INCIDENTAL HARASSMENT AUTHORIZATION APPLICATION: ACTIVITIES RELATED TO THE DEMOLITION OF PIER E3 OF THE EAST SPAN OF THE ORIGINAL SAN FRANCISCO-OAKLAND BAY BRIDGE

April 16, 2015

For:

California Department of Transportation
San Francisco-Oakland Bay Bridge Toll Bridge Program
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1. A Detailed Description of the Specific Activity or Class of Activities That Can Be Expected To Result In Incidental Taking of Marine Mammals.

Project Overview

The California Department of Transportation (Department), as part of the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (SFOBB Project), is in the process of dismantling the original east span of the SFOBB. As part of the SFOBB Project, the Department has replaced the east span of the SFOBB with a new bridge immediately to the north of the original east span (Figure 1). Also, as part of the dismantling phase of the SFOBB Project, the Department is proposing a demonstration project to remove Pier E3 via highly controlled charges (Demonstration Project). Controlled implosion is proposed as an alternate method to the original permitted mechanical methods for dismantling Pier E3, as it is expected to result in fewer in-water work days, have fewer effects on aquatic resources of the Bay, and require a shorter time frame for completion. The Department is requesting regulatory authorization for the incidental harassment of marine mammals during the use of highly controlled charges to dismantle the Pier E3 marine foundation.

Figure 1. SFOBB East Span Seismic Safety Project Map

The SFOBB Project is located in San Francisco Bay (Bay), between Yerba Buena Island (YBI) and the City of Oakland. The western limit of the SFOBB Project is the east portal of the YBI tunnel located in the City of San Francisco. The eastern limit of the Project is located approximately 1,312 feet (400 meters) west of the Bay Bridge toll plaza on a spit of land referred to as the Oakland Touchdown (OTD) area in the City of Oakland.

Construction of the original east span connecting YBI and the Oakland shoreline was completed in 1936. The original east span was a double-deck structure 12,127 feet (3,696 meters) in length and approximately 58 feet (18 meters) wide, carrying five traffic lanes in both east-and westbound directions. The original east span is supported by 22 in-water bridge piers (Piers E2 through E22), as well as land-based bridge piers and bents on both YBI and Oakland. As shown in Figure 2 below, the original east span is divided into three major sections.

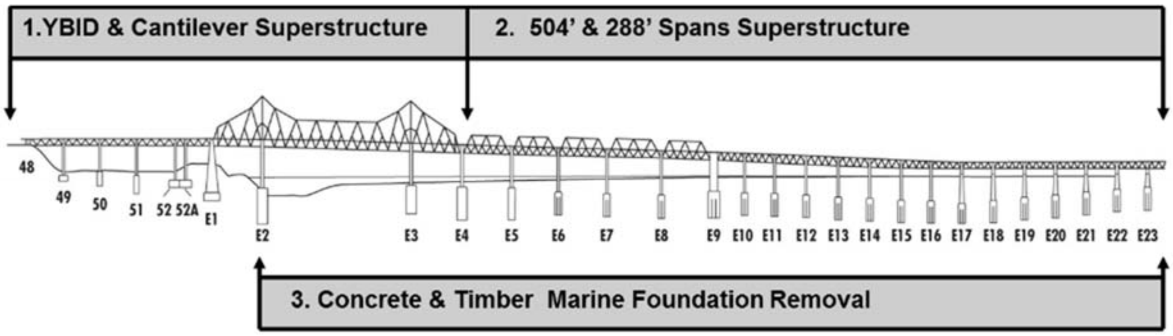

Figure 2. Schematic of the Existing East Span

Three Major Sections of the Original East Span

- Cantilever Superstructure and YBI Detour – The Cantilever section is comprised of three major components: (1) a cantilever anchor arm that is 508 feet (154.8 meters) long, (2) a cantilever section that is 512 feet (156 meters) long, and (3) a 1,400 foot (426.7 meter) long main span over the navigation channel consisting of a suspended segment which is supported on either side by anchor arms. The superstructure of this segment includes the trusses, road deck and steel support towers.

  YBI Detour – To complete construction of the new SFOBB east span and tie into the YBI tunnel, a portion of the original east span between Pier E1 and the YBI tunnel was dismantled in 2009 and replaced with the YBI Detour. The YBI Detour consists of a double-decked bypass structure that connects into the original east span at Pier E1 on the east side of YBI.

- 504' and 288' (504/288) Spans Superstructure – The 504/288 segment of the bridge is comprised of five 504-foot (153.6 meter) long steel truss spans and fourteen 288-foot (87.8 meter) long steel truss spans. The vertical clearance beneath the 504' spans is approximately 165 feet (50 meters) above mean high water levels, while the vertical clearance beneath the 288' spans gradually decrease from approximately 165 feet (50 meters) to approximately 10 feet (3 meters) as the structure descends towards the Oakland shoreline. The superstructure of this segment includes the trusses, road deck and steel and/or concrete support towers.

- Marine Foundations - The in-water or marine foundations vary in type. Piers E2 through E5 consist of concrete caissons founded on deep bedrock. Piers E6 through E22 consist of lightly reinforced concrete foundations that are supported by timber piles.

Dismantling of the SFOBB original east span began in late 2013. The dismantling of the original east span has been divided into multiple contracts corresponding to the different sections of the original east span (Figure 3). These contracts include:

- Yerba Buena Island Transition Structure No. 2 (YBITS 2) Contract
- 504/288 Contract
- Marine Foundation Contract

The first of the above mentioned contracts, the YBITS 2 dismantling contract, started in late 2013 and involves the dismantling of the YBI Detour structure and Cantilever Span. The second contract, the 504/288 dismantling contract, is anticipated to commence work in mid 2015. Lastly, the marine foundation contract is currently in the design phase. Construction work is anticipated to begin in mid 2015. Pier E3 has been selected for demonstrating the effective use of controlled charges in water to remove the marine foundations because it is the first marine foundation available for dismantling.

Figure 3. Sections of the SFOBB Original East Span

The original regulatory agency authorizations for the SFOBB Project covered the dismantling of the original east span via mechanical methods. In 2012, the Department amended the SFOBB Project's existing permits and received authorization to build temporary trestles and falsework to facilitate the dismantling of the original east span. These approvals did not cover the use of controlled implosion. For this reason, the Department is seeking authorization to incidentally harass marine mammals during the use of controlled charges to dismantle the Pier E3 marine foundation.

Updates to Project Description

To address potential impacts to environmental resources during bridge construction and dismantling, the Department and Federal Highway Administration (FHWA) prepared the SFOBB Project Final Environmental Impact Statement (FEIS), dated May 2001, pursuant to the National Environmental Policy Act (NEPA). The Department also obtained approvals from resource and regulatory agencies for all activities associated with both the construction of the new east span and the dismantling of the original east span. Mechanical dismantling methods and dismantling dredging were included in the FEIS and agency approvals. In addition, the FEIS, and certain agency approvals, contain language approving the disposal of all inert, non-toxic and non-hazardous dismantling debris of the original bridge in the hollow pier footings. To remove the marine foundations in an expedient manner and with less environmental impact, the Department is proposing to update the original project description to include the dismantling methods via the use of controlled charges to remove the Pier E3 marine foundation. An updated description of the Pier E3 marine foundation and the project activities associated for removal by controlled implosion are outlined below.

Pier E3 Site Location and Description

Pier E3 is located on the original east span of the SFOBB west of the OTD area and 1,535 feet (468 meters) east of YBI near the coordinates 37048’56.75”N 122021’14.75”W, in San Francisco County (Figure 4). Pier E3 flanks the east side of the approximately 50-foot (15 meters) deep shipping channel of the SFOBB original east span.

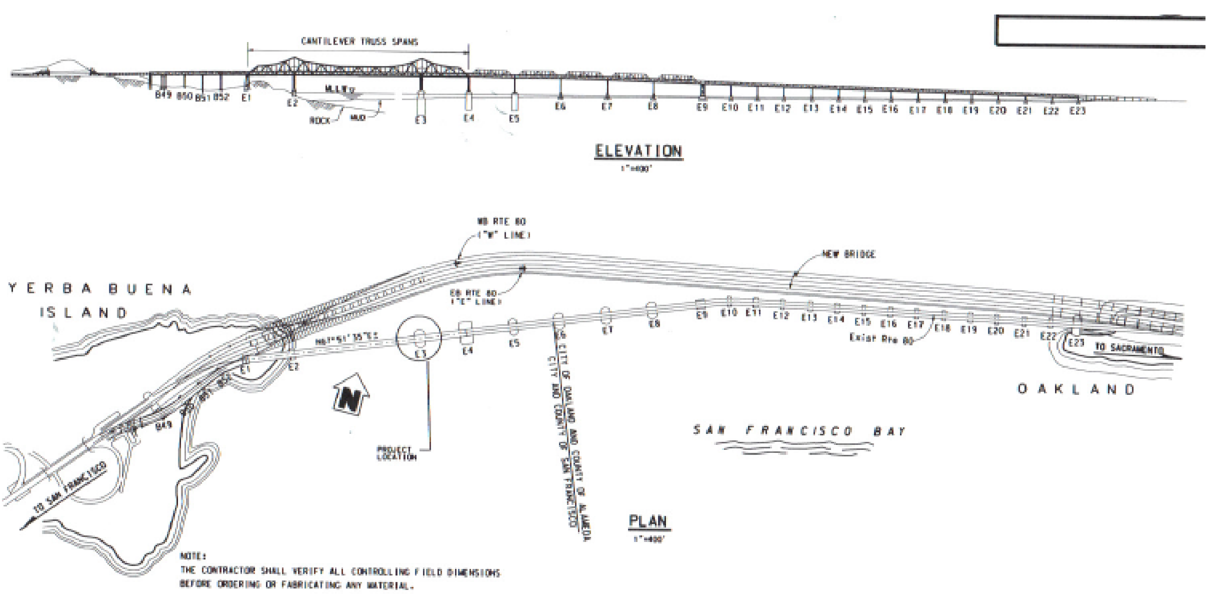

Figure 4. Schematic of the east span of the SFOBB showing the cantilever truss span and the location of Pier E3 (circled) relative to other piers on the bridge.

The Pier E3 caisson is a cellular concrete structure approximately 268 feet (82 meters) tall containing 28 total chambers. Of these, there are 24 rectangular chambers and 4 irregular shaped chambers. Fourteen of the chambers occur only below an elevation of approximately -51 feet (referenced to the 1929 National Geodetic Vertical Datum [NGVD 29]). These lower chambers occur in two separate rows of seven chambers on each length side of the structure. The four irregular shaped chambers occur at the terminal ends of these chamber rows. Fourteen of the chambers run lengthwise in two adjacent rows of seven through the middle of the structure and extend above the mudline to support the pier cap and concrete pedestals. The structure has 12 angled buttress walls that are approximately 51 feet (15.5 m) tall. Six walls occur on each of the two lengthwise faces of the upper portion of the pier between -51 feet and 0 feet and are completely submerged at most times. All are perpendicular to the structure. The hypotenuse side of each buttress wall runs at an angle from the outer top of the lower walls terminating at the face of the structure (Figure 5). Weep holes in the foundation located at an approximate elevation of -5 feet have allowed these chambers to fill with water. The water line inside the caisson varies with the tide, but +1.5 feet was the most common elevation measured in a recent Department sampling study of the caisson cell water. Its cutting edge (deepest part of the caisson) is at -231 feet (Figure 5). About 175 feet (53 meters) of the structure's height is buried in bay mud. The caisson was originally constructed on land and then towed to its current location before being sunk into place. The caisson does not reach bedrock.

Top dimensions of the pier cap are 80 feet (24 meters) by 167 feet (50.9 meters), not including the fender apron (Figure 5). Exterior walls along the perimeter of the caisson are 4 feet (1.2 meters) wide, while the interior walls comprising the rectangular chambers are 3 feet (1 meter) in width. The mudline (e.g., the bottom of the bay floor) at Pier E3 ranges in elevation from -43 to -51 feet. The pier cap, fender system and upper most portions extend above the water line to support the steel superstructure of the cantilever section and are visible from the Bay (Figure 6).

Pier E3 Demonstration Project Overview

The Department proposes removal of Pier E3 by use of controlled charges to implode the pier into its open cellular chambers below mudline. A Blast Attenuation System (BAS) will be used to minimize impacts to biological resources in the Bay. Given the complexity of removing the deep water caissons, the Department is proposing the Demonstration Project to evaluate in-water controlled implosion techniques for the removal of marine foundations. The Department's goal is to achieve a safe and efficient method for removing submerged foundations while avoiding and minimizing impacts to the Bay and natural communities and species within the project area.

The Demonstration Project expects to reduce environmental impacts as compared to currently permitted conventional dismantling methods which would employ large cofferdams with extensive amounts of associated pile driving and dewatering. The use of controlled charges is expected to greatly reduce in-water work periods and shorten the overall duration of marine foundation removal.

Dismantling of Pier E3

Dismantling of Pier E3 will take place in 4 phases:

- Dismantling of pier cap and fender system

- Drilling of bore holes into caisson and buttress walls and installing the BAS
- Installing charges, activating the BAS and imploding the pier
- Management and removal of remaining dismantling debris

Dismantling of Pier E3 would begin in June of 2015, following the removal of the SFOBB cantilever truss section (Figures 3 and 6) and steel support tower on the original east span that are part of the YBITS2 dismantling contract. The basic steps would involve removing the timber and steel-supported fender system that surrounds Pier E3, dismantling of the concrete pier cap by mechanical means to an elevation of +9 feet and drilling vertical boreholes to load charges for the controlled implosion. Charges will be loaded into the drilled boreholes as defined in the Blast Plan (Appendix A). Controlled implosion will be accomplished using hundreds of small charges with delays between individual charges. The entire detonation sequence of controlled charges will last approximately 4 to 6 seconds and will remove the pier to, or below, the current surrounding scour elevation of -51 feet. To minimize impacts to aquatic biological resources in the Bay, a BAS will be installed around the base of the pier. The BAS is specifically designed to minimize noise and pressure impacts generated by the controlled implosion. Installation of the BAS will be concurrent with the borehole drilling process. To help minimize impacts to biological resources, the controlled implosion event will be conducted at a slack tide in November 2015. Following the completion of the dismantling activities, any concrete debris remaining above the scour line will be removed by the following process:

- Remove debris to the current scour line elevation of -51 feet and raise it to the surface to be processed.
- Rebar will be removed to minimize bridging of open caisson cells.
- Processed debris will then be placed into the open voids of the caisson for disposal.

The entire Demonstration Project is expected to last approximately seven months. The Demonstration Project methods above are described in greater detail below, including examples of anticipated equipment, schedule, and other specifics.

Dismantling of Pier E3 Cap and Fender System

Dismantling of the Pier E3 cap is anticipated to start in June 2015. Support barges will be used to move hydraulic excavators (equipped with hoe rams and shearing attachments and other equipment needed for dismantling), cutting lances and torches to Pier E3. Support barges will be anchored and remain onsite for the duration of the Demonstration Project. The excavators and other equipment will be lifted onto the top of Pier E3 with a barge-mounted crane. Pier E3 mechanical dismantling process will remove the concrete pedestals and pier cap to expose the inner cells (Figure 7). A debris catchment system will be used to contain any concrete debris from discharging into the Bay. The concrete rubble from the mechanical dismantling will be placed into exposed cells of the caisson for disposal.

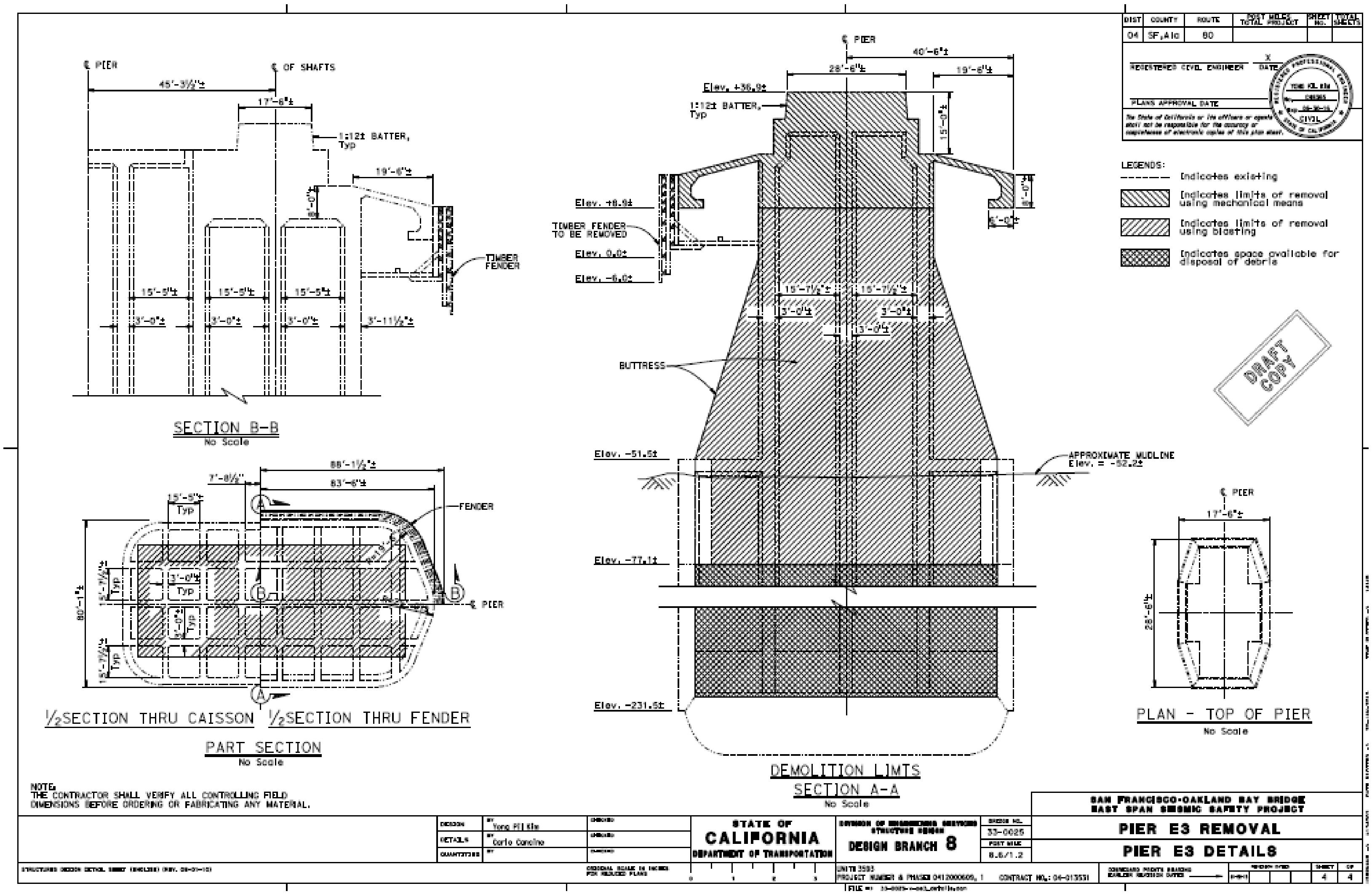

Figure 5. Draft plan sheet of Pier E3 caisson showing elevations, dimensions, and limits of removal.

