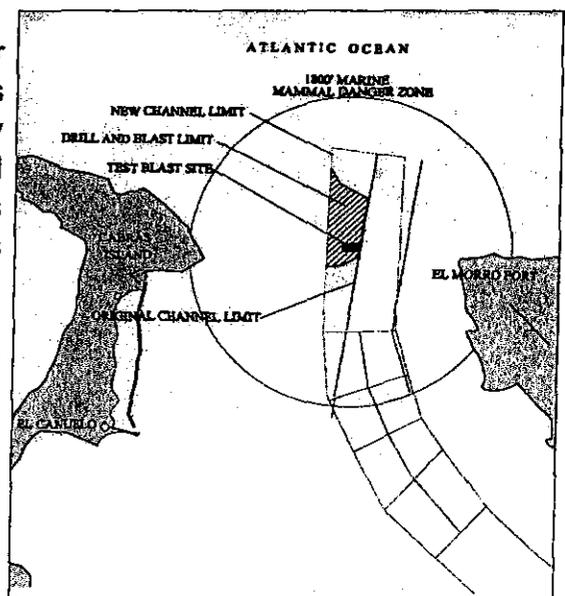


Figure 4. Diagram showing approximate safety zone for protected species.

bottom resting species so they would become visible to the observers, the second charge was used to initiate a movement away from the blast site, as the first may not have been detected directionally from the species. The third charge was used to initiate a startle response away from the blast site that would clear the area of any species immediately around the blast site that are at the highest risk of mortality.

Stationary Observers

Personnel involved in the Watch Program included the watch coordinator who was stationed on a small boat and three stationary observers. Stationary observers were placed on land and on barges to maximize their visibility of the 2000' danger zone depending on the location of the blast array.

One observer was placed on Fort El Morro on the east side of the blast site. The observer was placed on the highest possible location that allowed the best view of the survey area. This location was dependant on where the drill barge was located and as it moved farther north, so did the observer. Heights above the water surface for this observer ranged from approximately 6 meters to 45 meters (20' to 140').



Figure 5. View from the highest point of Ft El Morro looking West toward the blast site.



Figure 6. Another view from the lower walkway at Ft. El Morro looking west-northwest toward blast area.

One observer was placed on the upper catwalk of drill barge "Apache" which was within 500 ft of the blast array at all times. This observer primary responsibility was offshore to the north since the height, location and stability of the barge provided optimal visibility for that area of the danger zone. The height of this observer above the water was approximately 20 meters (60ft). The drill boat was located adjacent to the blast site during most of the watch period but pulled back from the blast zone approximately 15 minutes prior to blast time.



Figure 7. Drill boat Apache in place for blasting. Observer position is on catwalk surrounding central control tower (white).

A final observer was placed either on Isla De Cabras on the western side of the harbor or on the Dredge "Alaska" which was working within 1000' of the drill boat. Placement of this observer was based on the location of the blast array and where the optimal viewing location would be in relation to the blast.

Each ground observer was equipped with a radio that communicated with the chief observer and blasting personnel, a red flag and a yellow flag in case of radio failure, binoculars, polarized sunglasses, cameras, maps, and data sheets. The observers and their qualifications were pre-approved by USFWS and the NMFS. A list of observers can be found in Appendix B.

Water Craft Observer

The water craft observer was equipped with maps, polarized sunglasses and radio communication with the blaster-in-charge and ground observers. Water craft surveys were conducted by the primary observer/coordinator for the Watch Program. Surveys were done from the roof of a 30' utility boat that placed the observer approximately 3 meters above the water surface. The entire 2000' safety zone was surveyed with concentration on the area to the south of the drill barge where coverage was most critical. Transects throughout the area were conducted and any observations from the stationary observers were verified. All pre-blast surveys were at least one-hour duration with most being longer. Post blast surveys were between 30 and 60 minutes duration depending on the requirements set by the NMFS.

