DRAFT

AFTER ACTION REPORT

ON THE FISH KILLS RESULTING FROM BLASTING IN SUPPORT OF ROCK REMOVAL FROM THE FEDERAL NAVIGATION PROJECT -BOSTON HARBOR, MASSACHUSETTS- (FALL 2007)

PREPARED BY:

U.S. Army Corps of Engineers
New England District

JUNE 2008

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(continued)

SUBJECT

AFTER ACTION REPORT

I. Introduction

A. Purpose of the Report

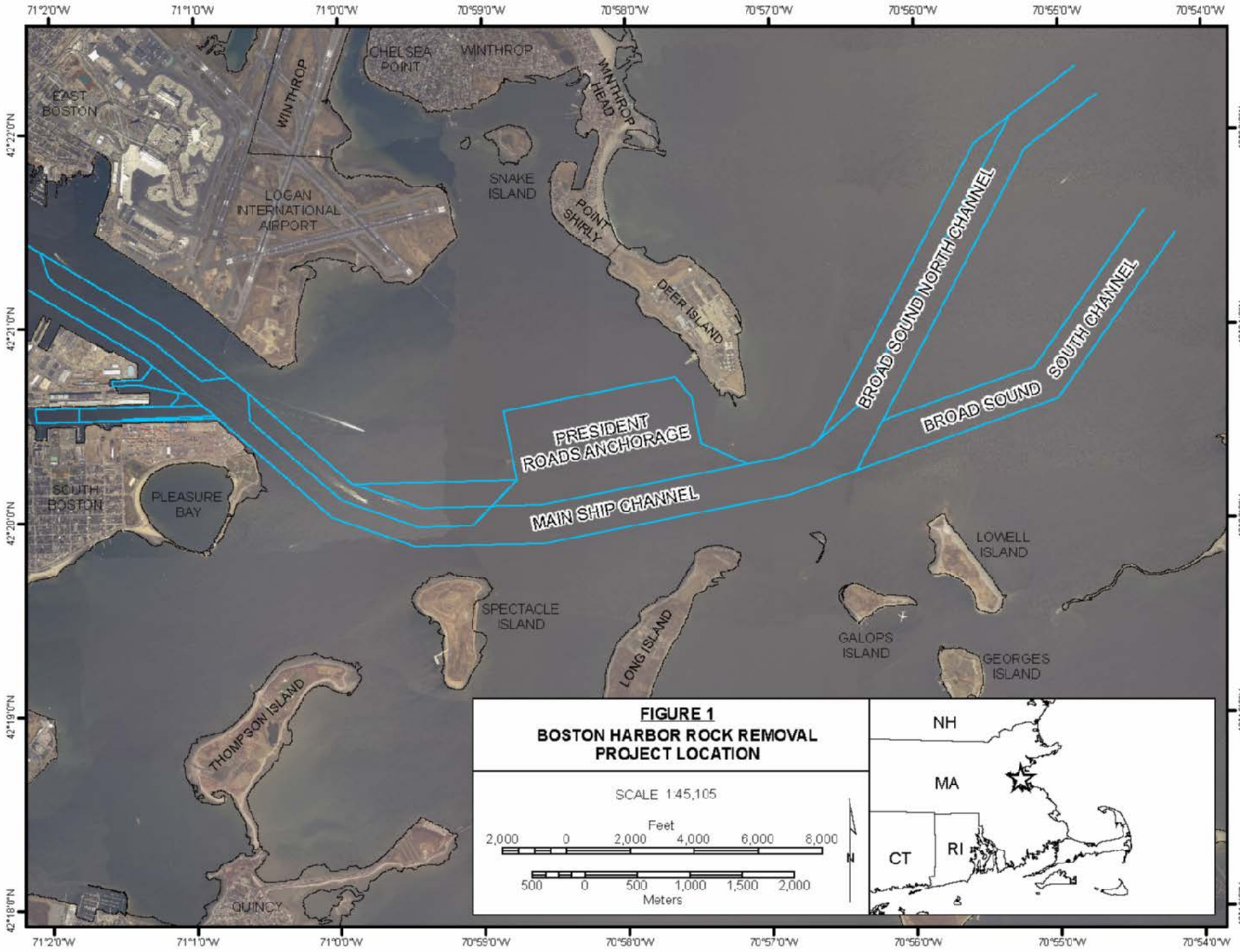
The purpose of this After Action Report (AAR) is to (1) document the project activities that resulted in fish kills, (2) the follow-up actions taken, and (3) the lessons learned during rock removal operations from the Federal channel and anchorage area in Boston Harbor, Boston, Massachusetts during 2007. The lessons learned from these blast events will be used to prepare a comprehensive blast plan for the upcoming Boston Harbor Deep Draft Navigation Improvement Project. In addition to the lessons learned from the events described in this AAR, a comprehensive blast plan to be developed for the Boston Harbor Deep Draft Project will also incorporate pertinent information obtained through literature reviews, advice from technical experts, lessons learned from other dredging/rock removal projects, results of resource agency coordination, and input from the project technical working group (TWG) sub-committee established specifically for this effort.