Figure 6. View of Pier E3 facing northwest showing the wood structure and concrete apron of the fender system. The pier cap including the concrete pedestals are visible below the netted tower legs.

All debris is expected to fall to the base of the caisson, well below mudline. This disposal method is congruous with the SFOBB Project FEIS, which states that the Department may "use the hollow interiors of the columns remaining below the mudline as receptacles for pieces of concrete. As the upper portion of the column is dismantled, pieces of concrete could fall into the hollow interiors below the mudline." Placement of concrete rubble may displace water within the cells. The water inside the caisson cells has been analyzed and presents manageable concerns. To appropriately manage water quality issues created by any displacement of the caisson cell water, the Department will monitor during this disposal activity while using appropriate minimization measures.

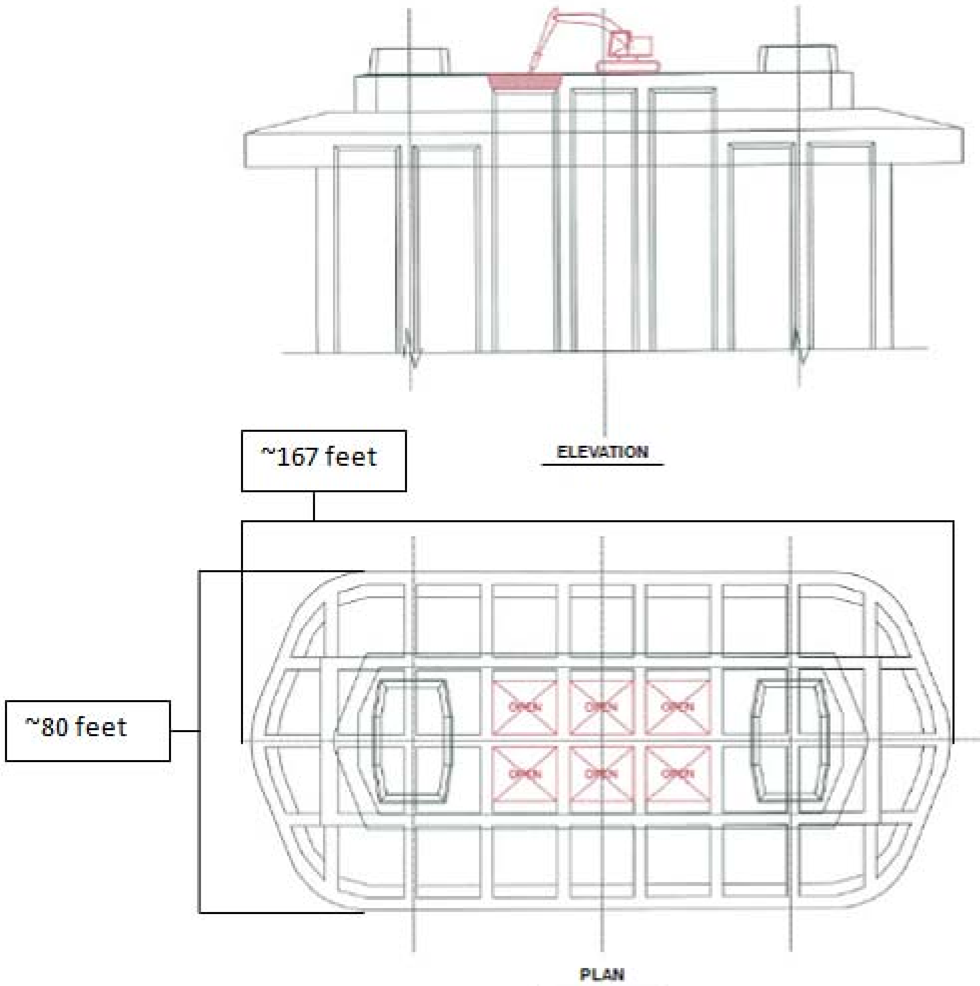

Figure 7. Schematic of Pier E3 elevation view, excavator is shown atop the pier cap removing the top slab of concrete to expose the inner cells of the pier. Exposed inner-cells are depicted in the plan view.

Support platforms will be installed to provide a working surface for the hoe rams to dismantle the upper portion of Pier E3 (Figures 8, 9 & 10). Concrete rubble from concrete pedestal dismantling will be disposed of inside the exposed inner cells of the pier.

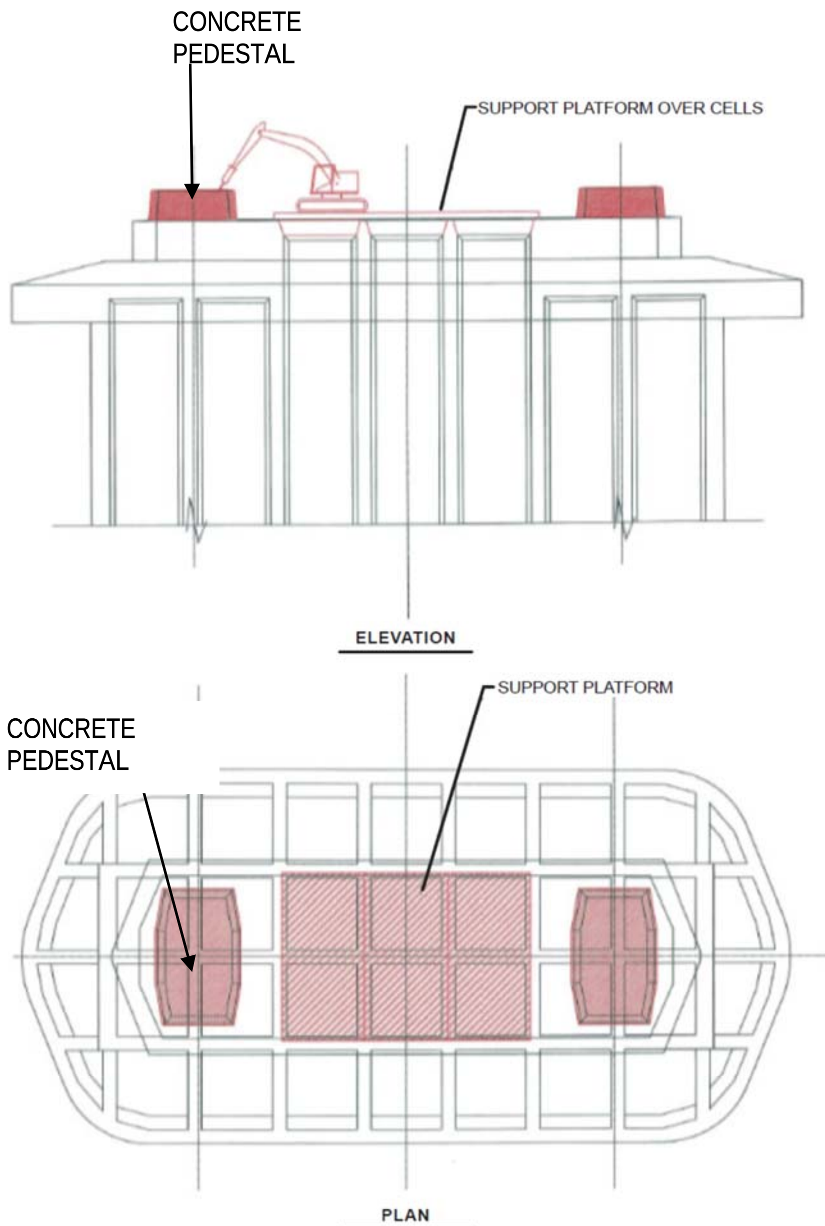

Figure 8. Pier E3 schematic. Elevation view depicts an excavator equipped with a hoe ram is shown dismantling a concrete pedestal. Plan view shows installed support platform over open cells to support construction equipment used for dismantling.

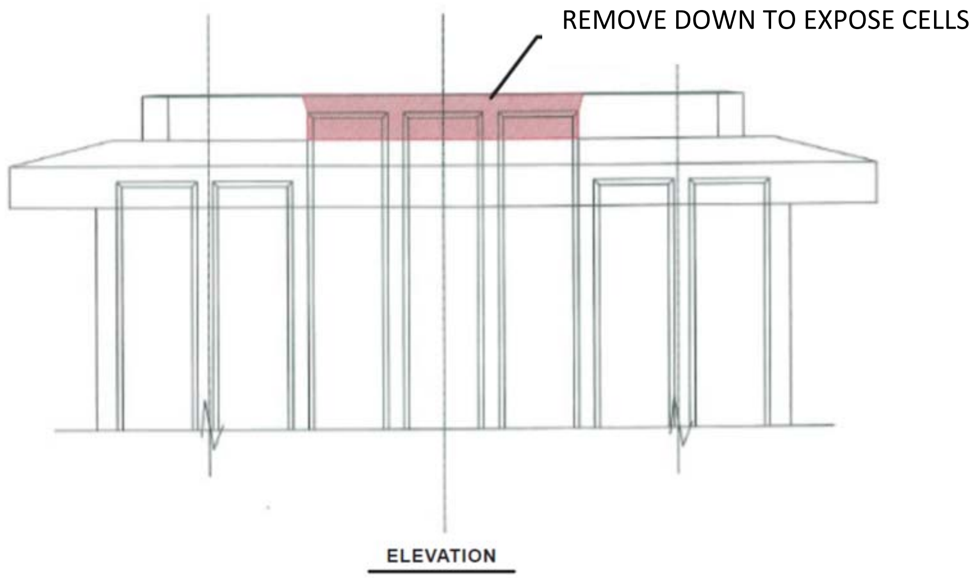

Figure 9. Pier E3 Schematic. Elevation view of the pier cap material over the inner cells of the pier, and the walls that are to be removed. An access platform is to be placed over them to support dismantling equipment.

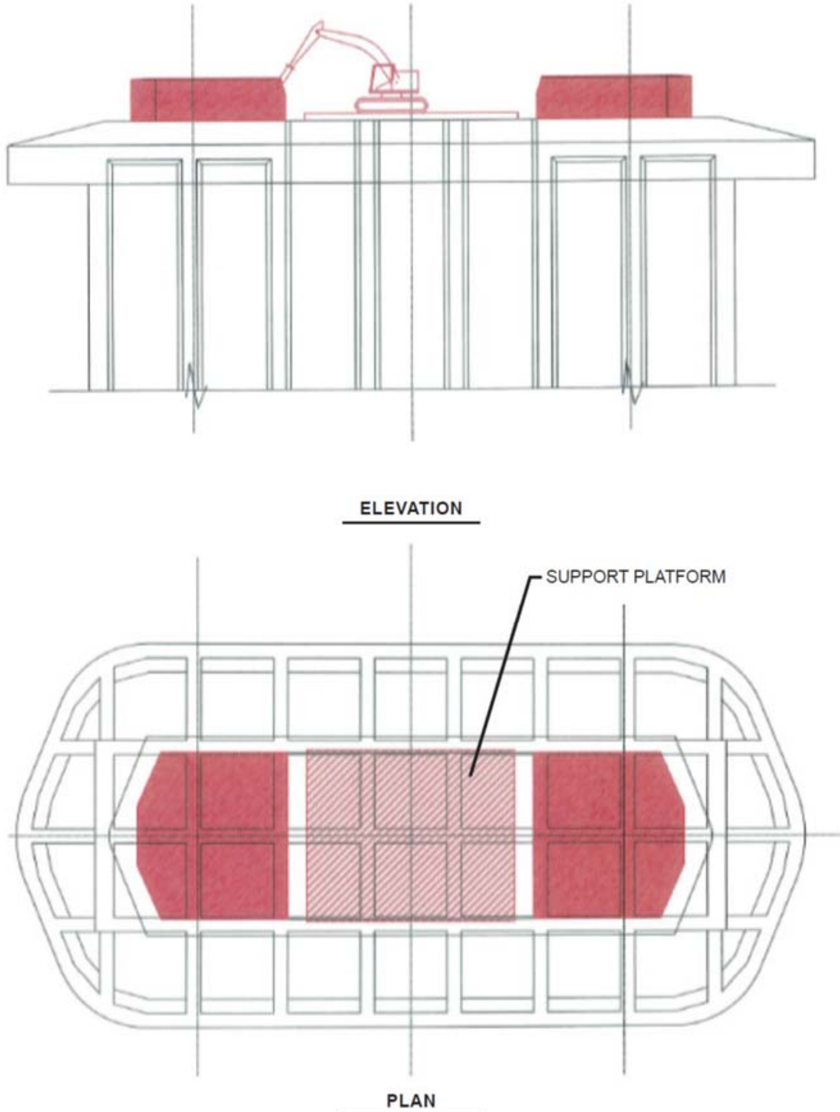

Figure 10. Pier E3 schematic. Elevation view depicts an excavator dismantling the outer portions of the pier cap after concrete pedestals have been removed**.** Plan view shows an installed platform over open inner cells to support the equipment used for dismantling.

The fender system will be removed including timber, metal framing and concrete apron. All metal and timber will be disposed of offsite. Falling concrete debris will be managed and contained. Concrete rubble from the apron will be disposed of inside the open cells of the pier (Figure 11).

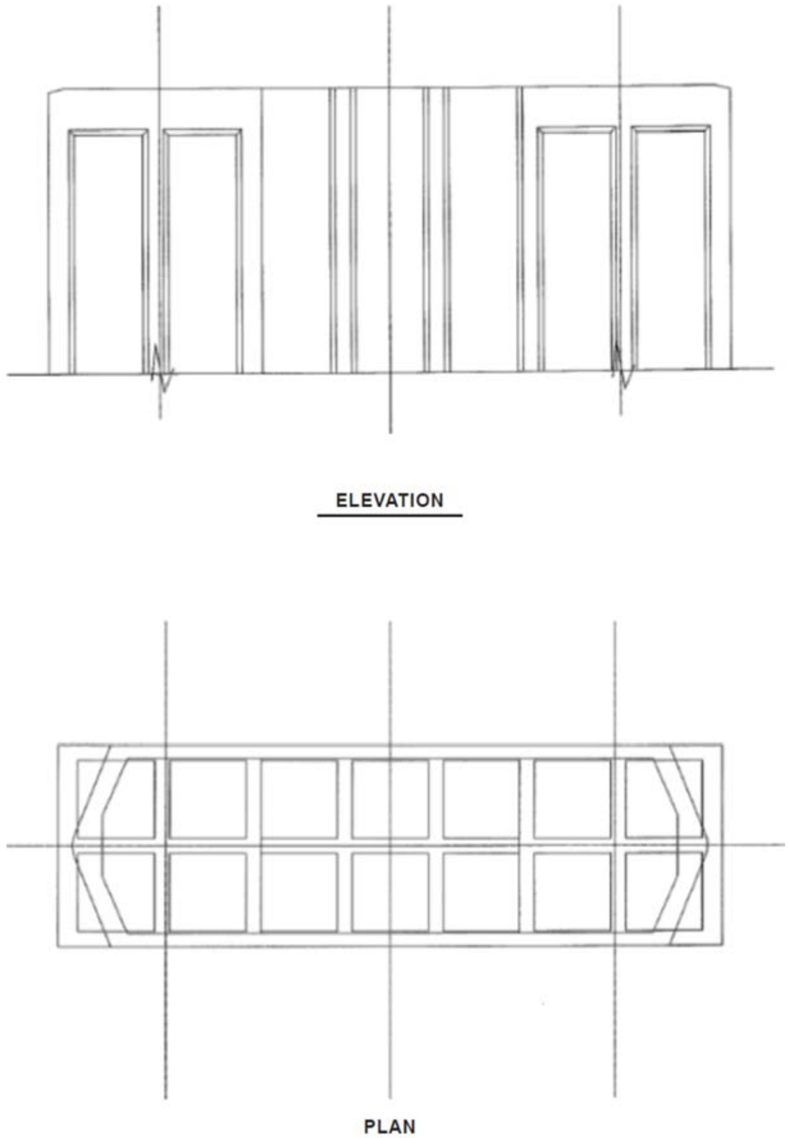

Figure 11. Pier E3 schematic. Elevation and plan view of Pier E3 after removal of pier cap and fender system including timber, steel frame, and concrete apron.