Constant radio communication was kept with the blaster and the stationary observers. An "all clear" was given by the primary observer at the 30-minute, 15-minute, 5-minute, and 1-minute-to-blast warnings. The blasting countdown was not permitted to continue until the "all clear" had been given. As the 15-minute warning approached, the survey was tightened to approximately 1500 ft around the blast array and kept within that general area unless a ground observer spotted an animal. An "all clear" was also given immediately after the blast and signified the start of the post-blast survey

RESULTS

Daily summary reports can be found in Appendix 2. Full data sheets with corresponding maps can be found in Appendix 3.

A total of 39 of protected marine species observations were made over 26 days of blasting which constituted 38 detonations. There were 6 manatee, 13 marine turtle, and 2 bottlenose dolphin sightings during pre-blast surveys. There were 4 manatee and 14 marine turtle sightings during post-blast surveys. No protected species were injured or killed during blasting operations. Table 1 summarizes the results of the pre and post blast surveys.

Protected species were observed 58% of the time for all of the blast events. Observations of marine turtles made up 69% of the observations while manatees made up 25% of the observations.

Species were spotted by the Ft. El Morro observer 51% of the time, by the water craft observer 44% of the time, and by the dredge "Alaska" observer 5% of the time. No animals were spotted from the Drill Boat which was located near the center of the harbor entrance along the shipping channel. Most of the observed animals were spotted along the eastern edge of the harbor between the Ft. El Morro walkway and channel markers 3 and 5. Turtles were most prevalent in this area, although a number of sightings occurred along the rocks of the Western margin. One juvenile green turtle (*Chelonia mydas*) was routinely observed by both the Ft. El Morro observer and the water craft observer between the eastern breakwater and channel marker 5. This particular animal was seen multiple times before and after blast events. All the manatee groups were spotted in this general area. Manatees were typically moving north or south along the eastern margin. During a reconnaissance survey conducted three days before operations began, 3 manatees were spotted along the western edge of the channel close to the Isla De Cabras rock outcropping.

On the morning of 7 September 2000, a billfish tournament was being conducted in San Juan with a large number of boats leaving San Juan Harbor at the same time. There was a near collision with a manatee as some of these boats left the inlet. The manatee had been spotted by the boat observer after the blast and was following the animal as it moved northeast. The tournament boats ran at high speeds over the manatee. The animal was seen diving in front of one of the boats, the chief observer searched for the animal for 30 minutes after the incident but the manatee was not seen again. An incident report was submitted to the US Army Corps of Engineers and to the USFWS. The local US Coast Guard issued a warning to the tournament sponsors and provided assistance to us on subsequent tournament days. No other incident reports were filed for the project.

Table 1. Observation Summaries

Date	Time of Blast	Pre-Blast Observations			Post-Blast Observations		
		Manatee	Turtle	Dolphin	Manatee	Turtle	Dolphin
16-Jul-00	cancelled	-	-	-	-	-	-
17-Jul	914	1	-	-	-	-	-
18-Jul	36532	-	1	-	-	1	-
23-Jul	1622	-	1	-	-	-	-
24-Jul	1546	-	1	1	-	-	-
25-Jul	1719	-	1	1	-	2	-
27-Jul	162-	-	-	-	-	1	-
28-Jul	1237	-	1	-	-	1	-
29-Jul	1-59	2	-	-	-	-	-
3-Jul	36531	-	-	-	-	-	-
31-Jul	851	-	1	-	-	1	-
31-Jul	1647	-	-	-	-	1	-
1-Aug	1729	-	1	-	-	2	-
27-Aug	1338	-	-	-	-	-	-
28-Aug	838	-	-	-	-	-	-
28-Aug	1754	-	2	-	-	-	-
29-Aug	824	-	-	-	-	-	-
29-Aug	1727	-	-	-	-	-	-
3-Aug	913	-	-	-	1	2	-
3-Aug	1611	-	-	-	-	-	-
31-Aug	758	-	-	-	-	-	-
31-Aug	1532	-	-	-	-	-	-
1-Sep	759	-	-	-	-	1	-
1-Sep	1734	-	-	-	-	-	-
2-Sep	759	-	-	-	-	1	-
2-Sep	1713	-	-	-	-	-	-
3-Sep	811	1	-	-	-	-	-
3-Sep	154-	-	1	-	-	-	-
4-Sep	749	-	-	-	-	-	-
4-Sep	17-6	-	-	-	-	-	-
5-Sep	36738	-	-	-	-	-	-
5-Sep	1449	-	-	-	-	-	-
6-Sep	734	-	1	-	-	1	-
6-Sep	1458	-	1	-	-	-	-
7-Sep	739	-	-	-	1	-	-
7-Sep	1613	2	-	-	2	-	-
8-Sep	756	-	-	-	-	-	-
8-Sep	1534	-	1	-	-	-	-
9-Sep	741	-	-	-	-	-	-
Totals:	38 Blasts	6	13	2	4	14	0