B. Project Description

It was discovered during maintenance dredging of the Boston Harbor Federal navigation channels in 2004 and 2005 that several areas of rock extended above the authorized navigation channel depths. These rock areas were located in the Main Ship Channel, President Roads Anchorage, and in the Broad Sound North Channel (see Figure 1). To eliminate this hazard to navigation and achieve authorized depths, it was necessary to remove this rock through blasting. A contract to remove the rock was awarded on March 15, 2007 to RDA Construction Corp. of Quincy, Massachusetts. RDA Construction began work in Boston Harbor in September 2007. They began to drill and blast in the President Roads Anchorage the week of October 1, 2007 and continued work until December 23, 2007 when operations were suspended in the Broad Sound North Channel due to safety concerns resulting from rough winter weather conditions. RDA Construction resumed work in April 2008. A hydraulic ram was used in the Broad Sound North Channel to remove the remaining rock material in the spring and summer of 2008. Table 1 provides the location, volumes of material removed, dates, and rock removal methods from the three locations containing the rock in the harbor.

Table 1. Information on Rock Removed From Each Section in Boston Harbor

Location	Amount (cy)	Dates	Method of Removal
President Roads Anchorage	1,029	Oct-Nov 2007	Blast
Main Ship Channel	235	November 2007	Blast
Broad Sound North Channel	42 XX	December 2007 April–June 2008	Blast Hydraulic Ram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42°21'0"N
42°20'0"N
42°19'0"N
42°18'0"N
EAST BOSTON
WINTHROP
CHELSEA POINT
WINTHROP
WINTHROP HEAD
SNAKE ISLAND
LOGAN INTERNATIONAL AIRPORT
POINT SHIRLY
DEER ISLAND
BROAD SOUND NORTH CHANNEL
BROAD SOUND SOUTH CHANNEL
BROAD SOUND
PRESIDENT ROADS ANCHORAGE
MAIN SHIP CHANNEL
SOUTH BOSTON
PLEASURE BAY
LOWELL ISLAND
SPECTACLE ISLAND
LONG ISLAND
GALOPS ISLAND
GEORGES ISLAND
THOMPSON ISLAND
QUINCY
FIGURE 1
BOSTON HARBOR ROCK REMOVAL
PROJECT LOCATION
SCALE 1:45,105
Feet
2,000 0 2,000 4,000 6,000 8,000
500 0 500 1,000 1,500 2,000
Meters
N
NH
MA
CT
RI

C. Operational and Construction Measures to Reduce Fish Impacts From Underwater Blasting

Blasting generates underwater shock waves which radiate from the point of the blast. These shock waves can injure or kill fish that transit or inhabit the impact area. Injuries can result either directly from the blast or when air bladders of the fish are impaired. To reduce the potential for fishery impacts, blast procedures were established for this project and approved by regulatory agencies prior to construction. These procedures seek to reduce shock waves in the overlying water column and deter schools of fish from the area at the time of blasting. Construction procedures implemented to reduce the shock wave included using inserted delays of a fraction of a second and stemming. Stemming is a method used to deaden the shock wave reaching the over-laying water column by placing stone or similar material into the top of the borehole. Operational procedures implemented to reduce potential impacts to fisheries in the areas of blasting included the use of side scan sonar to detect and avoid passing schools of fish during blasting, a fish startle system to deter fish of the Clupeid family (i.e. blueback herring and alewife) from entering the blast area, and a fish observer to oversee and coordinate these efforts and determine the appropriate blast time to avoid fishery impacts. The credentials of the fish observer, Eric Rydbeck of Normandeau Associates, were approved by the National Marine Fisheries Service (NMFS) on September 25, 2007 and MA Division of Marine Fisheries (MA DMF) on September 28, 2007.

The fish observer used hydroacoustic monitoring (i.e. side-scan sonar) prior to any blasting event to determine that schools of fish were not located within or transiting the blast zone area. In addition to the side-scan sonar, a fish startle system (Sonalysts, Inc.) was employed which is capable of deterring fish from the Clupeid family using high amplitude sound at specific frequencies.

The established procedure implemented by the fish observer during blast events was to first deploy the side scan equipment off a support vessel that navigated around the blast site to check for the presence of fish in the area. However, the presence of blast cords in the water column limited the ability of the vessel to completely circle around the area. As a result, only approximately 320^{o} to 340^{o} around the blast site could be monitored using this technique. The side scan sonar covers 150 feet on either side of the vessel. The fish observer made as many passes around the blast site as needed to feel confident there were no fish in the area. A minimum of two passes with no observed fish were conducted prior to approving the initiation of the blasting procedure.

The fish startle system was deployed prior to each blast event, regardless of whether fish were observed in the area, and removed from the water approximately five minutes before the blast for all events regardless if fish were observed in the area. The fish startle system was located on the blast barge and was deployed in the area of blasting to a depth of 10 feet off the seafloor, consistent with operating procedures described in the manufacture's manual. The fish startle system was removed from the water prior to the blast. The manufacturer of the fish startle system indicated that the fish startle system

can be removed from the water column up to 10 minutes before the blast and still be effective.

D. Blasting Specifications, Procedures and Safety Plan

Explosive products manufactured by Orica, USA were 2 or 2 ½" by 16", 40% gelatin charges. Non-electric delay blasting caps manufactured by Orica, USA were used. The bore holes were a minimum three inches in diameter, spaced a minimum of five feet apart, with a minimum five foot overburden. The average drill depth of the hole was eight feet with a minimum of three feet of stemming utilizing 1/8" peastone.