Platforms will be installed and relocated to allow excavators to access the top of the pier to dismantle the remaining concrete to the final mechanical dismantling elevation limit (Figure 12).

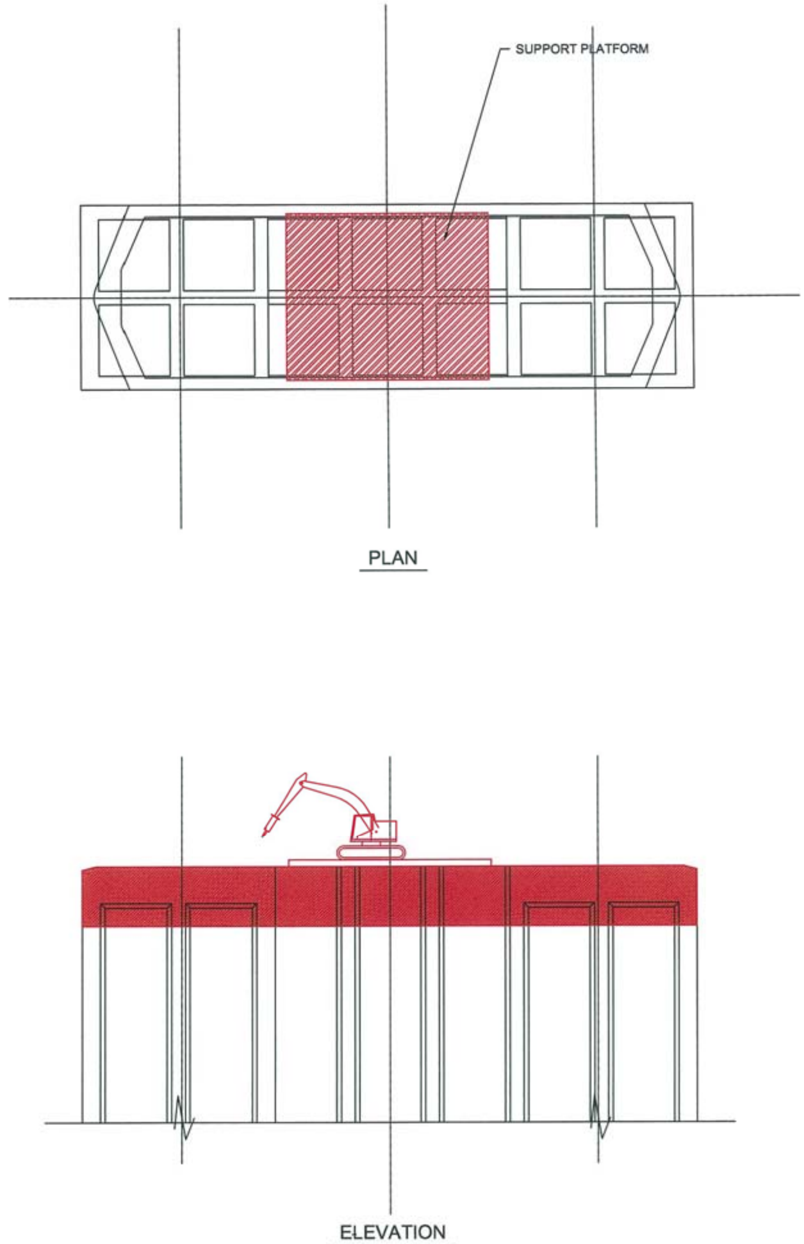

Figure 12. Pier E3 schematic. Plan view shows pier cap with fenders removed and an access platform installed. Elevation view shows installed platform supporting equipment used during dismantling and an excavator removing concrete to final mechanical dismantling elevation limit.

<u>Drill Boreholes, Install BAS, and Dismantle Remaining Portion of Pier E3 by Controlled Implosion</u>

Once the pier has been dismantled to the mechanical dismantling elevation, access platforms will be installed to support the drilling equipment while exposing the top of the interior cells and outside walls (Figure 13). Borehole drill locations will be marked on the inner cell walls and exterior walls of the pier. An overhanging template system will be installed to guide the drill below the waterline. Divers will be required to cut notches to guide the drilling of underwater boreholes. A concrete drill rig will be used to drill holes into the interior and exterior cell walls consistent with the Blast Plan (Appendix A).

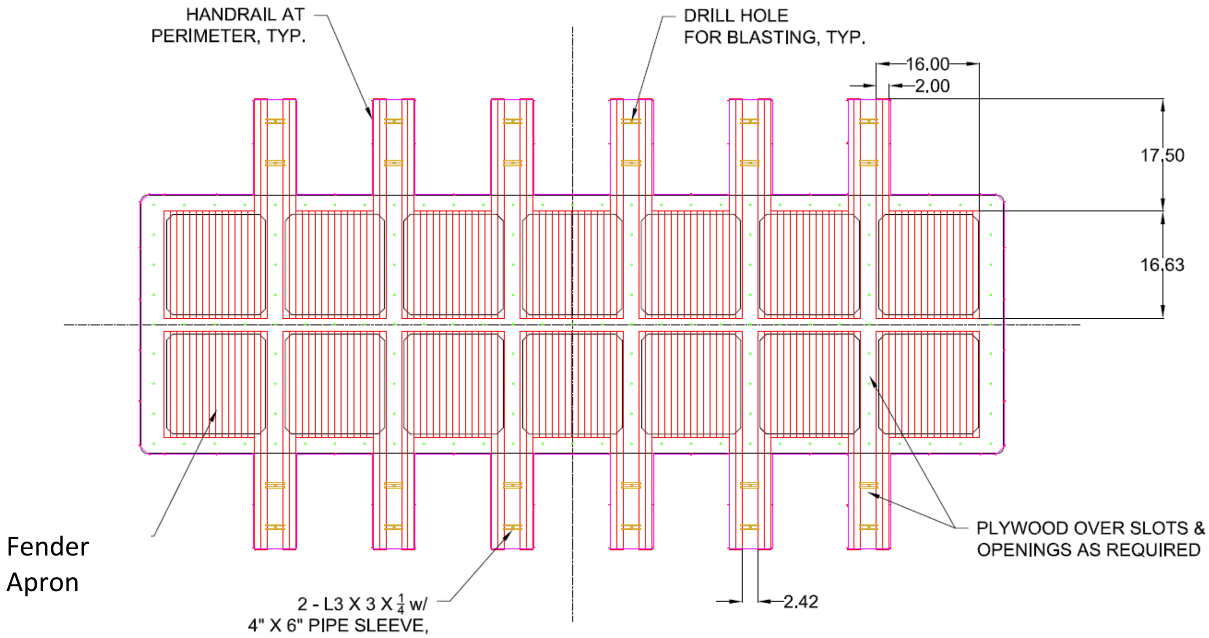

Figure 13. Pier E3 drilling template schematic. Plan view shows installed platforms over all inner cells to support drilling equipment and installed overhang template system to facilitate drilling activities below the waterline.

<u>Blast Attenuation System Installation and Deployment</u>

The BAS will be installed during drilling operations. The BAS to be used at Pier E3 is a modular system of pipe manifold frames that will be fed by 14-1600-cfm air compressors to create a curtain of air bubbles around the entire pier during the controlled implosion. Proposed BAS design details and specifications can be viewed in an appendix to this document (Appendix B). Each BAS frame will be lowered to the bottom of the Bay by a barge mounted crane and positioned into place (Figure 14). Divers will be used to assist frame placement and to connect air hoses to the frames. Based on location around the pier, the BAS frame elements will be situated from approximately 25 feet (7.6 meters) to 40 feet (12 meters) from the outside edge of Pier E3. The frames will be situated to contiguously surround the pier; frame ends will overlap to ensure no break in the BAS when operational. Each frame will be weighted to negative buoyancy for activation. Compressors will provide enough pressure to achieve a minimal air volume fraction of 3-4%, consistent with the successful use of BAS systems in past controlled blasting activities. System performance is anticipated to provide approximately 80% attenuation, or better, based on past experience with similar systems during controlled blasting. Previous implosions using similar BAS systems in Ontario, Canada showed 85%-95% attenuation, in Vancouver, Canada showed 84%-88% attenuation, and in Manitoba, Canada showed 90-98% attenuation (Kiewit-Mason, pers. Comm 2015). However, because each implosion is unique, the Department has elected to be conservative in estimating BAS performance during the Demonstration Project for analyzing potential effects to marine mammals.

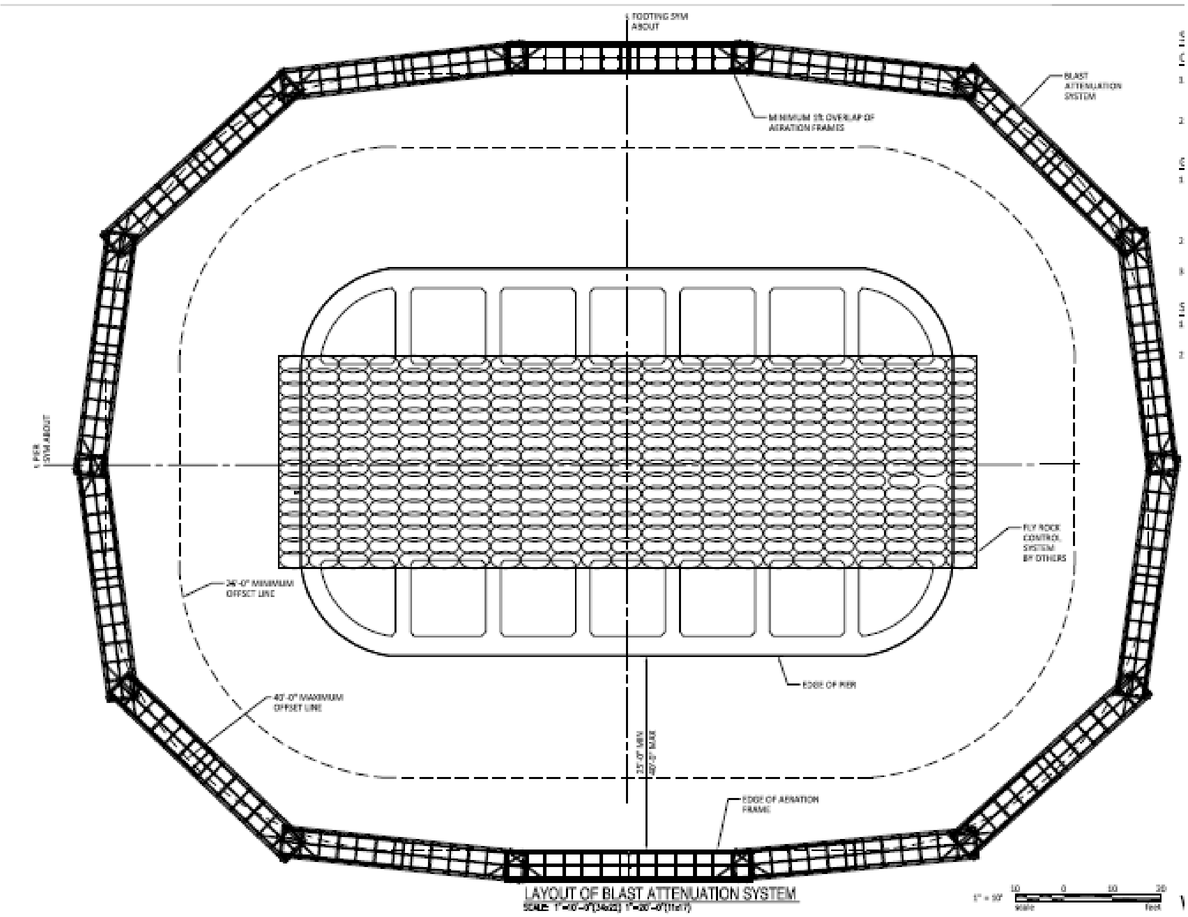

Figure 14. Figure shows BAS Layout on the bottom of the Bay.

Each BAS frame will be fed by an individual compressor mounted on a barge. This will require 14 compressors on approximately 14 flexi-float barges situated around the pier (Figure 15). Each barge will be temporarily anchored to maintain their position around the pier. Compressors will be turned on and each section of the BAS will be tested for uniform air flow prior to the controlled implosion. Once the controlled implosion event has been completed, the contractor will demobilize the BAS and all associated equipment.

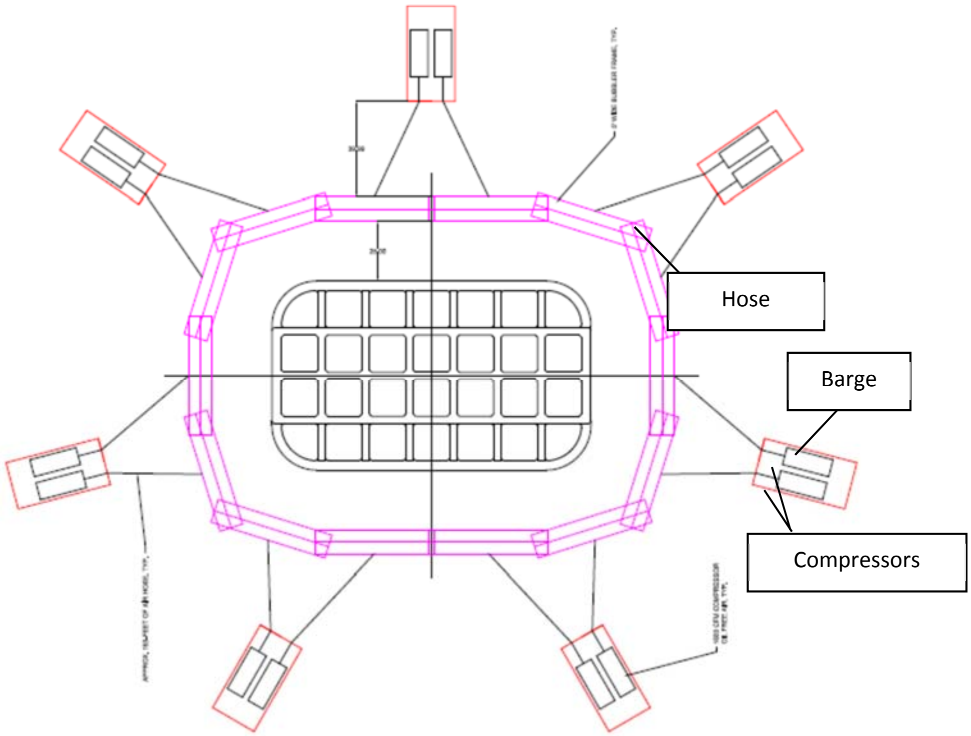

Figure 15. Schematic showing air compressors on barges with hose connections to each BAS frame. Please note this layout does not show all 14 barges that would be used to support the compressors.

Pre-implosion Test Charge

Acoustically capturing the implosion is critical for the determination of whether or not this technique can be used for future piers. A key factor in accurately capturing hydroacoustic information is to ensure triggering of the data acquisition/recording instrument used for high speed recording during near-field and far-field monitoring of the implosion. To this end, the pressure-time signature of a blast cannot be duplicated except with another blast. As such, release of a small test charge before the actual implosion is required to validate that all equipment is functional and to set the triggering parameters accurately for the implosion.

Release of the test charge will occur at least three to four days prior to the actual implosion and after the BAS is in place and functional. The BAS will be in operation during the test. The test will use a charge weight of 18 grain (0.0025 lbs) or less. The charge will be placed along one of the longer faces of the Pier and inside the BAS while it is operating. The charge will be positioned near the center of the wider face of the pier to shield the areas on the opposite side as much as possible from sound. The charge will be placed approximately halfway between the face of the pier and the BAS. Note, the BAS may be located anywhere from 25 to 45ft from the face of the Pier. Monitoring inside the BAS will be done at a distance of 20 to 30 feet from the blast. Outside the BAS, monitoring will occur at a distance of 100 feet from the charge. Acoustic measurements during the test blast will be made with the same transducers and instrumentation to be used for the near and far field monitoring of the actual implosion. Measurements inside the BAS will be made with near and far field systems using PCB 138A01 transducers. At the 100 foot distance, the near field system will use another PCB 138A01 transducer while the far field system will use both a PCB 138A01 transducer and a Reson TC4013 hydrophone. Prior to activating the BAS, ambient noise levels will be measured. While the BAS is operating and before the test, background noise measurements will also be made. After the test, the results will be evaluated to determine if any final adjustments are needed in the measurement systems prior to the implosion. Pressure signals will be analyzed for peak pressure and SEL values prior to the scheduled time of the implosion.

Controlled Implosion Dismantling of Remaining Pier

The controlled implosion event is scheduled to take place in November of 2015. Prior to the event, the bore holes in Pier E3 will be loaded with charges, as described in the Blast Plan (Appendix A). Individual cartridge charges, versus pump-able liquid blasting agents, have been chosen to provide greater accuracy in estimating the individual and total charge weights. Charges will be transported by boat to Pier E3. Security will be required for transporting, handling and processing of the charges.