DISCUSSION

Observation Conditions

Weather conditions remained fairly constant with winds coming from the north-northeast at 5 knots in the mornings and increasing to 15 knots by afternoon. The sea state was typically glassy in the mornings with increasing chop and white caps in the afternoons. Swells ranged from 4 ft to 6 ft. Visibility was optimized by placing stationary observers at the highest locations possible throughout the blast safety zone. This proved to be beneficial in that the stationary observer on EL Morro spotted protected species 51% of the time. When the dredge Alaska was available, one observer was placed on the deck approximately 20 meters above the water surface. This location was used in lieu of Isla De Cabras because of its relative location to the blast array and excellent observation potential. With the amount of open water area that needed to be surveyed, it was important to have these observers located at ingress and egress points like El Morro and an observer on the Drill Boat to cover the offshore area. Even though the Drill Boat observer did not spot any animals, the coverage for the offshore area was critical because the boat observer could not adequately cover that entire off shore area to insure animal safety.

Observations

Most marine mammal/turtle activity observed was along the eastern edge of the survey area. Based on some diving reconnaissance, the area off the breakwater is rocky with a significant drop off (5-10 meters). Added to the physical structure of the area, there is a reduced current behind the breakwater. This appeared to be suitable habitat for marine turtles. One apparent resident turtle was seen multiple times before and after the blasting nearly throughout the entire operation. The turtle appeared to be a juvenile green (*Chelonia mydas*) with a carapace length of less than 1 meter. This turtle was the most predictable observation during the blasting operations; however, based on carapace sizes and other unique features, there were approximately 10 turtle observations that were not of the "resident" individual. Although some of the 10 additional observations were certainly repeat sightings, both the eastern and western edges of the inlet showed a high degree of marine turtle use.

The manatees that were spotted along this edge were traveling verses milling around, feeding or resting. The manatees were moving either north or south at a steady rate. The manatees coming in from the north came from the northeast, not across the channel from the west; and similarly, manatees leaving the harbor from the south made a sharp turn to the east as they left the inlet. There are some seagrass beds on the western side of the harbor near Isla De Cabras; however, very little activity was observed in this area which was well out of the danger zone. During initial reconnaissance surveys, possible fresh water sources were identified at the Coast Guard and Cruise terminals well to the south of the blast operations. Although not abundant in the harbor, manatees appear to use the harbor and travel through the inlet regularly. Manatees were spotted in the inlet 15% of the

time. Given that the surveys only occurred for a maximum of two hours per day, (8% of a 24 hour period), the use of the inlet by manatees may be much greater than previously thought. It is difficult to determine whether the observations made during the blast surveys constitute any temporal movements due to the limited times of the surveys. It is also unknown whether the groups of observed manatees were the same individuals that move in and out of the inlet on a regular basis.

Relatively few bottlenose dolphin (*T. truncatus*) were observed during operations. It is possible that the noise and activity associated with the drilling, and later the cutter head and drilling, deterred dolphins from using the area.

Very few fish of any size were visibly killed during any of the blasting operations. On two occasions, large Cuberra snappers were killed by the blast. On another occasion well after the blast, a dead Cuberra was spotted and netted in the inlet by the boat observer. This individual had a burrfish expanded in its mouth and gills which is probably what killed the snapper. The snapper had been dead for quite some time and not likely killed in the blast. Given that the distribution of Cuberra in the literature is "uncommon throughout its range", it is surprising that we encountered three large (greater than 50lbs) specimens in such a short period of time. Other than these two large Cuberras, most of the fish killed, if any, were "minnow-sized" or up to a few inches in length. The fish scares appeared to reduce the number of fish killed based on observations of delayed scares, re-timing of scares and scares that discharged correctly. Although no statistical comparison was done, the scare charges do appear to reduce fish mortality.