Drilling was conducted from the barge with a Joy Mini-mustang equipped with a drilling nose to center the drill bit on the channel floor. The drilling nose was advanced to the floor via cable and winch on a drill. The drill steel was advanced to the nose. The diver guided the bit and still into the nose. The diver then surfaced and then the borehole was dug to the proper depth. The diver returned to the floor with a section of a PVC pipe, the nose was lifted and the PVC pipe inserted into the drill hole to keep the hole open and free from bottom silt. This was repeated until the area was completely drilled.

Packages of explosives and cap were assembled on the deck of the barge using 80 foot Nonel caps. Those packages were then lowered to the diver via a tag line weighted to the bottom. The diver inserted the package into the open hole through the PVC sleeve. The peastone was then lowered via a tag line and the hole stemmed. The Blaster marked and secured the surface delay on the deck of the barge. The process was repeated until the shot was fully loaded and stemmed. The circuit was "snapped" together on the deck of the barge in proper sequence to a "shock tube" lead-in-line. Surface delays were attached to plastic jugs with the lead line shock tube beading back to the barge for initiation by the Blaster. After clearing the vessel traffic and barge personnel, the whistle system described below was sounded and the blast fired. There was no drilling during loading operations. Each operation is completed prior to the next operation. The line was run out to a safe distance from the blast site to the Blaster.

Prior to initiating the blast, a whistle signal system was sounded at which time all equipment and personnel were moved from the danger zone. The whistle system began with warning signal of a one-minute series of long whistles five minutes prior to the blast. The second blast signals were identified by a series of short whistles which were sounded one minute to the blast. After the second set of signals and before initiation, the Blaster visually checked with each guard to obtain the final all-clear. The all-clear signal was sounded with one prolonged whistle once the blast was made and the inspection finalized.

After the blast, the Blaster inspected for misfires and then sounded the all-clear. If a misfire was noted, the following OSHA recommendations were followed:

- If a misfire was found, the Blaster provided proper safeguards for excluding all employees from the danger zone.

- No other work began except those necessary to remove the hazard of the misfire and the employees necessary to do the work remained in the danger zone.
- No attempt was made to extract explosives from any charged or misfired hole; a new primer would be installed and the hole reblasted.
- If there were any misfires while using cap and fuse, all employees would remain away from the charge for at least one hour. Misfires were to be handled under the direction of the Blaster. All wires would be carefully traced and a search made for unexploded charges.
- No drilling, digging, or picking was permitted until all missed holes were detonated or the authorized representative has approved that work could proceed.

No blasting occurred between sunset and sunrise. All blasting was required to be completed 45minutes before sunset. Once blasting was completed for the day, the explosives were returned to the truck and transported back to permanent storage at Orica USA in Templeton, MA. No explosives were stored on site overnight.

II. Information on Blasting in Boston Harbor Fall 2007

Blasting was initiated on October 5, 2007 to remove rock from Boston Harbor. No fish kills were experienced through the first seven blasts in the President Roads Anchorage area. A total of 14 blast events occurred in the fall of 2007 in Boston Harbor, of which four resulted in a fish kill of varying magnitude. The first fish kill event occurred during the eighth blast event on October 24, 2007. Table 2 below provides the location, dates, tidal conditions, and other pertinent information for all blast events. Figure 2 shows the blasting locations and the dates for each location.