Boreholes vary in diameter and depth and have been optimized for charge efficiency. Individual and total charge weight loads are provided in the Blast Plan. Charges are arranged in different levels (decks) separated in the boreholes by stemming. Stemming is the insertion of inert materials, like sand or gravel, to insulate and retain charges in an enclosed space. Stemming allows for more efficient transfer of energy into the structural concrete for fracture, and further reduces the release of potential energy into the adjacent water column. The total number of charges and delays, and total shot time are provided in the Blast Plan.

Public Safety measures will be implemented during the controlled implosion event. Safety zones will be established and enforced in conjunction with the United States Coast Guard (USCG) to exclude commercial and recreational marine vessels. Safety procedures will include a rolling traffic stop in both directions on the new east span of the SFOBB in advance of implosion. After the BAS is determined to have established an air curtain surrounding the pier, the controlled implosion sequence will be initiated. The Department will have a Traffic Management Plan in place during the controlled implosion event.

Debris Removal and Site Restoration

Following the controlled implosion event and confirmation that the area is safe to work in, construction crews will begin to remove all associated equipment including barges, compressors, BAS and blast mats.

Rubble resulting from the controlled implosion dismantling will consist of concrete and rebar. Most rubble is expected to fall within the caisson cells below mudline. A minimal amount of rubble is expected to either mound on top of the caisson, or fall onto the bay floor next to the caisson. Rubble that does not fall into caisson cells will need to be managed. Management of extraneous rubble will be done by a barge-mounted crane with a clamming bucket. Rubble bridging over the open cells of the caisson, or on the bay floor will be removed and placed on support barges where rebar and concrete will be sorted. Processed concrete debris will then be lowered over the caisson voids and released to sink into the open voids. Buckets used during this debris management phase will be equipped with a GPS unit to accurately guide the location of the bucket in the water. The clamming, sorting, and in-water operation is estimated to take several weeks.

2. The Date(s) and Duration of Such Activity and the Specific Geographical Region Where It Will Occur.

The authorization will be in effect from October 1, 2015 to September 30, 2016. All permitted activities will occur within the Bay in the area around the east span of the SFOBB between YBI and Oakland (Figure 16). Permitted activities may occur at any time of the year depending on the Department and contractor schedules, and Biological Opinion regulations for endangered/threatened fish species. The demolition of Pier E3 through controlled implosion is currently planned to occur during November 2015.

Figure 16. Map of the East Spans of the new and original San Francisco-Oakland Bay Bridge and surrounding area. Included are the locations of the harbor seal haul-out site on Yerba Buena Island and Pier E3 for proposed implosion.

3. The Species and Numbers of Marine Mammals Likely To Be Found Within the Activity Area.

Six species of marine mammals regularly inhabit or seasonally enter San Francisco Bay (Table 1). The two most common species observed are the Pacific Harbor seal (*Phoca vitulina richardii*) and the California sea lion (*Zalophus californianus*). Northern elephant seals (*Mirounga angustirostris*) seasonally enter the Bay (spring and fall) while harbor porpoises (*Phocoena phocoena*) may enter the western side of the Bay throughout the year but rarely occur near the east span of the SFOBB. Gray whales (*Eschrichtius robustus*) may enter the Bay during the northward migration in the spring and bottlenose dolphins (*Tursiops truncatus*) may enter the western side of the Bay and are unlikely to occur near the original SFOBB during November. None of these species are listed as Endangered or Threatened under the Endangered Species Act (ESA), or as depleted or a strategic stock under the Marine Mammal Protection Act (MMPA). In addition to the six common or regularly occurring species, eight species of marine mammals are considered extralimital (rare sightings or strandings) and are unlikely to occur within the Bay (Table 1).

Information on the seasonal occurrence and estimated densities of harbor seals, sea lions, and harbor porpoises in the area of the east span of the SFOBB were estimated from marine mammal monitoring conducted from 2000-2014 during pile driving for permanent and temporary piles, demolition of temporary tower foundations, and during blasting on YBI for Towers W2E and W2W. During 210 days of monitoring (including 15 days of baseline monitoring in 2003), 657 harbor seals, 69 California sea lions, and three harbor porpoises were observed within the area of the east span of the SFOBB (Department 2001, 2004, 2009, 2013b, 2013c, and 2014). During this time, only two individuals have shown responses to pile driving noise. In 2000, a sea lion was swimming slowly at the surface approximately 3,281 feet (1,000 meters) west of a pile driving site. This individual then rapidly swam north at the start of pile driving (Thorson and Wagner 2001). In 2004, a harbor seal swam toward the pile driving barge during pile driving for the eastbound Skyway and at approximately 180 feet (55 meters) from the piles abruptly turned around and dove (Department 2004). Otherwise, most seals or sea lions were observed at least 328 feet (100 meters) beyond pile driving. If an animal transited through the area, it would typically look toward the piles but not change swimming speed or direction (Thorson and Wagner 2001; Department 2004).

During past monitoring, the number of harbor seals observed increased as construction or demolition activities moved closer to YBI. The Coast Guard Cove and Clipper Cove (between YBI and Treasure Island), and a small trench area 984 feet (300 meters) southeast of YBI, are frequently used by harbor seals to forage. YBI also is the site of one of the main harbor seal haul-outs within the San Francisco Bay (Department 2004).

Table 1. Summary of the marine mammal species or the specific stock found within the San Francisco Bay area, status under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA), current population, estimate and population trend (information is from NMFS Stock Assessment Reports; Carretta et al. 2014 and Allen and Angliss 2014).

Species	Stock	Status (ESA and MMPA)	Population	Population Trend
Species With Regular or Seasonally Occurrence In the San Francisco Bay				
Phocids				
Pacific Harbor Seal *Phoca vitulina richardii*	California	Not Listed	30,196 (CV=0.157)	Decreasing
Northern Elephant Seal *Mirounga angustirostris*	California Breeding	Not Listed	124,000-179,000	Increasing
Otariids				
California Sea Lion *Zalophus californianus*	United States	Not Listed	296,750	Increasing
Odontocetes				
Harbor Porpoise *Phocoena phocoena*	San Francisco-Russian River	Not Listed	9,886 (CV=0.51)	Stable
Species That Are Extralimital To San Francisco Bay				
Sea Otter *Enhydra lutris*	Southern (California population)	Threatened (ESA) Strategic (MMPA) Depleted (MMPA)	2,826	Stable
Northern Fur Seal *Callorhinus ursinus*	California	Not Listed	12,844	Increasing
Steller Sea Lion *Eumetopias jubatus*	Eastern (California Haul-out Sites)	Threatened (ESA) Strategic (MMPA) Depleted (MMPA)	2,781	Increasing (Stable in California)
Common Bottlenose Dolphin *Tursiops truncatus*	California Coastal	Not Listed	323 (CV=0.13)	Stable
Short-Beaked Common Dolphin *Delphinus delphis delphis*	California/Oregon/ Washington	Not Listed	411,211 (CV= 0.21)	Increasing
Fin Whale *Balaenoptera physalus physalus*	California/Oregon/ Washington	Endangered (ESA) Strategic (MMPA) Depleted (MMPA)	3,051 (CV=0.18)	Stable

Species	Stock	Status (ESA and MMPA)	Population	Population Trend
Gray Whale *Eschrichtius robustus*	Eastern North Pacific	Not Listed	19,126 (CV=0.71)	Increasing
Humpback Whale *Megaptera novaeangliae*	California/Oregon/ Washington	Endangered (ESA) Strategic (MMPA) Depleted (MMPA)	1,918 (CV=0.03)	Increasing
Minke Whale *Balaenoptera acutorostrata scammoni*	California/Oregon/ Washington	Not Listed	478 (CV=1.36)	Unknown
Sperm Whale *Physeter macrocephalus*	California/Oregon/ Washington	Endangered (ESA) Strategic (MMPA) Depleted (MMPA)	971 (CV=0.31)	Unknown

CV=Coefficients of Variation

4. A 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.

There are six species that are likely to be affected by the Project. The following discussion outlines their distribution and current population status. A summary of the information in this section is presented in Table 2.

4.1 Pacific Harbor Seal (California Stock)

Status: The harbor seal is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The California stock of harbor seals has been increasing since 1972, but at a slower rate since 1990, with a maximum count in 2004 (Lowry and Carretta 2003; Lowry et al. 2008; Carretta et al. 2012). The population size for the California stock is estimated at 30,196 seals (Lowry et al. 2008; Caretta et al. 2012).

Distribution: Harbor seals are found from Baja California to the eastern Aleutian Islands of Alaska. They primarily haul out on remote mainland and island beaches and reefs, and estuary areas. Harbor seals tend to forage locally within 53 miles (85 kilometers) of haul-out sites (Harvey and Goley 2011). Harbor seals are the most common marine mammal species observed in the Bay and also commonly seen near the east span of the SFOBB (Department 2013b, 2013c). Tagging studies have shown that most seals tagged within the Bay remain in the Bay (Harvey and Goley 2011; Manugian 2013). Foraging often occurs within the Bay as noted by observations of seals completing foraging behavior (short dives less than five minutes, moving back and forth within an area, and sometimes tearing up prey at the surface).

The molt occurs from May through June. During both the pupping and molt seasons, the number of seals and the length of time hauled out per day increases with about 60.5% of the population hauled out during this time versus less than 20% in the fall (Yochem et al. 1987; Huber et al. 2001; Harvey and Goley 2011). Mother-pup pairs spend more time on shore; therefore, the percentage of seals on shore at haul-out sites increases during the pupping season (Stewart and Yochem 1994). Peak numbers of harbor seals hauling out in Central California occurs during late May to early June, which coincides with the peak of their molt. Seals haul out more often and spend more time on shore to molt. Yochem et al. (1987) found that harbor seals at San Miguel Island only hauled out 11-19% of the time in the autumn from late October through early December.

Harbor seals tend to forage at night and haul out during the day. Harbor seals predominately haul out from 10:00 through 19:00, with a peak in the afternoon between 13:00 and 16:00 (Yochem et al. 1987; Stewart and Yochem 1994, Grigg et al. 2002; London et al. 2012). Harbor seals in the Bay typically haul out in groups ranging from a few individuals to several hundred seals. One known haul-out site is on the south side of YBI, approximately 4,593 feet (1,400 meters) from Pier E3. The YBI haul-out site had a range of 0-109 harbor seals hauled out during November with the highest numbers hauled out during afternoon low tides (Department 2004). Pile driving for the SFOBB was not audible to the monitors just above the haul-out site and not response to pile driving was observed.

Tide level can also affect haul-out behavior by exposing and submerging preferred haul out sites. Tides likely affect the maximum number of seals hauled out, but time of day and the season have the greatest influence on haul-out behavior (Stewart and Yochem 1994; Patterson and Acevedo-Gutiérrez 2008).

SFOBB Area: During 210 days of SFOBB monitoring, 657 harbor seals were observed within the area of the east span of the SFOBB. Harbor seals comprised 90% of the marine mammals observed during monitoring for the SFOBB Project. Foraging near the SFOBB is common, particularly within the coves adjacent to the YBI U.S. Coast Guard Station and in Clipper Cove between YBI and Treasure Islands. Foraging also occurs within a shallow trench area southeast of YBI (Department 2013a, 2013b). These sites are approximately 2,297 to 4,593 feet (700 to 1,400 meters) west of Pier E3.

Reproduction and Breeding: Pupping begins in late March in central California and pups start weaning in May. All pups are weaned by mid-June. Breeding occurs between late March and early May.

Diving and Foraging: Harbor seals are generally shallow divers with about 90% of dives lasting less than seven minutes (Gjertz et al. 1991; Eguchi and Harvey 2005) with a maximum recorded dive time of 32 minutes (Eguchi and Harvey 2005).

Acoustics: Adult males produce low-frequency vocalizations underwater during the breeding season (Hanggi and Schusterman 1994; Van Parijs et al. 2003). Male harbor seals produce sounds in the frequency range of 100 to 1,000 Hz (Richardson et al. 1995). Generally, harbor seals do not vocalize while traveling or feeding; therefore, attempts to acoustically detect them prior to underwater implosions would not be useful. Harbor seals hear at frequencies from 1 to 180 kilohertz (kHz) (Møhl 1968); however, the species' hearing is most acute below 60 kHz, with peak hearing sensitivity at 32 kHz in water and 12 kHz in air (Terhune 1968; Terhune and Turnball 1995; Kastak and Schusterman 1998; Wolski et al. 2003).

4.2 California Sea Lion (United States Stock)

Status: The California sea lion is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2012), or listed as endangered or threatened under the ESA. The United States stock has been increasing since 1975 through 2008, with an estimated population of 296,750 sea lions (Carretta et al. 2012).

Distribution: California sea lions breed on the offshore islands of California from May through July (Heath and Perrin 2008). During the non-breeding season, adult and sub-adult males, and juveniles migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island (Jefferson et al. 1993). They return south the following spring (Lowry and Forney 2005; Heath and Perrin 2008). Females and some juveniles tend to remain closer to rookeries (Antonelis et al. 1990; Melin et al. 2008).

California sea lions have been observed occupying docks near Pier 39 in San Francisco, about 3.2 miles (5.2 kilometers) from Pier E3, since 1987. A reported high of 1,105 sea lions at Pier 39 occurred in 2001 (Marine Mammal Center 2002). Occurrence of sea lions here typically is lowest in June (breeding season) and the highest in August. Approximately 85 percent of the animals that haul out at this site are males and no pupping has been observed here or at any other site in the Bay (Lander pers. com. 1999). Pier 39 is the only regularly used haul-out site around the SFOBB but sea lions do occasionally haul out on man-made structures such as bridge piers, jetties, or navigation buoys (Riedman 1990).

SFOBB Area: During monitoring for the SFOBB Project, 69 California sea lions were observed from 2000-2014. Sea lions appear to be transiting through the SFOBB area rather than feeding with the exception of a single observation. In 2004, several sea lions were observed following a school of Pacific herring that moved through the SFOBB construction area.

Reproduction and Breeding: Breeding and pupping occur from mid-to-late May until late July. After the mating season, adult males migrate northward to feeding areas as far away as the Gulf of Alaska (Lowry et al. 1992) and remain away until spring (March–May), when they migrate back to the breeding colonies. Adult females remain near the rookeries throughout the year and alternate between foraging and nursing their pups on shore until the next pupping/breeding season.

Diving and Foraging: Over one-third of the foraging dives by lactating females are 1–2 minutes in duration and 75% of dives are < 3 minutes, with the longest recorded dive of 9.9 minutes (Feldkamp et al. 1989). More recent studies of adult lactating females have reported a range of mean dive durations of 1.6 to 8.1 minutes (Melin et al. 2008). Most sea lions in the Bay are juveniles or sub-adult males, and are similar in size to adult lactating female sea lions; therefore, these dive data should approximate the diving abilities of Bay sea lions.

Acoustics: California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks (Schusterman et al. 1966; Schusterman 1969). All underwater sounds have most of their energy below 4 kHz (Schusterman et al. 1967). The range of maximal sensitivity underwater for sea lions is between 1 and 28 kHz (Schusterman et al. 1972). Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz (Schusterman et al. 1972). The California sea lion shows relatively poor hearing at frequencies below 1,000 Hz (Kastak and Schusterman 1998). The best range of sound detection is from 2 to 16 kHz (Schusterman 1974). Kastak and Schusterman (2002) determined that hearing sensitivity generally worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed. Octave band noise levels of 65 to 70 dB above the animal's threshold produced an average TTS of 4.9 dB in the California sea lion (Kastak et al. 1999). Center frequencies were 1,000 Hz for corresponding threshold testing at 1,000 Hz and 2,000 Hz for threshold testing at 2,000 Hz; the duration of exposure was 20 minutes.

4.3 Northern Elephant Seal (California Breeding Stock)

Status: The northern elephant seal is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The population size for the California breeding stock is estimated at 124,000 to 179,000 seals and is increasing (Lowry et al. 2010; Carretta et al. 2012).

Distribution: Northern elephant seals are common on California coastal mainland and island sites where they pup, breed, rest and molt. The largest rookeries are on San Nicolas and San Miguel islands in the Northern Channel Islands. Near the Bay, elephant seals breed, molt, and haul out at Año Nuevo Island, the Farallon Islands, and Point Reyes National Seashore.

Northern elephant seals haul out to give birth and breed from December through March. Pups remain onshore or in adjacent shallow water through May. Both sexes make two foraging migrations each year: one after breeding and the second after molting (Stewart 1989; Stewart and DeLong 1995). Pup mortality is high when they make the first trip to sea in May and this period correlates with the time of most strandings. Pups of the year return in the late summer and fall to haul out at rookery sites but may occasionally make brief stops in the Bay.

SFOBB Area: Generally, only juvenile elephant seals enter the Bay and do not remain long. The most recent sighting was in 2012 on the beach at Clipper Cove on Treasure Island when a healthy yearling elephant seal hauled out for approximately one day. Approximately 100 juvenile northern elephant seals strand within the Bay each year, including individual strandings at YBI and Treasure Island (less than 10 strandings per year).

Diving and Foraging: Elephant seals have the highest diving capacity of any pinniped. Elephant seal juveniles regularly dive for 10-15 minutes with a maximum reported time of 45.5 minutes (Thorson and Le Boeuf 1994; Le Boeuf et al. 1996).