Oceanic birds such as Terns (*Sterna spp.* and others), Boobies (*Sula spp.*) Frigates (*Fregata spp.*) and Gulls (*Larus spp.*) were routinely within the blast area either above the water or on the surface during detonation. The birds took flight at the initial blast and often returned to the area to pick out dead or disoriented fish.

Protected marine species were observed before or after blasts on 22 occasions out of 38 possible blasts (58%). Compared to other locations where similar blasting operations and surveys have been performed, San Juan Harbor represents an area with a high degree of use by marine mammals and marine turtles. The area around the blast site, particularly the eastern and western edges are used by manatees mainly for traveling in and out of the inlet. There was no indication that the area was conducive for feeding or bottom resting until the animals were well south of the inlet. On the other hand, the area seems to contain suitable habitat for marine turtles of all sizes. From the observations, it appears that turtles use this area both as a "resident" location and as a "transient" location.

Following strict survey standards and Watch Plan protocols as well as having the cooperation of all operational and support personnel was key to being able to safely blast in this location. The location of the stationary observers aided in the ability to locate species and monitor their movements to insure wildlife safety.

Appendix B

Observer List

Appendix A

CDB Marine Wildlife Safety Plan

ENDANGERED SPECIES
MARINE WILDLIFE SAFETY PLAN
SAN JUAN HARBOR

This *Marine Wildlife Safety Plan* is prepared as part of the "Endangered Species Protection" of paragraph Protection of Environmental Resources of Section 01130 Environmental Protection, paragraphs 3.1.12.1, 3.1.12.1.2, and 3.1.12.3.2.

Historical data from blasting underwater-buried charges is very limited. Some of the important characteristic and parameters to be considered are as follows:

- Substrata Characteristics
- The amount and type of stemming
- Decking and/or delaying
- Type of Explosives Used
- Blast Pattern and Geometry
- Geology

Note: The density, strength, and variety of the geology have a significant impact on the energy attenuation and the path of pressure waves being transmitted. A number of pre-blast procedures will be employed to provide the maximum level of protection for Marine Mammal Wildlife.

The danger zone radius in feet from the blast can be determined by using the Safety Formula from the U.S. Navy Dive Manual for an uncontrolled blast suspended in the water column. This formula is extremely conservative since the charges to be used for San Juan Harbor are confined within the rock. This is the most effective way of reducing the pressure and impulse of water shock waves. Additionally, the borehole will be stemmed at the collar to further contain the pressures.

The danger zone radius in feet is determined by the following formula:

Safety Formula $R = 260 \sqrt[3]{W}$

R = Radius

W = Weight of Explosive in pounds per delay

The anticipated maximum pounds per delay for the San Juan Harbor is approximately 375 lbs.

$$R = 260 \sqrt[3]{(375)}$$

$$R = 260 (7.21)$$

$$R = 1875 \text{ ft.}$$

To ensure the maximum protection for manatees, the Safety Zone radius will be set at 2,000 ft.

SURVEY / WATCH PLAN

San Juan Harbor

To minimize the impacts of the construction activities for San Juan Harbor, a continuous Watch Plan ("Plan") has been developed. This Plan serves to address concerns relating to the potential impacts of the activities to protected marine wildlife, including manatees, dolphins, whales, and marine turtles.