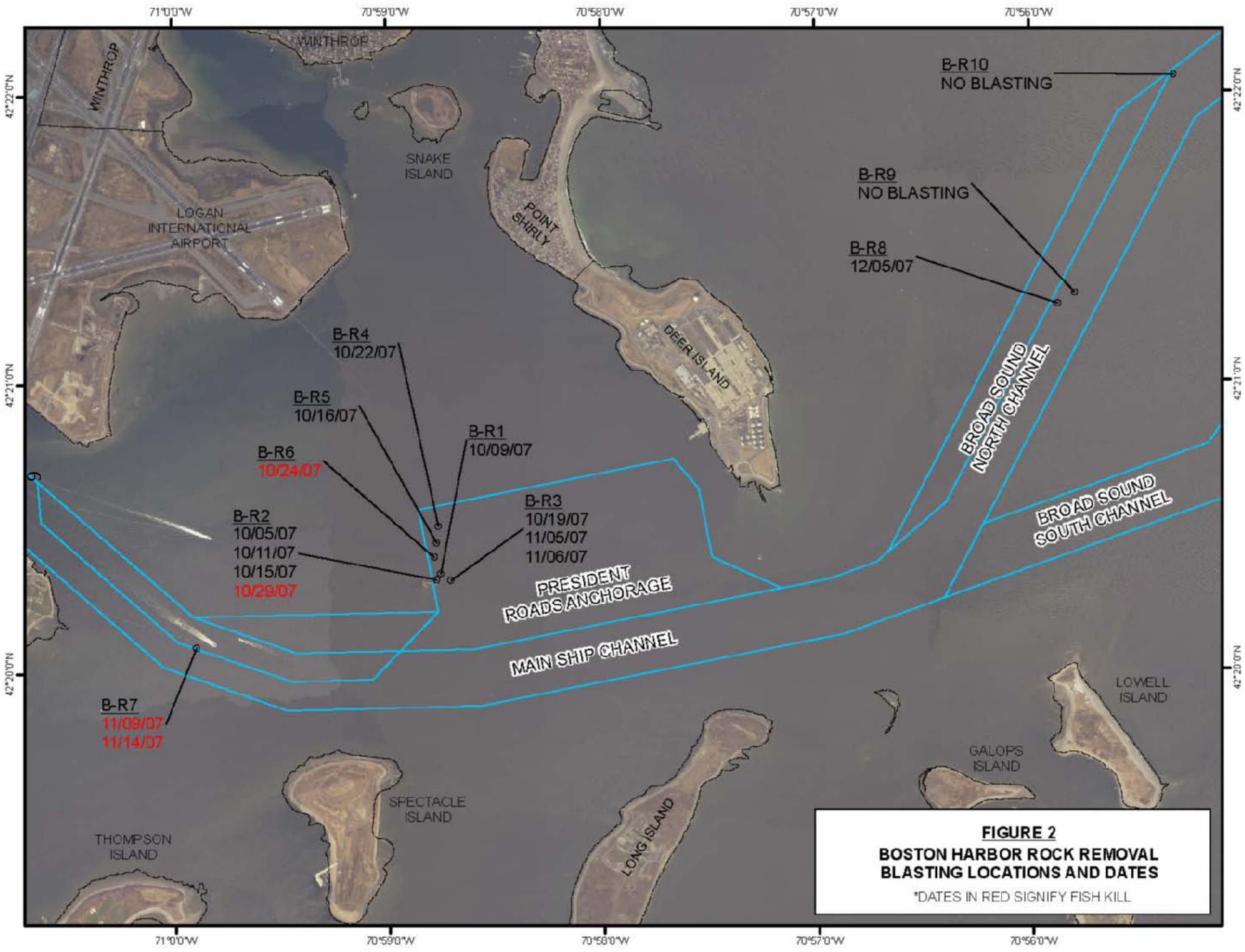
71°0'0"W
70°59'0"W
70°58'0"W
70°57'0"W
70°56'0"W
42°22'0"N
42°21'0"N
42°20'0"N
WINTHROP
WINTHROP
SNAKE ISLAND
LOGAN INTERNATIONAL AIRPORT
POINT SHIRLY
DEER ISLAND
B-R10
NO BLASTING
B-R9
NO BLASTING
B-R8
12/05/07
B-R4
10/22/07
B-R5
10/16/07
B-R1
10/09/07
B-R6
10/24/07
B-R2
10/05/07
10/11/07
10/15/07
10/29/07
B-R3
10/19/07
11/05/07
11/06/07
B-R7
11/09/07
11/14/07
BROAD SOUND NORTH CHANNEL
BROAD SOUND SOUTH CHANNEL
PRESIDENT ROADS ANCHORAGE
MAIN SHIP CHANNEL
LOWELL ISLAND
GALOPS ISLAND
SPECTACLE ISLAND
LONG ISLAND
THOMPSON ISLAND
FIGURE 2
BOSTON HARBOR ROCK REMOVAL
BLASTING LOCATIONS AND DATES
*DATES IN RED SIGNIFY FISH KILL

Table 2. Information on Each Blast Event

Date (2007)	Location*	Weather Low/High/Rain (^{0}F/inches)	Tide	Time of Blast (PM)	Current Speed (mph)	No. of Bore Holes	Explosive (pounds)	Fish Kill
October 5	PR Anchorage	67/75	2h03m after high tide	3:18	5	34	819	No
October 9	PR Anchorage	52/61	30m before high tide	4:25	15	25	624	No
October 11	PR Anchorage	52/63/.50”	1h21m after high tide	1.23	10	36	897	No
October 15	PR Anchorage	52/66	33m after high tide	2:59	10	34	836	No
October 16	PR Anchorage	52/70	1h08m before high tide	2:00	12	29	702	No
October 19	PR Anchorage	65/70/.50”	2h58m before high tide	2:45	7	30	819	No
October 22	PR Anchorage	65/72	34m before low tide	1:52	10	28	819	No
October 24	PR Anchorage	56/64	3h20m before low tide	12:54	7	14	351	Yes
October 29	PR Anchorage	37/65	12m after high tide	2:17	10	31	858	Yes
November 5	PR Anchorage	40/55/.62”	2h08m after low tide	4:05	10	32	858	No
November 6	PR Anchorage	37/51	59m after low tide	3:46	15	34	854.1	No
November 9	Main Ship Channel	32/43	45m before low tide	4:05	5	29	819	Yes
November 14	Main Ship Channel	37/60	3h39m after low tide	1:49	15/20	8	214.5	Yes
December 5	North Channel	24/32	55m after low tide	3:11	10	22	565.5	No

*PR Anchorage=President Roads Anchorage

III. Fish Kill Events During Blasting

Despite the construction and operational fish avoidance procedures implemented, as described above in Section C, four fish mortality events were experienced over a three-week period during blast operations in the President Roads Anchorage and Main Ship Channel areas. Table 3 below provides the dates, locations, and information on approximate number of fish observed killed from each blast event. Appendix A provides the number of dead fish species collected for each fish kill event. The length and weight for individuals collected and recorded for three of the four blast events are presented in Appendix B. Length and weights for fish collected during the first blast event, October 24, 2007, were not available. The details for each fish kill event are described below.

Table 3. Date, Location, and Approximate Number of Fish Killed

Date	Location	Approximate Number of Observed Fish Killed
October 24, 2007	President Roads Anchorage	150
October 29, 2007	President Roads Anchorage	1,000
November 9, 2007	Main Ship Channel	900-1,000
November 14, 2007	Main Ship Channel	300

A. Fish Kill Number 1

1. Event Specifics

The first fish kill event occurred on October 24, 2007. The fish observer made two passes on a support vessel with the side scan sonar around the blast zone. The initial sweep identified what was believed to be a school of fish near the surface within the blast area. A second sweep was conducted and no schools of fish were observed. The startle system was removed and the blast sequence initiated. See Section C above. The blast was detonated at 12:54 pm.