Acoustics: The audiogram of the northern elephant seal indicates that the best sensitivity is between 3.2 and 45 kHz, with greatest sensitivity at 6.4 kHz and an upper frequency cutoff of approximately 55 kHz (Kastak and Schusterman 1998).

4.5 Harbor Porpoise (San Francisco-Russian River Stock)

Status: The harbor porpoise is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The population size for the San Francisco-Russian River stock is estimated at 9,189 porpoises (CV= 0.38) and is increasing (Carretta et al. 2012).

Distribution: This species is seldom found in waters warmer than 17°C (Read 1990) or south of Point Conception and occurs as far north as the Bering Sea (Barlow and Hanan 1995; Carretta et al. 2009; Carretta et al. 2012; Allen and Angliss 2013). The San Francisco-Russian River stock is found from Pescadero (30 km south of San Francisco Bay) north to Point Arena (99 miles [160 kilometers] north of San Francisco Bay; Carretta et al. 2012). In most areas, harbor porpoises occur in small groups consisting of just a few individuals.

SFOBB Area: Harbor porpoises are frequently seen outside of the Bay and began to re-enter the Bay in 2008. Keener et al. (2012) reports sightings of harbor porpoises from just inside the Bay northeast to Tiburon and south to the west span of the SFOBB. Harbor porpoises have only been observed on three occasions (all single animals) swimming near the east span of the SFOBB. Those observations were made during spring and summer and occurred near YBI (May to August; Department 2013c, 2014). The rare occurrence of harbor porpoises near the east span of the SFOBB makes it unlikely they will be exposed to implosion activities.

Diving and foraging: Tagged harbor porpoise individuals spend 3 to 7 percent of their time at the surface and 33 to 60 percent within 6.5 feet (two meters) of the surface (swimming behavior). Average dive depths range from 46 to 135 feet (14 to 41 meters), with a maximum known dive of 741 feet (226 meters), and average dive durations ranging from 44 to 103 seconds (Westgate et al. 1995). Harbor porpoises spend about 23% of their time at or near the surface; therefore, they are relatively easier to sight then other cetacean species (Laake et al. 1997).

Reproduction and Breeding: Calves are born in late spring (Read 1990; Read and Hohn 1995). Harbor porpoises make brief dives, generally lasting less than five minutes.

Acoustics: Harbor porpoise vocalizations include clicks and pulses (Ketten 1998), as well as whistle-like signals and echolocation clicks (Verboom and Kastelein 1995). The dominant frequency range is 110 to 150 kHz (Ketten 1998) and a behavioral audiogram indicated the range of best sensitivity is 8 to 32 kHz at levels between 45 and 50 decibels re 1 micropascal-meter (dB re 1 µPa-m) (Andersen 1970) and 16 to 140 kHz (Kastelein et al. 2002). The Temporary Threshold Shift (TTS) criteria was estimated at approximately 163 dB sound exposure level (SEL) from a 4 kHz airgun blast (Lucke et al. 2009).

EXTRALIMITAL OR RARE SPECIES

Extralimital species currently do not regularly enter the Bay, but may occur sporadically in the Bay or strand in the Bay, and some species may only occur seasonally. These species are mentioned because they infrequently enter the Bay and, while very unlikely, could be near Pier E3 during implosion activities.

Common Bottlenose Dolphin (California coastal stock)

Status: The common bottlenose dolphin is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The population size for the California coastal stock is estimated at 323 dolphins and is stable (CV = 0.13; Carretta et al. 2012). SFOBB Area: Bottlenose dolphins have only recently begun to enter the Bay. Movements primarily have been just east of the Golden Gate Bridge and along the west coastline of the Bay, south to Redwood City (J. Stern, Pers. Comm. Golden Gate Cetacean Research). Bottlenose dolphins have not been observed in the vicinity of the SFOBB Project. However, bottlenose dolphins are known to frequent bay and estuary areas. As their population becomes more established in Northern California, they may venture into other areas of the Bay.

Southern Sea Otter (California Population)

The southern sea otter (*Enhydra lutris*) is protected under the MMPA and is listed as threatened under the ESA (Carretta et al. 2012). The estimated population size is 2,500 sea otters (Carretta et al. 2012). Sea otters are common in the near-shore waters from Point Conception to Half Moon Bay but juvenile sea otters occasionally wander well beyond the observed range limits. Sea otters are not a regular visitor to the Bay, but several animals have been observed in the Bay in the last decade (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Northern Fur Seal (California Stock)

The northern fur seal (*Callorhinus ursinus*) is protected under the MMPA and is not listed as a depleted or strategic stock under the MMPA (Carretta et al. 2012). Northern fur seals are not listed as threatened or endangered under the ESA. The estimated Eastern Pacific stock is 611,617 fur seals (Allen and Angliss 2013) and 12,844 fur seals for the California Stock of San Miguel and Farallon Islands (Carretta et al. 2014). It is likely that only sick or injured northern fur seals would enter the Bay. Northern fur seals are not a regular visitor but several animals have stranded in the Bay since the 1980s (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Gray Whale (Eastern North Pacific)

The gray whale is protected under the MMPA, but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the ESA. The population size for the eastern north Pacific stock is estimated at 19,126 (CV=0.71; Laake et al. 2009) and is increasing (Punt and Wade 2010). Reports from the Marine Mammal Center (MMC) indicate that, since 1999, gray whale sightings in the Bay have become more common with at least two to six whales entering the Bay annually. Most gray whale sightings have occurred during the spring migration north. Although none have been sighting near the east span of the SFOBB, there have been reports of whales at the north end of Treasure Island during March and one sighting about 1,000 yards (0.6 mile) south of YBI (P. Thorson, GANDA, February 2014).

Humpback Whale (California/Oregon/Washington Stock)

The humpback whale (*Megaptera novaeangliae*) is protected under the MMPA and is listed as a depleted and strategic stock under the MMPA (Carretta et al. 2012). Humpback whales are listed as endangered under the ESA. The current best estimate for the California, Oregon, and Washington stock is 1,918 whales (Carretta et al. 2014). There are several reports of humpback whales entering the Bay and heading up the Delta waterway. The most recent occurrence was in 2007 when an injured mother and calf entered the Bay for seven days (Gulland et al. 2008).

Minke Whale (California/Oregon/Washington Stock)

The minke whale (*Balaenoptera acutorostrata scammoni*) is protected under the MMPA and is not listed as a depleted or strategic stock under the MMPA (Carretta et al. 2012). Minke whales are not listed as threatened or endangered under the ESA. The current best estimate for the California, Oregon, and Washington stock is 478 whales (Carretta et al. 2012). Minke whales are not a regular visitor to the Bay but have been observed several times since the 1980s (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Sperm Whale (California/Oregon/Washington Stock)

The sperm whale (*Physeter macrocephalus*) is protected under the MMPA and is listed as a depleted and strategic stock under the MMPA (Carretta et al. 2012). Sperm whales are listed as endangered under the ESA. The current best estimate for the California, Oregon, and Washington stock is 971 whales (Carretta et al. 2012). Sperm whales are not a regular visitor to the Bay but have been observed once since the 1980s (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Fin Whale (California/Oregon/Washington Stock)

The fin whale (*Balaenoptera physalus physalus*) is protected under the MMPA and is listed as a depleted and strategic stock under the MMPA (Carretta et al. 2012). Fin whales are listed as endangered under the ESA. The current best estimate for the California, Oregon, and Washington stock is 3,051 whales (Carretta et al. 2014). Fin whales are not a regular visitor to the Bay but have been observed once since the 1980s (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Steller Sea Lion (Eastern Stock, California Population)

The Steller sea lion (*Eumetopias jubatus*) is protected under the MMPA and is not listed as a depleted and strategic stock under the MMPA (Allen and Angliss 2014). The eastern stock of Steller sea lions are no longer listed as threatened under the ESA (NOAA 2013). The current best estimate for the Eastern stock is 63,160 to 78,198 sea lions, with most of the population in Southeast Alaska and British Columbia (Allen and Angliss 2014). From 1982 to 2009, the population of Steller sea lions using central California (Año Nuevo and the Farallon Islands) has been relatively stable or slowly decreasing to approximately 2,781 in 2011 (Allen and Angliss 2013). Steller sea lions are not a regular visitor to the Bay but several animals have stranded in the Bay since the 1980s (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Short-Beaked Common Dolphin (California/Oregon/Washington Stock)

The short-beaked common dolphin (*Delphinus delphis delphis*) is protected under the MMPA and is not listed as a depleted or strategic stock under the MMPA (Carretta et al. 2012). Common dolphins are not listed as threatened or endangered under the ESA. The short-beaked common dolphin is the most abundant cetacean in California waters, although they tend to be found further offshore. The current best estimate for the California, Oregon, and Washington stock is 411,211 dolphins (CV =0.21; Carretta et al. 2012). There is only one report of a short-beaked common dolphin stranding in the Bay since the 1980s (Geno De Rango, Pers. Comm., Marine Mammal Center, 2013).

Table 2. Summary of the seasonal occurrence and distribution, pupping/calving seasons, pinniped haul-out sites, dive duration, hearing range, and efficacy of real time acoustic monitoring of marine mammals with potential to occur near Pier E3

Species	Population in SF Bay	Distribution in SF Bay	Seasons Present In SF Bay	Pupping/ Calving Season	Dive Duration	Audiogram (Maximum Sensitivity)	Real Time Acoustic Monitoring	Group Or Pod Size	Haul-Out Sites (Distance to East Span)
Pacific Harbor Seal	Up to 2,000	Throughout Bay	All Seasons	March-June (In SF Bay)	3 to 10 minutes (max of 30 min)	1-60 kHz (32 kHz)	No	1	YBI (4,593 feet; 1,400 meters)
California Sea Lion	Up to 2,000	Throughout Bay	Summer to Winter	May-July (not SF Bay)	3-7 minutes (max of 10 min)	1-40 kHz (2-16 kHz)	No	1	Pier 39 (3.2 miles; 5.2 kilometers)
Northern Elephant Seal	Up to 100 (stranded juveniles)	Throughout Bay	Spring to Fall	December-March	10-15 minutes (max of 45 min)	3.2-55 kHz (3.2-45 kHz)	No	1	Mostly stranded, some haul out on YBI and TI
Harbor Porpoise	Up to 200	Western and Northern Bay	All Seasons	Spring (Not SF Bay)	Short Dives up to 5 minutes	8–140 kHz (16-140 kHz)	Yes	Up to 6	N/A

5. The 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.

The Department requests an Incidental Take Authorization (IHA) pursuant to Section 101 (a)(5)(A) of the MMPA for the harassment of marine mammals incidental to demolition activities for the original east span of the SFOBB. Marine mammals within the Bay may be incidentally taken by Level B Harassment during demolition using controlled charges (impulse sound) related to the demolition of the original east span of the SFOBB. The number of each marine mammal species exposed to implosion of Pier E3 were calculated based on acoustic propagation models for each activity and the estimated density of each species in the exposed areas.

Estimation of Distances to Marine Mammal Criteria:

Blast Confinement:

Department engineers and consultants have determined that the blast model for the proposed Pier E3 implosion should incorporate a degree of confinement, rather than being modeled as an open-water blast. Confinement is a concept in blasting that predicts the amount of blast energy that is expected to be absorbed by the surrounding structural material, resulting in the fracturing necessary for demolition. The energy beyond that absorbed by the material is the energy that produces the pressure wave propagating away from the source. The Department has determined that modeling with confinement was appropriate for the proposed Pier E3 blast by evaluating blast results from case study data for underwater implosions similar to the proposed SFOBB Pier E3 implosion. In addition, the Department compared case study results to published blast models that incorporate a degree of confinement.

Data from 39 underwater concrete blasts (Figure 17) were provided to the Department to evaluate potential equations for modeling blast-induced peak pressures and subsequent effects to marine mammals (Kiewit-Mason, pers. Comm 2015). All 39 blasts occurred in approximately 55 feet (16.8 meters) of water, similar to the maximum water depth around Pier E3. In addition, all blasts had burdens (i.e., distance from the charge to the outside side of the material being fractured) of approximately 1.5 to 2 feet (0.5 to 0.6 meter). Burdens for Pier E3 also are estimated to be in this range. Data provided included the charge weight, observed peak pressure, distance of peak pressure observation, and the modeled peak pressure using Cole's confined equation, Cole's unconfined equation, and Oriard's conservative concrete equation (Cole 1948; Oriard 2002).

Using these data, from real events, the Department moved forward with using an appropriate equation for modeling the associated hydroacoustic impacts from the Demonstration Project's implosion. Cole's unconfined equation greatly overestimated peak pressures for all blasts while Cole's confined equation appeared to most accurately predict observed peak pressures. Oriard's conservative concrete equation overestimated peak pressures, but not as dramatically as under Cole's unconfined equation. Because the proposed project is a demonstration study and the Department recognizes some uncertainty in predicting the hydroacoustic effects, the Department has used Oriard's equation when modeling potential hydroacoustic impacts to marine mammals. The Department has opted to use more conservative methods to ensure an additional level of safety when predicting the monitoring zone and potential impact areas to marine mammals from the proposed Project.

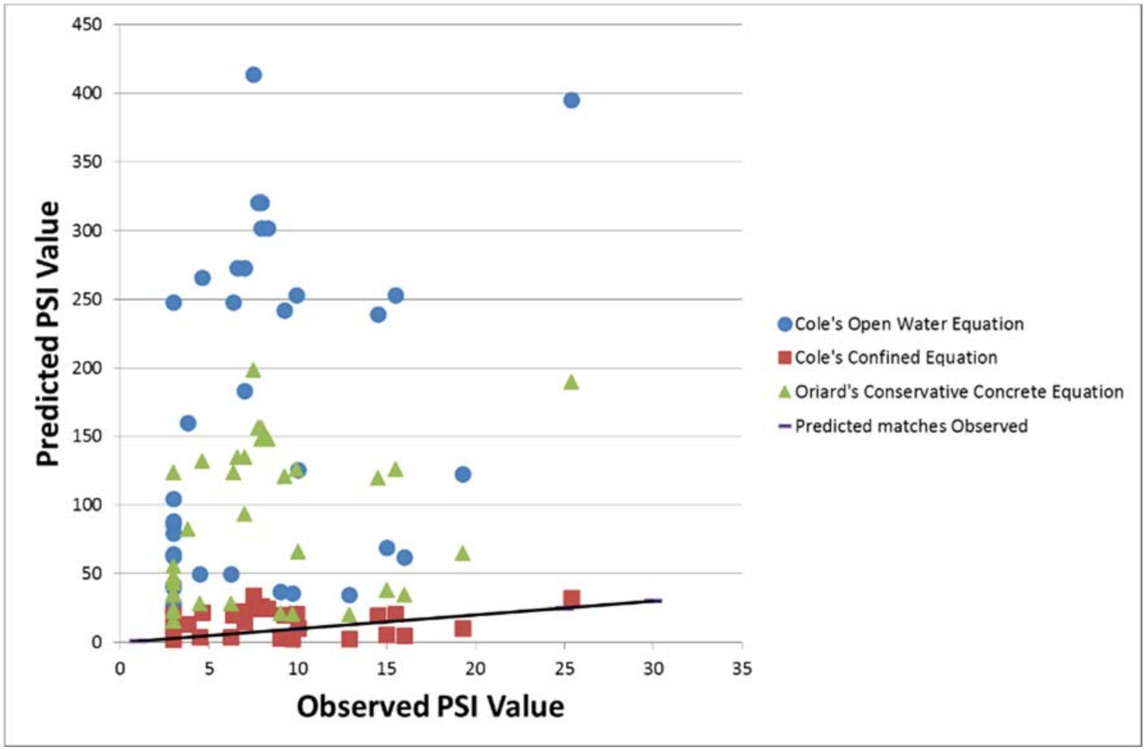

Figure 17. Observed and predicted peak pressure values for 39 underwater concrete blasts under different equations for estimating peak pressure based on data from three implosion projects (Kiewit-Mason, pers. Comm 2015).

Pier E3 Hydroacoustic Modeling

This discussion presents the methods used to estimate underwater noise metrics as a function of distance for proposed implosion of Pier E3 of the original east span of the SFOBB. The applicable metrics discussed are the peak pressure (P_{pk}) expressed in dB, the accumulated SEL also expressed in dB, and the positive acoustic impulse (I) in Pa-sec. The criteria for marine mammals are grouped into behavioral response, slight injury, and mortality, and the specific acoustic thresholds depend on group and species. These are summarized in Figure 18. The metrics for these are criteria defined as:

Peak pressure level

$$L_{pk} = 20\ Log_{10}\left(P_{pk}/P_{ref}\right) \qquad (1)$$

where L_{pk} is the peak level in dB and p_{ref} is the reference pressure of 1µPa;

SEL

$$SEL = 10\ Log_{10}\left(\int_0^T \frac{P^2(t)\,dt}{P_{ref}^2 \cdot T_{ref}}\right) \qquad (2)$$

where T is the duration of the event, $P^2(t)$ is the instantaneous pressure squared and T_{ref} is the reference time of 1 second;

Impulse:

$$I = \int_0^T \left({P(t)dt}\Big/{P_{ref}} \right) \qquad (3)$$

where T is the duration of the initial positive portion of p(t). In order to calculate these quantities, p (t) for the blast event is needed as a function of distance from the blast, or alternatively, empirical relationship can be used for L_{pk} and I. From Figure 18, it should be noted that for the SEL criteria, there are different designations for the SEL for each group/species. These refer to group/species specific filter shapes that are to be applied to the pressure signal. For L_{pk} and I, no filters are specified.