1. No less than thirty (30) days prior to the first detonation, the contractors will provide the U.S. Fish and Wildlife Service (USFWS), and the Office of Protected Species for the National Marine Fisheries Service (NMFS). A list and qualifications of all observers to be utilized in this survey, CDB, may contract this out. At this time, additional information including proposed timetables for the surveys (start times for the aerial survey), observer positions, and sample log sheets and recording methods for sightings will be submitted.
2. A formal Plan Coordination Meeting will be held no later than three days before the first detonation event. Attendants may include the Chief Observer, the Ground Observers, General Contractors, Subaqueous Blaster, Contractor, USFWS, NMFS and other interested parties such as the U.S. Coast Guard and Department of Natural Resources. All participants will be informed about the possible presence of species in the area and the potential civil and criminal penalties associated with harassment, injury, and/or death of an endangered species. The logistics of the detonation schedule be discussed. Responsibilities for delaying/calling off the detonations will be assigned so that a clear path of communication is established.
3. The survey will consist of one primary observer in a small water craft. This primary observer will be designated as Chief observer and watch coordinator. Additional observers will be stationed on the drill barge and Ft. El Morro. Stationary observers will be placed in other key locations if deemed necessary by the USFWS or NMFS. All observers will have prior survey experience. During construction events, observers will be stationed to maximize visibility of the Safety Zone and all ingress/egress points as established in the attached Marine Wildlife Safety Plan. Possible personnel utilized as observers will be identified at the Plan Coordination Meeting and qualifications will be submitted. Any inexperienced observers will be trained in methods of surveillance and supervised for 10 hours prior to observing alone.
4. Observers shall follow the protocol established for the Plan and shall conduct the survey in good faith and to the best of their ability. The Chief Observer will make the determination as to whether acceptable observation conditions exist to allow the survey to be initiated before the detonation event.
5. All observers will be positioned to maximize visibility of the *Safety Zone*. The exact locations will be established at the Plan Coordination Meeting.
6. Marine wildlife surveys will be conducted by the observers no less than one hour before the scheduled blast event and one hour after the blast event.

7. During the final 15 minutes prior to the detonation event the survey will focus on the immediate Danger Zone surrounding the project site.
8. Observers will be equipped with a two-way radio that will be dedicated exclusively to the Watch. Observers will also be equipped with polarized sunglasses, binoculars, and a protected species sighting log and map to record sightings in the blasting vicinity. Each observer will have a safety flag, in different colors, should all other communication fail.
9. All of the observers will be in close communication with the Blaster in Charge in order to halt the detonation in the event a marine mammal or turtle is spotted within a *the Safety Zone* around the blast site. The blasting event will be immediately halted upon the request of any of the observers. The blast will not take place until the animal(s) move(s) away from the area under its own volition. Animals will not be herded away or harassed into leaving. If an animal is not sighted a second time, the event will not resume for 30 minutes after the initial sighting. A radio check will be made with the observers in approximate 15 minute intervals prior to detonation. At the 5 and 1-Minute to Blast an "All Clear" must be received from all observers in the *Safety Zones*. After detonation, the watercraft observer will make a complete survey of the Safety Zone and surrounding area for an additional 1 hour. Stationary observers will remain in place for at least 30 minutes. If a protected species is injured or dead after the detonation event, the observers will contact the Caribbean Stranding Network at 787-380-0025, the USFWS, Caribbean Field Office at 787-851-7297, and the National Marine Fisheries Service at 727-893-3366. The Watch Team will react accordingly to the above situation. Should this condition occur and a resolution required to change the Plan, the USFWS and NMFS may make such changes followed by written concurrence.
10. If an injured or dead manatee, marine mammal, or turtle is rescued/recovered within the project area during the detonation period, detonation events shall be postponed until NMFS or USFWS determines that the cause of injuries or mortality was not likely a result of the detonation event. If injuries are documented to be caused by detonation events occurring at the project site, all detonation events will cease until a revised protection plan is approved by NMFS and USFWS.
11. A daily report will be submitted to all interested parties including the USACOE, USFWS, NMFS, and PRDNER that will include all sightings, action taken, weather conditions, observations, blast times and the next blast schedule.
12. Within two weeks after completion of the all detonation events, the chief observer will submit a report to the agencies providing all data from the Watch surveys including the names of the observers and their positions during the event, number and location of protected species seen and what actions were taken when the species were observed.

Observers

Mary Jo Barkaszi – Primary Observer, Watch Coordinator

Christos Dedes – Senior Observer

Mary Gray – Senior Observer

Karen Blair – Senior Observer