After blasting occurred approximately 150 dead or injured fish were observed floating at the surface. The fish observer collected the floating fish, which he counted and identified to species. For this event, 124 rainbow smelt (*Osmerus mordax*), two alewife (*Alosa pseudoharengus*), 23 cunner (*Tautogolabrus adspersus*), three red hake (*Urophycis chuss*), and one butterfish (*Peprilus triacanthus*) were collected.

2. Discussion of a Possible Cause and Corrective Action(s) Taken

The Corps contract specification for rock removal activities required that "If at any time during the implementation of the project, a significant fish kill or significant water quality problem occurs, and can be attributed to the project, all site activities impacting the water shall cease until the source of the problem is identified. Adequate mitigating measures shall be followed as outlined in the contingency plan or upon discussion with the appropriate state and local agencies." Upon observation of the fish kill, the Corps resident engineer directed that all blasting activity cease until a mitigation/contingency

plan could be developed through coordination with affected resource agencies (NMFS, MA DMF, and the MA Department of Environmental Protection (MA DEP)). Based on the information received, NMFS stated that they considered this a significant fish kill.

As a follow-up corrective action, the Corps performed a system review to ensure that all equipment was working properly, calibration and monitoring protocols were implemented correctly, and identify corrective measures, if any, to minimize the potential for reoccurrence of a similar event. To verify that the equipment was working properly, a technician from Sonalysts (fish startle system) checked the equipment and confirmed that the system was in fact fully operational and functioning properly.

The fish startle system was located on the blast barge, deployed to a depth of 10 feet off the bottom, and removed from the water approximately one minute prior to the blast, as also outlined in the manufacturer's procedures.

After confirmation that all equipment was properly functioning and that all operational procedures had been followed, it was determined that the fish kill was most likely due to the movement of fish into the blast area after it had been scanned and cleared by the sonar system. Although two passes were made around the blast area and no fish were observed in the second pass, it is probable that fish had moved into the area through a previously scanned and cleared zone while the vessel was completing its sweeping activity of another section of the blast perimeter.

The side scan sonar projects from the vessel down to the bottom at an angle. This could result in a small "inverted cone" of the water column not being scanned as the vessel transits the perimeter of the blast site. To increase the field of vision within the water column, a modified scanning procedure was to be implemented for all future blast events. The fish observer on the sonar vessel was instructed to begin screening for schools of fish as close as possible to the blast center. He then was to move out in a spiral to capture nearly the entire water column from the surface to the bottom throughout the blast area. It was thought that this technique would minimize the potential for fish schools to enter the blast zone undetected.

B. Fish Kill Number 2

1. Event Specifics

The second fish kill occurred during the ninth blast event on October 29, 2007. At approximately 12:30 pm the loading of the charges was completed. At 12:50 pm the fish startle system was deployed from the blast support barge located within the blasting zone. At 1:00 pm the side scan sonar was deployed and activated off a support vessel that moved along the perimeter of the blast zone monitoring for schools of fish. The side scan sonar vessel traversed the majority of the blast zone circumference but avoided that portion of the area where the down tubes are located which could result in severed lines and unexploded charges. The fish observer identified schools of fish transiting the area and subsequently performed additional sweeps (approximately 20) which showed varying

amounts of fish within and transiting the area. The fish observer observed and noted that there were unusually high numbers of fish in the area. The side scan sonar had indicated that fish were rapidly moving in and out of the blast area.

As the day progressed, less fish were observed transiting through the area. The fish observer, Contractor and the Corps construction representatives evaluated the situation to try and determine what if any operational conditions might potentially be attracting fish to the blast area and what steps could be taken to discourage fish from entering the project area. Based on the sonar observations it was speculated that the fish were potentially being attracted to the shadow projecting from the barge within the water column. It was also possible that suspended organic debris in the blast area resulting from a nearby dredging operation removing rock from earlier blasts could also be attracting fish to the area. It was generally concluded that moving the barge back from the blast zone as an implementable measure that may serve to reduce fish in the area.

At 2:02 pm the barge started to pull back from the blast zone. Once this was accomplished, the Contractor assumed that it was necessary to commit to initiating the blast sequence within 10 minutes since the fish startle system was relocated beyond the range of effectiveness for the entire blast zone. Vendor specifications state that the startle system should be deployed until 10 minutes before the blast since fish would not return to the area until 15 minutes after deactivation.

In the event blasting does not occur, the barge can not be moved back into the blast area due to the presence of the down tubes that run from the barge to the charges set along the bottom. Moving the blast barge into the area after it is "backed out" would likely entangle the down tubes which could result in an incomplete blast posing a significant safety hazard to both the crew and other vessels.

The charges were set off at approximately 2:17 pm and dead fish were observed floating in the blast zone. The fish observer estimated that approximately 1,000 small bait fish floated to the surface after the blast. He began to collect the fish for analysis and identification. Seagulls were feeding on some of the floating fish during the collection. The fish collected post-blast included 103 alewife, 18 blueback herring (*Alosa aestivalis*), 30 menhaden (*Brevoortia tyrannus*), 38 Atlantic herring (*Clupea harengus harengus*), 16 rainbow smelt, five cunner, and four red hake. The fish were then delivered to MA Division of Marine Fisheries (Ms. Tay Evans). Fish lengths and weights were also recorded and are included in Appendix B.