GENERAL ASSUMPTIONS

The blast event will consist of a total of 588 individual delays of varying charge weight; the largest is 35 pounds/delay and the smallest is 21 pounds/delay. The blasting sequence is rather complex. On the full height walls, 30 pound weights will be used for the portion below mud line, 35 pound weights will be used in the lower structure immediately above mud line, 29.6 pounds in the mid-structure, and 21 pounds in the upper structure. Full details on the delay weights and locations can be found in the Blast Plan (Appendix A). Blasts will start in several interior webs of the southern portion of the structure followed by the outer walls of the south side. The blasts in the inner walls will occur just prior to the adjacent outer walls. The interior first, exterior second blast sequence will continue across the structure moving from south to north. The time for the 588 detonations is 5.3 seconds with a minimum delay time of 9 milliseconds (ms) between detonations. As the blasting progresses, locations to east, north, and west of the pier will be shielded from the blasting on the interior of the structure from the still-standing exterior walls of the pier. However, towards the conclusion of the blast, each direction will experience blasts from the outer walls that are not shielded.

To estimate P_{pk} and $P^2(t)$, several assumptions were made. For simplification, it was assumed that there is only one blast distance and it is to the closest point on the pier from the receiver point. In actuality for almost all explosions, distances from the blast will be greater as the pier is approximately 135 feet (41 meters) across and 80 feet (24 meters) wide. Based on these dimensions, the actual blast point could be up to 135 feet (41 meters) further from the receptor point used for the calculation. As a result, the calculated peak level is the maximum expected for one 35 pound blast while the other levels would be lower depending on the distance from the actual blast location to the calculation point and weight of the charge. In other words, the pressure received at the calculation point would not be 588 signals of the same amplitude, but would be from one at the estimated level for a 35 pound charge and 587 of varying lower amplitudes. Similarly, in the vertical direction, the location varies over a height of about 50 feet (15 meters) and those blasts that are not at the same depth as the receiver would also be lower. This effect of variation in assumed blast to receiver distance will be most pronounced close to the pier, while at distances of about 1,000 feet (305 meters) or greater, the effect would be less than 1 dB.

Group	Species	Behavior		Slight Injury			Mortality
		Behavioral (for ≥2 pulses/24 hours)	TTS	PTS	Gastro-Intestinal Tract	Lung	
Low-frequency Cetaceans	Mysticetes	167 dB SEL (LF_{II})	172 dB SEL (LF_{II}) or 224 dB peak SPL	187 dB SEL (LF_{II}) or 230 dB peak SPL	237 dB SPL or 104 psi	39.1 $M^{1/3}$ $(1+[D_{Rm}/10.081])^{1/2}$ Pa-sec Where: M = mass of the animals in kg D_{Rm} = depth of the receiver (animal) in meters	91.4 $M^{1/3}$ $(1+[D_{Rm}/10.081])^{1/2}$ Pa-sec Where: M = mass of the animals in kg D_{Rm} = depth of the receiver (animal) in meters
Mid-frequency Cetaceans	Most delphinids, medium and large toothed whales	167 dB SEL (MF_{II})	172 dB SEL (MF_{II}) or 224 dB peak SPL	187 dB SEL (MF_{II})or 230 dB peak SPL			
High-frequency Cetaceans	Porpoises and *Kogia* spp.	141 dB SEL (HF_{II})	146 dB SEL (HF_{II}) or 195 dB peak SPL	161 dB SEL (HF_{II}) or 201 dB peak SPL			
Phocidae	Hawaiian monk, elephant, and harbor seal	172 dB SEL (P_{WI})	177 dB SEL (P_{WI}) or 212 dB peak SPL	192 dB SEL (P_{WI}) or 218 dB peak SPL			
Otariidae	Sea lions and fur seals	195 dB SEL (O_{WI})	200 dB SEL (O_{WI}) or 212 dB peak SPL	215 dB SEL (O_{WI}) or 218 dB peak SPL			

Figure 18. Noise criteria and thresholds for underwater blasting

In the calculations, it was also assumed that there would be no self-shielding of the pier as the explosions progress. From the above discussion of the blast sequence, some shielding of the blasts along the interior of the pier will occur. However, the blasts that occur in outer wall (towards the end of the implosion) will not be shielded for all blasts. A blast in the outer wall that has a direct line of sight to the receptor calculation point will not be shielded and will generate the highest peak pressure relative to be compared to the L_{pk} criterion. The cumulative SEL and the root-mean-square (RMS) levels; however, will be reduced to some degree by the outer walls until they are demolished as these metrics are defined by the pressure received throughout the entire 5.3 second event. However, due to the complexity of the blast sequence, this shielding effect was not considered in the calculated SEL and RMS levels.

Based on the Blast Plan, the delays are to be placed in 2¾ to 3 inch (7 to 7.6 centimeter) diameter holes drilled into the concrete pier structure. The outer walls of the pier are nominally 3 feet-11½ inch (1.5 meter) thick and inner walls are nominally 3 feet (0.9 meter) thick. Individual blasts should be not exposed to open water and some confinement of the blasts is expected. For confined blasts, the predicted pressures can be reduced by 65 to 95% (Nedwell & Thandavamoorthy 1992; Rickman 2000; Oriard 2002; Rivey 2011), corresponding to multiplication factors from 0.35 to 0.05, respectively. Based on a review of the available literature and recent data from similar explosive projects, the Department has decided to use a conservative confinement factor of K=7500 which equates to a 65% reduction in pressure and by a multiplication factor of 0.3472.

Another assumption was to consider only the direct wave from an individual blast. In shallow water, the signal at the receiver point could consist of the direct wave, surface-relief wave generated by the water/air interface, a reflected wave from the bottom, and a wave transmitted through the bottom material (USACE 1991). For estimating P_{pk}, only the direct wave is considered as it will have the highest magnitude and will arrive at the receiver location before any other wave component. However, P(t) after the arrival of the direct wave peak pressure will be effected. The surface-relief wave is negative so that when it arrives at the receiver location, it will reduce the positive pressure of the direct wave and can make the total pressure negative at times after the arrival of the initial positive peak pressure. Since the SEL is a pressure squared quantity, any negative pressure can also contribute to the SEL. However, the amplitude and arrival time of the surface-relief wave depends on the geometry of the propagation case, that is, depth of water, depth of blast, and distance and depth of the receiver point. The effect of this assumption is discussed further in the section on SEL.

ESTIMATION OF PEAK PRESSURE

Peak pressures were estimated by following the modified version of the Cole Equation for prediction of blasts in open, deep water (Cole 1948). The peak pressure is determined by:

$$P_{pk} = K(\lambda)^{-1.13} \quad (4)$$

where P_{pk} is peak pressure in pounds per square inch (psi), and λ is the scaled range given by $R/W^{1/3}$ in which R is the distance in feet and W is the weight of the explosive charge in pounds. A modified version of the Cole Equation has been documented in U.S. Army Corps of Engineers (USACE) Technical Letter No. 1110-8-11(FR) and is applicable to shallow water cases such as that of the Pier E3 demolition (USACE 1991). The constant *K* factor multiplier in the USACE calculation is 21,600 for an open-water blast instead of the 22,550 from the original Cole Expression. This factor is slightly less (~4%) than the original Cole. The decay factor (-1.13) used in the USACE modified equation remains the same as the original Cole Equation. To account for the confining effect of the concrete pier structure, a conservative *K* factor of 7,500 was used corresponding to multiplying USACE P_{pk} by a factor of 0.3472. With a minimum delay between of blast of 9 ms, the individual delays will be spaced sufficiently far in time to avoid addition of the peak pressures. In this case, the peak pressure is defined by that calculated for the largest charge weight of 35 pounds/delay. A BAS is specified in the Blast Plan. Based on the literature and recent results from similar projects, reductions in the pressure peak of 85% to 90% or more are expected. For determining P_{pk} in this analysis, a conservative reduction of 80% has been used. Based on values of confinement, BAS performance, and the General Assumptions above, the calculated peak pressures are expected to be conservative.

ESTIMATION OF SEL VALUES

Estimating the weighted SEL values for the different groups/species is a multiple step process. The first step is to estimate SEL values as a function of distance from the blast pressure versus time histories for each of the six charge weights as a function of distance. The open-water equation used for this calculation was that modified by the USACE (1991) based on methods pioneered by Cole (1948). Pressure as a function of time is given by:

$$p(t) = P_{pk} e^{-\left(\frac{t-t_a}{\theta}\right)} \qquad (5)$$

where t_a is given as R/5000 and θ is:

$$\theta = 6.0x10^{-5} W^{1/3} (\lambda)^{0.18} \qquad (6)$$

Some of the time histories produced by these equations are shown in Figure 19 for varying distances from the blast. These calculations were then extended to distances out to 160,000 feet (48.8 kilometers).

As discussed previously, there are other wave components that could be considered in the SEL estimation, including the surface relief wave, reflection from the bottom, and transmission through and re-radiation from the bottom. Little or no contribution is expected from the bottom based on its sedimentary nature and previous experiences from measuring noise from underwater pile driving in the area around Pier E3. The negative surface relief wave could be a factor in the SEL estimation. This wave could either increase or decrease the SEL depending on its arrival time relative to the direct wave. For small differences in arrival time, the surface relief will decrease the total SEL as a portion of the positive direct wave is negated by the addition of the negative surface relief wave. This is illustrated in Figure 20 for a blast and receptor depth of 30 feet (9 meters) and a range of 1,000 feet (305 meters). In this case, the surface relief wave essentially balances the direct wave so that the total SEL is within a few tenths of a decibel of the direct wave only. For closer distances and when the receptor and blast locations are near the bottom, the total SEL can become greater than the direct wave SEL, but only by less than 3 dB. However, whenever the source or receiver is near the surface, the direct wave SEL will be greater than the total SEL and can approach being 10 dB greater for distances beyond 1,000 feet (305 meters). As a result, the surface relief wave is ignored in this analysis knowing that the surface relief wave would only tend to produce lower SEL values than the direct wave.

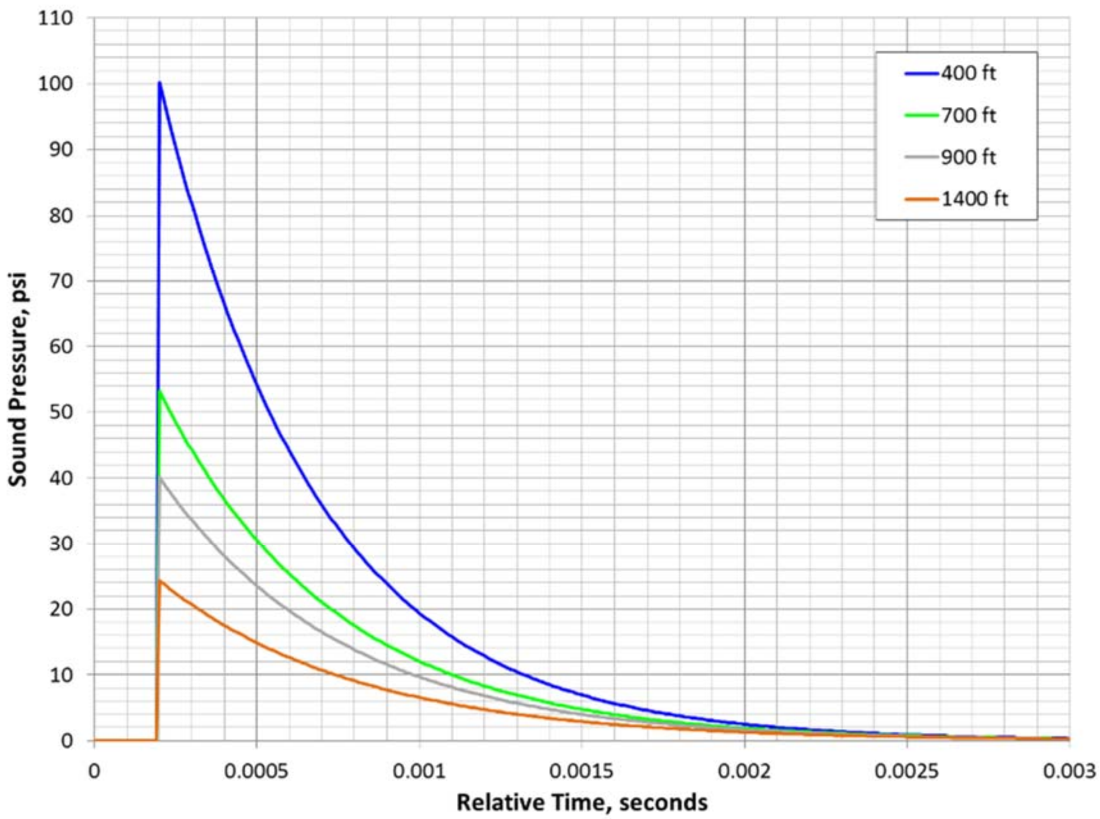

Figure 19. Blast wave forms vs. time relative the same arrival time calculated for different blast distances

Considering only the direct wave, the time histories such as those in Figure 19 were squared and summed in a numerical version of Equation 2 to calculate single blast SEL for the each blast weight. These calculations were then extended to distances out to 160,000 feet (48.8 kilometers). To determine the cumulative SEL for all 588 blasts, the single blast SEL values as a function of distance were calculated for the other charge weights of 35, 32.5, 30, 29.6, 26, 24, 22.5, and 21 pounds. For each weight, the cumulative SEL was determined by adding 10Log (N) where N is the number of the blasts for each weight. For example, 21.3 dB was added to the 35 pound single blast SEL to account for 135 blasts of this charge weight. The values for all of the charge weights are shown in Table 3. These cumulative SEL values for each charge weight were then summed (on an energy basis) to get the total accumulative SEL for the unconfined blast sequence. To account for the confinement factor of 0.3472 (*K*=7500), 20Log(0.3472) or -9.2 dB was added to the unconfined values.

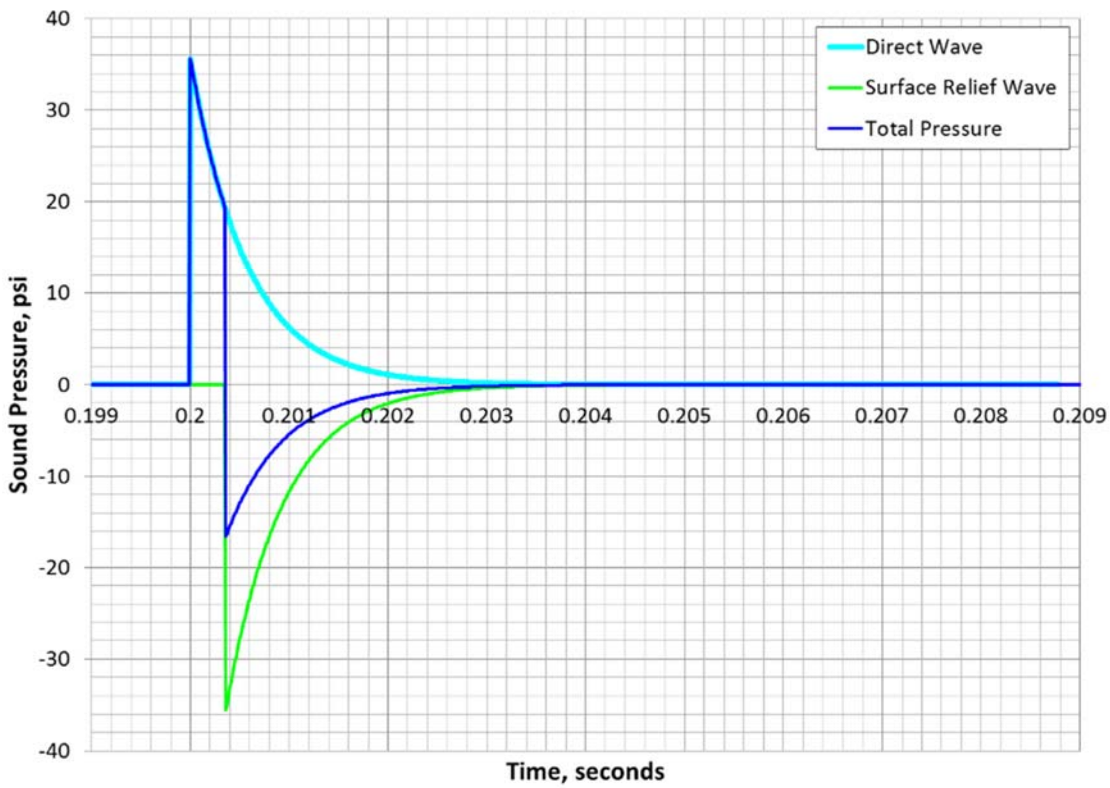

Figure 20. Total pressure versus time history for combined direct and surface relief wave 1,000 feet from the blast with source and receptor 30 feet deep

Table 3. Charge weights per delay, number of delays, & added level to accumulate number of blasts

Pounds/Delay	Total Number of Delays, N	10Log(N), dB
35	135	21.3
32.5	24	13.8
30	135	21.3
29.6	111	20.5
26	24	13.8
24	12	10.8
22.5	12	10.8
21	135	21.3
Total	**588**	

For each of the marine mammal groupings included in Figure 18, specific filter shapes apply to each group. The filters corresponding to Low-Frequency Cetaceans (LF_{II}), Mid-Frequency Cetaceans (MF_{II}), High-Frequency Cetaceans (HF_{II}), Phocidaes (P_{WI}), and Otariidaes (O_{WI}) are shown in Figure 21. To apply this weighting, the Fast Fourier Transform (FFT) was calculated for the time histories at each analysis distance. Each FFT was then filtered using the frequency weighted specified for each group/species from Figure 21. Filter factors were then determined for each distance by subtracting the filtered result from the unfiltered FFT data and determining the overall noise reduction in decibels. These filter factors were applied to the accumulated SEL determined for the entire blast event for each distance from the Pier.

The BAS of the Blast Plan will have an effect on the wave once a blast passes through it. In a research report by USACE in 1964, the performance of a BAS was examined in detail (USACE 1964). It was reported that the BAS reduces the peak pressure and elongates the pressure time history as shown in Figure 22. It has also been found that for an energy metric such as SEL, the reduction produced by the BAS was equal to or greater than the reduction of the peak pressure (USACE 1991; Rude 2002; Rude and Lee 2007; Rivey 2011). To estimate the reduction for SEL values due to the BAS proposed in the Blast Plan, SEL was reduced by 80%. Effectively, this was done by reducing the SEL by 20 Log (0.20), or 14 dB. Delays below the mudline, which will be located below the BAS, were also reduced by 80% based on an assumption that the outside Pier walls here (which will not be removed) and Bay mud sediments will provide a similar level of attenuation. These SEL values and those without the BAS were then compared to the appropriate criteria for each marine mammal group. Because the calculation of SEL is based on the peak pressure, these estimates for the direct wave component are expected to be conservative for the same reasons as described for the peak pressures.

ESTIMATION OF POSITIVE IMPLUSE

To estimate positive impulse values, the expression originally developed by Cole for open water was used (Cole 1948). This expression includes only contributions from the direct wave neglecting any contribution from the surface relief, bottom reflected, and bottom transmitted consistent with the assumptions used to estimate SEL. In this case, impulse is given by:

$$I = 2.18 \times W^{1/3} \times \left(\frac{W^{1/3}}{R}\right)^{1.05} \qquad (7)$$

with the variables defined in Equation 4. The impulse can also equivalently be calculated from wave forms as shown in Figure 19. Equation 5 produces impulse values in psi-msec which were converted to Pa-sec by multiplying by 6.9 for comparison to the marine mammal criteria.

Unlike P_{pk} and SEL, no reduction by the BAS is assumed for the impulse calculation. As illustrated in Figure 22, the area under the p(t) curve under goes little change after passing the BAS. The peak pressure is reduced as noted previously, however, since the p(t) expands in duration, the area change is minimal. This behavior is well documented in the literature (Cole 1948; USACE 1964; USACE 1991; Rickman 2000). As discussed above, this is not the case for SEL which is determined by the area under the $p^2(t)$ curve.

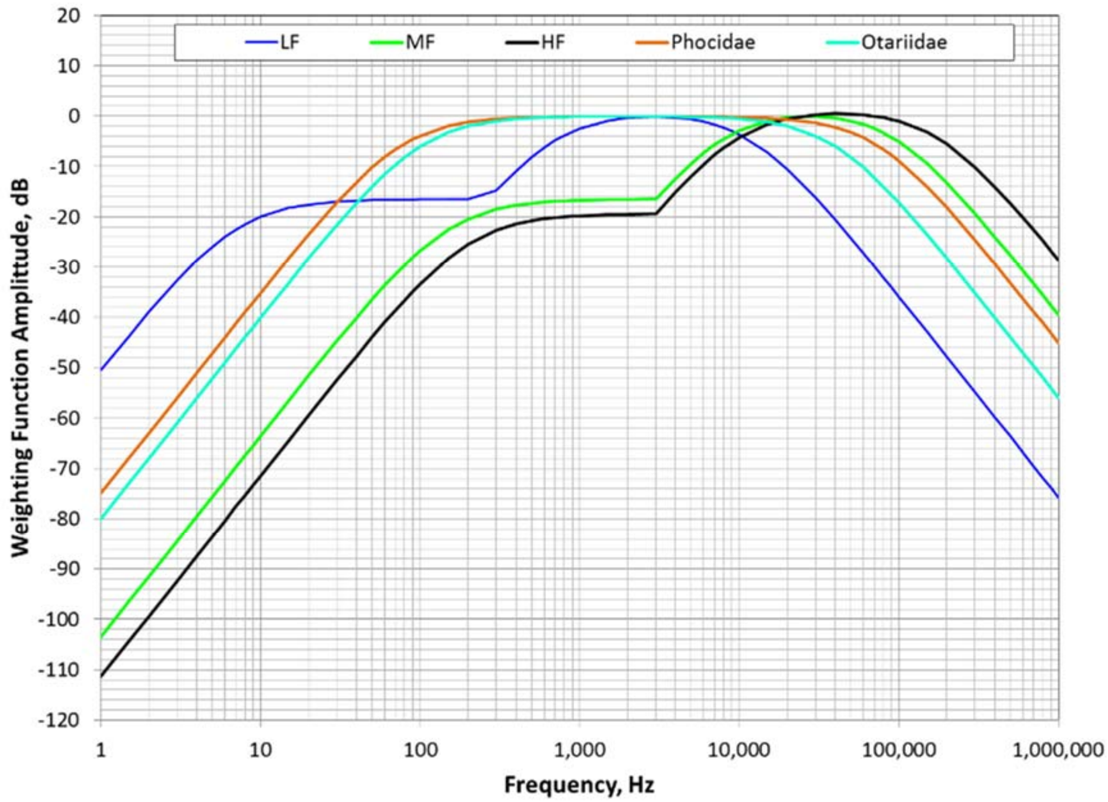

Figure 21. Filters for marine mammal – low frequency (LFII), mid frequency (MFII), high frequency (HFII), Phocidae (PWI), and Otariidaes (OWI)

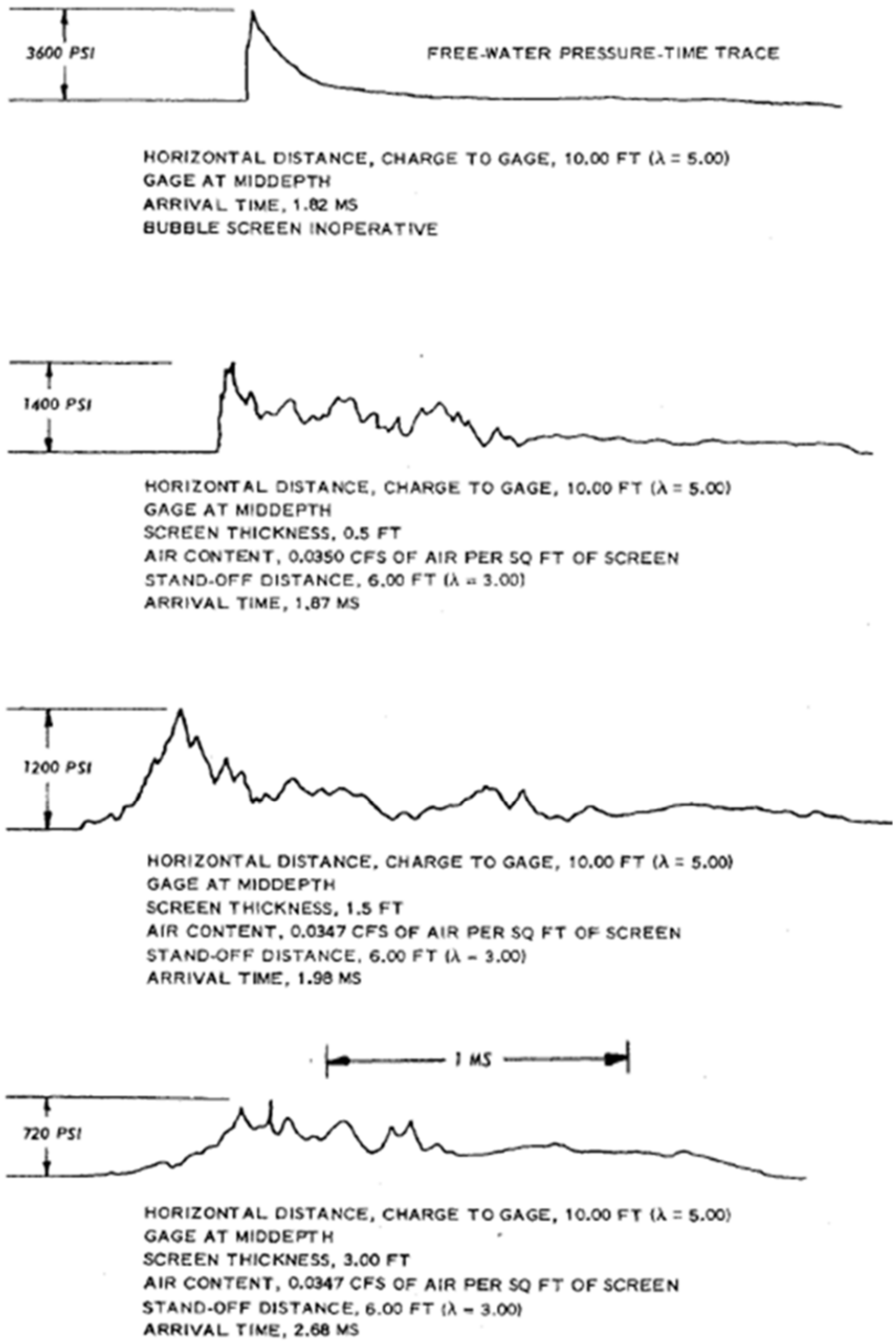

Figure 22. The effect of bubble screens of different parameters on underwater unconfined blast (Cole 1948)

SUMMARY

The estimated distances (Table 4) to the marine mammal criteria for peak pressure, SEL, and impulse are based on established relationships between charge weight and distance from the literature. The estimated distances were determined assuming unconfined open water blasts from the original Cole equations or the Cole equations modified by USACE. The assumption of open water neglects several effects that could produce lower levels than estimated. These include no shielding by the pier structure prior a specific blast, confining of the individual delays in the holes drilled into the pier structure, and longer distances to individual blasts than assumed by closest distance between the pier and the receptor point. For SEL, the assumption of open water blasts neglects the surface relief wave which at longer distances from the pier, would tend to reduce the SEL due to interference with the direct wave. Although the estimated levels and distances may be conservative, there is sufficient uncertainty in the blast event and its propagation such that further, less conservative adjustments would not be appropriate.

Table 4. Estimated distances to NMFS marine mammal impulse criteria for Level B Harassment, Level A Harassment, and mortality from the proposed Pier E3 implosion. A BAS with 80% efficiency in acoustic attenuation is assumed for the implosion. For criteria thresholds with dual criteria, the largest criteria distances (i.e., more conservative) are presented in bold.

Species	**Level B Criteria**		**Level A Criteria**			**Mortality**
	Behavioral Response	**TTS Dual Criteria**	**PTS Dual Criteria**	**GI Track**	**Lung Injury**	
Pacific Harbor Seal	9,700 ft (2,957 m)	**5,700 ft (1,737 m)** 440 ft (134 m)	**1,160 ft (354 m)** 70 ft (21 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)
California Sea Lion	800 ft (244 m)	470 ft (143 m) 440 ft (134 m)	**245 ft (75 m)** 97 ft (30 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)
Northern Elephant Seal	9,700 ft (2,957 m)	**5,700 ft (1,737 m)** 440 ft (134 m)	**1,160 ft (354 m)** 70 ft (21 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)
Harbor Porpoise	44,500 ft (13,564 m)	**26,500 ft (8,077 m)** 2,600 ft (792 m)	**5,800 ft (1,768 m)** 1,400 ft (427 m)	35 ft (11 m)	450 ft (137 m)	205 ft (63 m)

Estimates of Species Densities and Exposures

There are no systematic line transect surveys of marine mammals within San Francisco Bay, therefore, the in water densities of harbor seals, California sea lions, and harbor porpoises were calculated from 14 years of observations during monitoring for the SFOBB construction and demolition. During the 210 days of monitoring (including 15 days of baseline monitoring in 2003), 657 harbor seals, 69 California sea lions and three harbor porpoises were observed within the waters of the east span of the SFOBB. Density estimates for other species were made from stranding data provided by the MMC (Sausalito, CA; Northern elephant seal).

Pacific Harbor Seal Density Estimates

Most data on harbor seal populations are collected while the seals are hauled out. This is because it is much easier to count individuals when they are out of the water. In-water density estimates rely on haul-out counts, the percentage of seals not on shore based on radio telemetry studies, and the size of the foraging range of the population. Harbor seal density in the water can vary greatly depending on weather conditions or the availability of prey. For example, during Pacific herring runs further north in the Bay (near Richardson Bay, outside of the Pier E3 hydroacoustic zone) in February 2014, very few harbor seals were observed foraging near YBI or transiting through the SFOBB area for approximately two weeks. Sightings went from a high of 16 harbor seal individuals foraging or in transit in one day to 0-2 seals per day in transit or foraging through the SFOBB area (Department 2014). Calculated harbor seal density (Table 5) is a per day estimate of harbor seals in a one kilometer square (km^2) area within the fall/winter or spring/summer seasons.

Harbor seal density for the proposed project was calculated from all observations during SFOBB Project monitoring from 2000 to 2014. These observations included data from baseline, pre, during and post pile driving and onshore implosion activities. During this time, the population of harbor seals within the Bay has remained stable (Manugian 2013), therefore, we do not anticipate significant differences in numbers or behaviors of seals hauling out, foraging or in their movements over that 15 year period. All harbor seal observations within a km^2 area were used in the estimate. Distances were recorded using a laser range finder (Bushnell Yardage Pro Elite 1500; ± 1.0 yards accuracy). Care was taken to eliminate multiple observations of the same animal although this was difficult when more than three seals were foraging in the same area.

Density of harbor seals was highest near YBI and Treasure Island, probably due to the haul-out site and nearby foraging areas in the Coast Guard and Clipper coves (Figure 16). Therefore, density estimates were calculated for a higher density area within 3,936 feet (1,200 meters) west of Pier E3, which includes these two foraging coves. A lower density estimate was calculated from the area east of Pier E3 and beyond 3,936 feet (1,200 meters) to the north and south of Pier E3.

These density estimates were then extrapolated to the threshold criteria areas delineated by the hydroacoustic models to calculate the number of harbor seals likely to be exposed (Table 6).

California Sea Lion Density Estimates

Most data on California sea lion populations are collected while the seals are hauled out as it is much easier to count individuals when they are out of the water. In-water density estimates rely on haul-out counts, the percentage of sea lions not on shore based on radio telemetry studies, and the size of the foraging range of the population. Sea lion density, like harbor seal densities, in the water can vary greatly depending on weather conditions, the availability of prey, and the season. For example, sea lion density increases during the summer and fall after the end of the breeding season at the Southern California rookeries.

For the proposed project, California sea lion density was calculated from all observations during SFOBB monitoring from 2000 to 2014. These observations included data from baseline, pre, during and post pile driving and onshore implosion activities. During this time, the population of sea lions within the Bay has remained stable as have the numbers observed near the SFOBB (Manugian 2013). As a result, we do not anticipate significant differences in the number of sea lion or their movements over that 15 year period. All sea lion observations within a km^2 area were used in the estimate. Distances were recorded using a laser range finder (Bushnell Yardage Pro Elite 1500; ± 1.0 yards accuracy). Care was taken to eliminate multiple observations of the same animal, although most sea lion observations involve a single animal. Calculated California sea lion density is a per day estimate of sea lions in a one km^2 area within the fall/winter or spring/summer seasons.

Northern Elephant Seal Density Estimates

Northern elephant seal density around Pier E3 was calculated from the stranding records of the MMC from 2004 to 2014. These data included both injured or sick seals and healthy seals. Approximately 100 elephant seals were reported within the Bay during this time, most of these hauled out and were likely sick or starving. The actual number of individuals within the Bay may be higher as not all individuals would necessarily have hauled out. Some individuals may have simply left the Bay soon after entering. Data from the MMC show several elephant seals stranding on Treasure Island and one healthy elephant seal was observed resting on the beach in Clipper Cove in 2012. Elephant seal pups or juveniles also may strand after weaning in the spring and when they return to California in the fall (September through November).

Harbor Porpoise Density Estimates

Harbor porpoise density was calculated from all observations during SFOBB monitoring from 2000 to 2014. These observations included data from baseline, pre, during and post pile driving and onshore implosion activities. Over this period, the number of harbor porpoises that were observed entering and using the Bay increased. During the fifteen years of observational data around the SFOBB Project, only four harbor porpoises were observed and all occurred from 2006 to 2014 (including two in 2014). All harbor porpoise observations within a km^2 area were used in the estimate. Distances were recorded using a laser range finder (Bushnell Yardage Pro Elite 1500; ± 1.0 yards accuracy).

Table 5. Estimated in-water density of marine mammals that may occur in the Marine Mammal Exclusion Zone (MMEZ). Densities for harbor seals, California sea lions and harbor porpoises are based on monitoring for the East Span of the SFOBB from 2000 to 2013. Gray whale and elephant seal densities are estimated from sighting and stranding data from the MMC.