2. Discussion of a Possible Cause and Corrective Action(s) Taken

The resulting fish kill appears to be the result of a miscommunication between the fish observer and the Contractor who believed he needed to execute the blast within 10 minutes of the removal of the fish startle system from the area and not wait for an “all clear” from the fish observer. As a result of this blast event, the following changes to blast protocols were instituted to minimize the potential for additional fish kills:

- Fish Startle System: The Contractor is to deploy the fish startle system on an alternate and more mobile vessel instead of on the blast barge. This is to allow the fish startle system to remain operational and mobile in the blast area while the blast barge is being pulled back from the area to minimize potential "attraction" to the barge shadow. It will also allow the startle system to be redeployed to the area in the event blasting is not initiated since it will have the ability to enter the area so as to not impact down tubes.
- Dredging at Adjacent Areas: Dredging at adjacent areas will be curtailed if it is determined that it is the source of any detrital plumes impacting the blast area which could potentially be acting as an attractant to fish. Dredging would be allowed to continue only during portions of a tidal cycle that results in a plume trajectory away from the blast zone.
- Improved Communication: All parties will be clearly informed of communication pathways and roles and responsibilities relative to fish observance and blast initiation. It will be emphasized that it is the sole responsibility of the fish observer to give the "all clear" signal to initiate the blasting sequence based on fish observations. The fish observer would not signal for initiation of the blast sequence until he determined, through use of the side scan sonar and any other observations that there were no schools of fish present in the blast area. The only overriding condition would be the need to initiate the blast sequence for safety reasons as directed by the safety officer. One example would be when it would be necessary to initiate a blast sequence to comply with the "45minutes prior to sunset" provision. At this point blasting must be initiated due to safety considerations and to comply with safety regulations. All involved parties are to be made aware of these protocols and the need for clear and constant communication between the fish observer and the blast barge personnel.

It is also noted that the blasting safety officer reserves the right to override the fish observer in the event that a situation develops which could jeopardize human safety. The safety officer would communicate the reasons for the override to the fish observer prior to the initiation of the blast sequence which would be documented in both the blast report and the fish observer report. An additional overriding safety requirement is that once the blast sequence is initiated with the first five minute warning blast, the blast must continue according to safety regulations.

C. Fish Kill Number 3

1. Event Specifics

The third fish kill was observed after the 12th blast event on November 9, 2007. Normal sequencing protocols were followed which incorporated the corrective actions identified after the second fish kill event. The fish startle system was deployed at 3:38 pm and removed at 4:02 pm. Schools of fish were observed sporadically on the side scan sonar transiting through the area. The barge was moved 250 feet outside the blast area. Once it was determined that no fish were in the area, an "all clear" signal was given by the fish observer and the blasting sequence was initiated. Blasting occurred at 4:05pm,

approximately 45 minutes before sunset. The corrective actions implemented after fish kill #2 were implemented for this blast event.

After the blast, approximately 900 to 1,000 fish were observed floating on the surface. Less than 100 fish were collected with a dip net until no more fish were observed at the surface. As in previous events seagulls fed on the floating fish. The majority of the fish collected were blueback herring (80) and menhaden (14). The length, weight, and species of fish collected were recorded.

2. Discussion of a Possible Cause and Corrective Action(s) Taken

For safety reasons, blasting needed to be initiated 45 minutes before sunset. Although no fish were observed when the "all clear" signal was given by the fish observer, it is possible that because fish had been previously seen sporadically transiting the project area on the side scan, that some of these fish moved into the blast area after the "all clear" signal was given.

D. Fish Kill Number 4

1. Event Specifics

The fourth and last fish kill event occurred after the 13th blast event on November 14, 2007. Approximately 300 fish were observed floating or being eaten by the seagulls, far less fish than the last fish kill event. About one-fourth the amount of explosives was used for the third fish kill than was used for this blast event. Only six fish were collected, mainly due to gusty winds and wave action which carried the fish out of the area. All the fish collected were menhaden. Lengths and weights were recorded and presented in Appendix B.

2. Discussion of a Possible Cause and Corrective Action(s) Taken

As in Event #3, the corrective actions recommended after Fish Kill Event Number 2 were implemented during this event. The fish startle system was located on a separate boat, no dredge plume from adjacent dredging operations were observed in the area, and the blasting sequence was not initiated until after the fish observer has swept the area and had given an "all clear" signal.

After this event it was agreed that the Corps agreed would prepare an "After Action Report" to document the blasting operations and fish kill events to discuss lessons learned and possible recommendations for consideration in the development of a comprehensive blasting plan for the upcoming Boston Harbor Deep Draft Project.

E. Note

After the last blast event on December 5, 2007, it was noted that one fish, a menhaden (97 mm long and weighing 8 grams), was observed floating at the surface in the Broad

Sound North Channel. There were no other fish observed floating at the surface after the blast.

IV. Lessons Learned and Corrective Actions to be Instituted for Future Blast Events

Based on the events that occurred in 2007 during rock removal operations, the following recommendations should be considered for implementation for future blasting events.

A. Communication Plans

1. Fish Observer/Contractor Communication Plan

The contract specification on fish protection will clearly identify, with the exception of an overriding safety issue as identified in the previous sections, that it is the sole responsibility of the fish observer to determine when conditions are favorable for the blasting sequence to be initiated based on fishery observations. The fish observer will give approval for initiation of the blast sequence until s/he has determined, through use of appropriate technology, that no schools of fish are present in the blast area. However, it is recognized that the on-site safety officer has the authority and responsibility to override the fish observer's determination at those times when either safety concerns or regulatory compliance becomes an issue. The specifications will outline required protocol and the need for clear and constant communication between the fish observer and the blast barge personnel.

2. Fish Observer Reports

The fish observer will prepare an after action report for all blast events monitored, regardless of whether the event resulted in a fish kill. The report should include the date and time monitoring was initiated, deployment and retrieval of the fish startle system, the time of the blast, current speed and direction, tidal conditions, and weather observations throughout the day, and other pertinent observations. The fish observer will note if fish were observed in the project area prior to blasting and if there were any dead or injured fish after the blast. The fish observer must record the number of fish killed or injured, and species including representative sizes and weights. Any equipment or operational issues that may have contributed to the fish kill will also be noted.

The fish observer will report his/her findings to the Resident Engineer for each day of blasting. The Resident Engineer will compile the previous week's reports and forward to the Project Manager or Study Manager and the Environmental Resources Team Member. If a fish kill is observed, the Resident Engineer will notify the Project Manager or Study Manager and the Environmental Resources Team Member immediately. Pertinent information along with the fish observer's report will be forwarded to the above parties as soon as possible. Based on the fish observer's report, the Project Manager, or Study Manager, will convene a meeting with the Resident Engineer and appropriate personnel

to discuss events and to determine what, if any, corrective actions can be taken to reduce the changes of further fish kills.

3. External Communication Plan

In the event of a fish kill, the Project Manager or Environmental Team Member will notify the appropriate resource agencies as soon as possible after the event. Additional communication will occur as soon as all pertinent facts and issues surrounding the event have been determined. In the case of the Boston Harbor Deep Draft Project, the NMFS, U.S. EPA, MA DEP, MA DMF, MA Coastal Zone Management Office, and Massport will receive a copy of the fish observers report along with other factual information. If determined necessary, a meeting and/or conference call will be scheduled between the Corps, Massport, and the resource agencies to discuss and identify potential corrective measures. These measures will then be forwarded along with the fish observer report to the agencies.

B. Operational Changes to Minimize Potential for Fisheries Impact

The Contractor will deploy the fish startle system on an alternate vessel instead of the blast barge to allow greater coverage of the blast area and extend duration of the systems deterrence action just prior to blasting. This will allow the fish startle system to stay deployed in the blast area while allowing the blast barge to be pulled back from the area to minimize potential fish "attraction" to the barge shadow in the water column.

It is possible that a dredging plume may serve as an attractant to the fish towards the blast zone. Consequently, it is recommended that any dredging activities adjacent to the area of blasting occur when tidal conditions allow for the transport of resuspended material to move any residual plumes away from the blast area(s).

Additional conversation among the Corps, their blasting contractor, and the fish observer resulted in identifying some additional operational steps that could potentially be taken for future blasting events to help deter the presence of fish in the blast area. These included the use of setting off small charges in the blast area to "scare" the fish from the area or perhaps using bait to attract the fish to another area. After further discussion with the blasting contractor the use of small charges as a deterrent was dismissed since the blast is set off through a percussion process. Small charges could prematurely set of the blast for a percussion process which would constitute a significant safety hazard. Small charges can only be used when electric charges are used.

"Baiting" was another suggestion to draw fish away from the blast zone. However, it would likely act as an attractant for other fish and could make the situation worse. Also, since the target species (herring) are primarily planktonic feeders, appropriate bait was questionable.

V. Discussions for Development of a Blast Plan

In order to move the development of a formal blast plan for both the upcoming Boston Harbor Deep Draft Project and other similar type Corps projects forward, scheduled meetings should be held with the blast subgroup of the Technical Working Group for the Boston Harbor Deep Draft Project. This subgroup would identify blast issues that require further discussion, research, and resolution for incorporation into the plan. At a minimum, the following items should be included for discussion:

- Significance – What constitutes a significant fish kill and what would determine the need for corrective actions, and mitigative measures?
- Mitigation Measures and Operational Approaches – What are the available mitigation measures that can be incorporated into the blast plan? What approaches should be considered and incorporated into the dredge plan to minimize impacts to fisheries?
- Time of Year and Sequencing – Time of year and sequencing approaches based on the presence of fish resources should be explored with the resource agencies as a mitigative tool to minimize blasting impact to fishery resources.

Discussion with the resource agencies should occur to determine, based on the species of concern prevalent in the harbor, and the amount of rock to be blasted in the various harbor locations, what time of year blasting should occur in the harbor and in which location or tributaries.

C. Plan of Action for Fish in the Blast Zone

A discussion of alternatives, if any, should be considered for those times when the side scan sonar survey indicates large numbers of fish are in the blast zone throughout the day and the charges have been set. According to the fish observer (personal communication June 17, 2008), no fish were observed on the side scan sonar during the non-fish kill events. (The exception to this is the first fish kill; during this event, no smelt were observed on the sonar.) This would indicate that, in general, the sonar can and did detect schools of fish in the blast area. There may be days when a suitable time to initiate blasting is not available due to the presence of fish observed in the blast area. Alternatives, if available, should be explored when this condition arises. Safety may dictate that blasting will need to be initiated, even if there are schools of fish in the area.

APPENDIX A

Table A-1. Number and Fish Species Collected By Blast Date

Common Name	Latin Name	Fish Kill Dates (2007)			
		October 24	October 29	November 9	November 14
Alewife	*Alosa pseudoharengus*	2	103		
Atlantic Herring	*Clupea harengus harengus*		38		
Blueback Herring	*Alosa aestivalis*		18	80	
Butterfish	*Peprilus triacanthus*	1			
Cunner	*Tautogolabrus adspersus*	23	5		
Menhaden	*Brevoortia tyrannus*		30	14	6
Rainbow Smelt	*Osmerus mordax*	124	16		
Red Hake	*Urophycis chuss*	3	4		
Total Number of Fish Collected		**153**	**214**	**94**	**6**

APPENDIX B

Table B-1. Length and Weight of Fish Species Collected October 28, 2007

Alewife		Atlantic Herring		Blueback Herring		Cunner		Menhaden		Rainbow Smelt		Red Hake	
L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)
135	18	138	20	123	17	58	3	98	8	103	5	92	4
157	28	118	11	139	19	55	2	99	9	105	6	80	3
145	26	136	18	155	27	75	8	100	9	125	10	72	2
142	22	158	25	143	22	53	2	102	7	135	14	62	1
137	20	143	22	127	14	38	1	100	11	117	8		
167	37	160	30	120	12			99	10	105	6		
138	19	140	20	125	13			92	7	111	8		
153	29	156	30	137	18			82	5	120	8		
167	38	140	21	143	17			83	7	92	4		
226	94	150	22	120	12			95	7	123	11		
146	23	152	22	119	11			92	8	100	5		
147	24	152	28	117	12			102	11	127	11		
194	70	150	26	137	19			95	7	130	12		
135	19	170	40	141	20			100	9	115	9		
146	26	182	43	120	13			100	9	111	7		
1X*	17	160	30	132	18			81	7	112	7		
167	40	143	23	139	20			85	5				
150	26	152	24	120	13			100	9				
156	27	136	20	122	13			98	8				
148	26	169	33					85	6				
130	17	150	24					110	13				
145	25	134	27					92	7				
145	25	138	20					93	8				
139	20	177	41					113	13				
132	18	162	33					89	6				
150	23	165	34					88	7				
150	26	140	18					100	10				
160	32	130	17					92	7				
145	30	145	21					93	7				
169	39	148	24					100	9				
144	23	140	20										

*1X = No Tail

Table B-1 (cont.). Length and Weight of Fish Species Collected October 28, 2007

Alewife		Atlantic Herring		Blueback Herring		Cunner		Menhaden		Rainbow Smelt		Red Hake	
L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)
155	27	141	20										
150	27	142	22										
135	20	158	30										
145	22	138	20										
138	19	144	24										
153	28	150	25										
153	32	128	16										
152	28												
177	40												
138	20												
157	32												
148	24												
162	32												
130	17												
133	19												
165	36												
145	23												
158	30												
135	18												
135	20												
157	32												
142	21												
134	18												
150	26												
157	29												
136	20												
156	27												
155	30												
141	20												
155	29												
137	19												
158	34												

Table B-1 (cont.). Length and Weight of Fish Species Collected October 28, 2007

Alewife		Atlantic Herring		Blueback Herring		Cunner		Menhaden		Rainbow Smelt		Red Hake	
L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)
149	25												
142	23												
171	38												
149	23												
158	31												
143	23												
138	22												
129	17												
151	27												
156	29												
155	29												
155	29												
135	20												
168	37												
139	20												
135	17												
156	27												
177	45												
138	20												
157	28												
140	22												
129	16												
161	31												
161	35												
152	28												
130	17												
167	36												
139	20												
147	24												
147	25												
148	24												
145	23												

Table B-1 (cont.). Length and Weight of Fish Species Collected October 28, 2007

Alewife		Atlantic Herring		Blueback Herring		Cunner		Menhaden		Rainbow Smelt		Red Hake	
L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)	L (mm)	W (g)
145	24												
150	25												
166	33												
149	25												
173	40												
150	26												
142	21												
128	16												

Table B-2. Length and Weight of Fish Species Collected November 9, 2007

Blueback Herring				Menhaden	
Length (mm)	Weight (g)	Length (mm)	Weight (g)	Length (mm)	Weight (g)
99	7	102	8	75	4
100	7	94	6	108	12
89	5	93	6	96	9
93	6	88	5	83	6
98	7	98	6	70	4
90	5	94	6	61	2
95	6	100	7	70	3
103	8	97	7	64	2
93	6	92	6	81	5
94	6	93	6	54	2
97	8	97	7	80	5
95	8	97	7	60	2
113	11	90	6	59	2
105	9	93	6	57	2
96	8	97	7		
101	9	96	6		
108	10	106	9		
90	6	87	5		
98	7	104	9		
103	9	92	6		
96	6	88	5		
99	7	104	8		
104	8	94	7		
85	5	98	7		
95	7	96	7		
93	6	99	7		
103	8	100	8		
101	7	90	6		
113	10	91	5		
94	6	90	5		
94	6	97	7		
96	7	94	5		
108	9	90	6		
92	6	91	6		
96	7	85	5		
90	6	99	7		
100	7	96	7		
92	6	99	7		
91	6	110	9		
90	6	99	7		

Table B-3. Length and Weight of Fish Species Collected November 14, 2007

Menhaden	
Length (mm)	**Weight (g)**
90	6
62	2
50	1
61	2
51	1
65	3