Species	Main Season Of Occurrence	Density Within 1,200m of SFOBB (animals/km^2)	Density Beyond 1,200m of SFOBB (animals/km^2)
Pacific Harbor Seal	Spring – Summer (pupping/molt seasons)	0.30	0.15
Pacific Harbor Seal	Fall- Winter	0.77	0.15
Sea Lion	Late Summer – Fall (Post Breeding Season)	0.12	0.12
Sea Lion	Late Spring-Early Summer (Breeding Season)	0.06	0.06
Northern Elephant seal	Late Spring-Early Winter (Pups After First Trip To Sea)	0.03	0.03
Harbor Porpoise	All Year	Very Low estimated at 0.004	Very Low estimated at 0.004

<u>Pre-implosion Test Charge</u>

Release of the test charge outside of the pier's perimeter walls but inside of the BAS may produce an underwater pressure wave to be evaluated against the marine mammal acoustic thresholds previously presented. The distances to Level B Harassment - TTS or greater exposures for marine mammals during the release of the test charge were estimated based on a single explosion. A distance to TTS of 48 feet (15 meters; 212 dB peak SPL) from the charge was calculated for Phocidae and Otariidae species, 14 feet (4 meters; 224 db peak) for low and mid-frequency cetaceans, and 270 feet (82 meters; 195 dB peak) for high frequency cetaceans.

All distances, with the exception of the High Frequency Cetaceans (harbor porpoise), are extremely close to Pier E3 and within the potential deployment of the BAS. Occurrence of marine mammals at these distances would not be expected. Using these distances and the marine mammal densities previously described, estimated exposure values for TTS were calculated. Exposures were calculated at 0.0005 harbor seals, 0.00002 northern elephant seals, 0.00008 California sea lions, and 0.00008 harbor porpoises. Harbor porpoises, however, are not expected to occur in the Project area during the November. Two or three marine mammal observers would be on-site during the test to confirm the absence of harbor porpoise within 270 feet prior to the release of the charge. As a result of this action, plus the small amount of potentially affected area subject to harmful sound, no effects to marine mammals are anticipated from the test charge and no authorization for incidental take is requested for this specific activity of the Demonstration Project.

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.

Behavioral Responses

Generally, a louder source of sound results in a more intense behavioral response. However, other factors such as the proximity of a sound source, type and frequency of the sound, and the animal's experience, motivation, and conditioning are also critical factors influencing the response (reviewed by Southall et al. 2007). The distance from the sound source and whether it is perceived as approaching or moving away can also affect the type and the intensity of the animal's response to a sound (Richardson et al. 1995, Wartzok et al. 2003, Nowacek et al. 2007; Southall et al. 2007). Behavioral responses can vary from a minor response (i.e., orientation to the sound or head movement) to a strong response (i.e., rapidly swimming away from the sound, abandonment of the area).

Most low-frequency cetaceans (i.e., mysticete) usually avoided sound sources at levels of 160 dB re 1 μPa (Richardson et al. 1995). Gray whales migrating along the U.S. west coast and in the Bering Sea showed avoidance responses to seismic vessels by 10 percent of animals at 164 dB re 1 μPa, and by 90 percent of animals at 190 dB re 1 μPa (Malme et al. 1986, 1988). In contrast, impact noise from seismic surveys was not found to impact feeding behavior or exhalation rates from resting or diving western gray whales off the coast of Russia (Gailey et al. 2007; Yazvenko et al. 2007). The behavior of baleen whales to loud sounds included avoidance of the sound (Malme et al, 1986, 1988), a decrease in surface intervals and breathing (Richardson et al. 1995), and changes in vocalizations rates or source level (Gordon and Moscrop 1996; Miller et al. 2000; Croll et al. 2002; Gordon et al. 2003, Southall et al. 2007). Seismic pulses caused blue whales to increase call production (Di Iorio and Clark 2010), although a blue whale stopped vocalizing and changed its travel direction within six miles (10 kilometer) of a seismic survey ship (McDonald et al. 1995).

Mid-frequency cetaceans, including sperm whales and bottlenose dolphins, may show no clear tendency in response to sound sources. Captive US Navy bottlenose dolphins sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al. 2002).

High-frequency cetaceans (e.g., harbor porpoises) exhibited changes in respiration and avoidance behavior when exposed to sounds between 90 and 140 dB re 1 μPa. Sperm whales in the Gulf of Mexico did not show any movement away from a seismic survey ship located approximately 2 to 7 nautical miles (3.7 to 13.0 kilometers) away (Madsen et al. 2006 and Miller et al. 2009).

Phocid seals showed avoidance reactions at or below 190 dB re 1 μPa (Richardson et al. 1995). Blackwell et al. (2004) observed that ringed seals exhibited little or no reaction to pile driving noise with mean underwater levels of 157 dB re 1 μPa and suggested that the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an impulsive source at levels of 165-170 dB re 1 μPa (Finneran et al. 2003). Although noise was not necessarily a factor, harbor seals abandoned a haul-out site after was repeatedly disturbed by small boats (Allen et al. 1984).

Hearing Threshold Shifts (TTS and PTS)

The magnitude of TTS or permanent threshold shift (PTS) is dependent on the level of sound, frequency, and duration of the sound (Parvin et al. 2007). Recovery from TTS usually occurs within minutes to hours depending on the severity of the TTS exposure (Nachtigall et al. 2004; Finneran et al. 2005; Mooney et al. 2009). PTS has not been measured in marine mammals because of ethical concerns but it has been measure in terrestrial animals. For marine mammals, it has been assumed that PTS would occur at a level about 6 dB above the level that causes TTS.

Injury and Mortality

Injury from impulse sounds, including underwater implosions usually involve air filled cavities such as the lungs, gastro-intestinal tract, and nasal sinuses, as well as to the auditory system (Yelverton et al. 1973; Goertner 1982; Craig and Hearn 1998). Damage to the tissues of the brain may also occur (Knudsen and Øen 2003). Impulse injuries to the respiratory system may consist of lung contusions, collapsed lungs, air in the chest cavity between the lungs, traumatic lung cysts, or interstitial or subcutaneous emphysema (Phillips and Richmond 1990). The reinforced trachea, flexible thoracic cavity, and ability to deflate and re-inflate the lungs during diving (Kooyman et al. 1970; Ridgway and Howard 1979) may decrease the risk of lung injury when exposed to loud sounds or pressures in marine mammals. Additionally, the gastro-intestinal tract is more robust than lung tissues requiring higher pressures for tissue damage to occur here.

Mortality to fur seals occurred within 75.5 feet (23 meters) of a 24.25 pound (11kilogram) submerged dynamite charge (peak pressure of 530 psi [252 dB re 1μPa; reported in Parvin et al. 2007]). Sea otters were injured when exposed to peak pressures of 100 psi (236 db re 1μPa), and mortality occurred at peak pressures of 300 psi (246 dB re 1μPa) (reported in Parvin et al. 2007). Many marine mammals must quickly breathe when surfacing and undergo lung collapse during deep diving so lung injuries can be particularly debilitating or fatal. Mortalities to bottlenose dolphins have also occurred from underwater implosions associated with oil rig removal in the Gulf of Mexico (Klima et al. 1988) and to long-beaked common dolphins during Navy training in Southern California (Danil and St. Ledger 2011).

The number, and types, of exposure by species type from the Pier E3 implosion are presented in Table 6.

Species Impacts

Pacific Harbor Seal: The harbor seal would be the most vulnerable species to sounds or pressures originating from the Pier E3 implosion. They are the most numerous marine mammal in the Bay, and most likely to be in the area of the Pier E3. However, all of the observations made during monitoring for the SFOBB were of seals transiting through the Pier E3 area rather than remaining there to forage.

Table 6. Summary of the estimated exposures of marine mammals to the PierE3 implosion for each of the Level A, Level B, and mortality threshold criteria. Exposures are presented as whole number of animals exposed with the actual calculated value presented below.

Species	LEVEL B EXPOSURES		LEVEL A EXPOSURES*			Mortality*
	Behavioral Response	Temporary Threshold Shift	Permanent Threshold Shift	Gastro Intestinal Track Injury	Slight Lung Injury	
Pacific Harbor Seal	6 (5.923)	3 (3.443)	0 (0.148)	0 (0.001)	0 (0.008)	0 (0.002)
California Sea Lion	0 (0.026)	0 (0.010)	0 (0.003)	0 (0.001)	0 (0.009)	0 (0.003)
Northern Elephant Seal	1 (0.534)	0 (0.225)	0 (0.012)	0 (0.001)	0 (0.009)	0 (0.003)
Harbor Porpoise	1 (0.562)	0 (0.328)	0 (0.031)	0 (0.0004)	0 (0.0003)	0 (0.00008)
Total	**8**	**3**	**0**	**0**	**0**	**0**

* No implosion would occur if any marine mammal is within the Level A or mortality threshold criteria zones.

If a harbor seal remained undetected and entered the established marine mammal exclusion zone (MMEZ) during the implosion, it may be subject to slight lung, gastrointestinal (GI) track, and inner ear injury (PTS), or mortality. The use of active monitoring; however, will be implemented to ensure harbor seals at the surface are likely to be detected by observers. The long dive durations of harbor seals (generally up to 10 minutes with a maximum of 30 minutes) do suggest that an individual could swim through the established MMEZ without surfacing. To reduce this possibility, the implosion will be delayed if a harbor seal is observed within the MMEZ. The implosion will not proceed until the individual leaves the MMEZ, or at least 20 minutes have passed since the last observation.

Behavioral responses by harbor seals in response to the implosion may involve rapid movement away from the area and short-term abandonment of the area around Pier E3. Alternatively, seals foraging in the Coast Guard and Clipper Coves may continue foraging as they do during pile driving and mechanical demolition activities. Long-term abandonment of the Pier E3 area is not expected as SFOBB construction activity has been ongoing since 2003 with continued use of the area by harbor seals.

Based on the calculated density estimates, and the hydroacoustic modeling for the implosion, the Department estimates that nine harbor seals may be exposed to sound thresholds within the larger Level B Harassment Zone. Six of those exposures will be within the Level B behavioral response criteria threshold and three will be within the TTS threshold criteria. Due to the mitigation measures employed prior to the controlled implosion of Pier E3 (Section 13), and the monitoring in place to detect harbor seals at the surface, no harbor seals are expected to be exposed to sound thresholds that would result in Level A PTS, lung or GI tract injury, or mortality exposure.

California Sea Lion: The California sea lion would be the second most vulnerable species to controlled implosion as they are the second most numerous marine mammal species in the Bay. They may occur in the Pier E3 area during the implosion. Similar to the discussion for harbor seals, California sea lions at the surface are likely to be detected by the observers during monitoring. Unlike harbor seals, sea lions are not long-duration divers and it is unlikely that a sea lion would swim through the MMEZ without surfacing and being detected. In addition, sea lions tend to spend more time at the surface while swimming than harbor seals. If a sea lion remained undetected and entered the established exclusion zone during the implosion, it may be subject to lung injury, GI tract injury, inner ear injury (PTS), or mortality Behavioral responses of sea lion to the controlled implosion would likely involve rapid movement away from the area and short-term abandonment of the Pier E3 area. As with harbor seals, long-term abandonment of the Pier E3 area by sea lions is not expected as construction activity has been ongoing since 2003 with continued use of the area.

Based on the calculated density estimates and the hydroacoustic modeling, the Department estimates that no sea lions will be exposed to the sound thresholds within the larger Level B Harassment Zone. Due to the mitigation measures employed prior to the controlled implosion of Pier E3 (Section 11) and the monitoring in place to detect sea lions at the surface, no sea lions are predicted to be exposed to sound thresholds that would result in Level A PTS, lung or GI tract injury, or mortality exposure.

Northern Elephant Seal: Northern elephant seals are infrequently found near Treasure Island and are unlikely to be in the area around Pier E3. Elephant seals at the surface are likely to be detected by the observers during monitoring prior to the controlled implosion. However, elephant seals are very long-duration divers, which suggests that an individual could swim through the MMEZ without surfacing. To reduce this possibility, the implosion will be delayed if an elephant seal is observed within the MMEZ. The implosion will not proceed until the individual leaves the MMEZ, or at least 20 minutes have passed since the last observation. If an elephant seal remained undetected and entered the established exclusion zone during the implosion, it may be subject to lung injury, inner ear injury, or mortality if it was within. Behavioral responses of elephant seals to the controlled implosion would likely involve rapid movement away from the area and short-term abandonment of the area around Pier E3. Long-term abandonment of the Pier E3 area by elephant seals is not expected as construction activity has been ongoing since 2003 with limited, continued use of the area for transit or resting.

Based on the calculated density estimates and the hydroacoustic modeling, the Department estimates that one elephant seal may be exposed to sound thresholds that fall within the larger Level B Harassment Zone. This one exposure would be within the Level B behavioral response Zone with no exposures in the TTS threshold Zone. Due to the avoidance and minimization measures that would be employed prior to the controlled implosion (Section 13) and the monitoring in place to detect elephant seals at the surface, no elephant seals are predicted to be exposed to sound thresholds that would result in Level A PTS, lung or GI tract injury, or mortality exposure.

Harbor Porpoises: Impacts to harbor porpoises are unlikely. This species rarely occurs in the area around Pier E3. Their common behavior of traveling in pods of several animals along with frequent surfacing events make it very likely that observers would detect any harbor porpoises in the MMEZ. If a harbor porpoise remained undetected and entered the established exclusion zone during the implosion, it may be subject to lung injury, inner ear injury, or mortality. Behavioral responses of harbor porpoises from the controlled implosion would likely be rapid movement away from the area and short term abandonment of the SFOBB area. Long-term abandonment is not expected as construction activity has been ongoing since 2003 with limited, continued use of the area for transit or foraging.

Based on the calculated density estimates and the hydroacoustic modeling, the Department estimates that one porpoise may be exposed to the sound thresholds that fall within the larger Level B Harassment Zone. This one exposure would be within the Level B behavioral response criteria with no exposure in the TTS threshold Zone. Due to the avoidance and minimization measures that would be employed prior to the controlled implosion (Section 13), and the monitoring in place to detect harbor porpoises at the surface, no individuals are predicted to be exposed to sound thresholds that would result in Level A PTS, lung or GI tract injury, or mortality exposure.

7. The Anticipated Impact of the Activity Upon The Species Or Stock.

The numbers presented in Table 6 represent estimated modeled exposures to each harassment threshold criteria zone under the MMPA. These calculated values are conservative (i.e., over predictive) estimates of harassment, that calculate exposure without taking into consideration avoidance and minimization measures that would be employed (i.e., marine mammal observers, real time acoustic monitoring, BAS, and acoustic deterrent devices). As a result of this analysis and through the implementation of avoidance and minimization measures, the Department concludes that the controlled implosion of Pier E3 would only result in Level B harassment of behavioral harassment or TTSs. Based on the best available science, exposures to marine mammal species and stocks due to the controlled implosion would result in only short-term effects to individuals exposed, would likely not affect annual rates of recruitment or survival, and employed mitigation measures will prevent any Level A exposures or mortality.

Based on 14 years of previous construction and demolition activities associated with the east span of the SFOBB, and the protective measures described, and the very short duration of the implosion, the Department believes there will be no permanent injury or mortality to animals, or impacts (short or long term) to the populations or stocks of marine mammals that regularly inhabit or occasionally enter the Bay.

8. The Anticipated Impact Of The Activity On The Availability Of The Species Or Stocks Of Marine Mammals For Subsistence Uses.

Non-Applicable, none of the species or stocks of marine mammals regularly found within San Francisco Bay are used for subsistence uses.

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 removal of the east span of the SFOBB is not likely to negatively affect the habitat of marine mammal populations as there would be no permanent loss of habitat and only a minor, temporary modification of habitat from the hydroacoustic impacts of the controlled implosion. The SFOBB is not used as a haul-out site by pinnipeds and demolition of the concrete marine foundations is unlikely to permanently decrease fish populations.

10. The Anticipated Impact Of The Loss Or Modification Of The Habitat On The Marine Mammal Populations Involved.

The removal of Pier E3 through controlled implosion is not likely to negatively affect the habitat of marine mammal populations as there would be no loss of habitat and only a minor, temporary modification of habitat from the hydroacoustic impacts of the controlled implosion. The SFOBB is not used as a haul-out site by pinnipeds and demolition of the concrete marine foundations is unlikely to permanently decrease fish populations The physical effects from pressure waves generated by underwater impulse sounds (e.g., underwater implosions) would likely affect fish populations within the proximity of project activities. The abundance and distribution of fish near Pier E3 could be altered for a few hours after the implosion and before individual fish from surrounding areas repopulate the area. These fish populations, however, would be replenished as project activities cease and the local population mixes again.

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.

The methods proposed to demolish Pier E3 provide the least impact on marine mammal stocks and their habitat. A BAS will be used for all activities that produce impulse sounds, including controlled implosion. The use of controlled charges for demolition decreases the cumulative amount of marine habitat, and the individual marine mammals within this habitat, exposed to potentially harmful sound thresholds.

An analysis of the potential effects to marine mammals from the alternative use of mechanical methods to remove Pier E3 was completed and is presented in Appendix C. In summary, the analysis concluded that the cumulative area subject to Level B Behavioral Harassment would be much greater for mechanical removal of Pier E3, largely due to the increased time required for pile driving to install a cofferdam around Pier E3. The cumulative area exposed to Level B (TTS) or Level A (PTS or greater harm) Harassment of marine mammals is higher for the one-day controlled implosion (109 acres [44.1 hectares]) when compared at the 190 dB RMS threshold for pinnipeds (9.3 acres [3.8 hectares]) during cofferdam installation. However, for cetaceans (the 180 dB RMS threshold), cumulative exposure during pile driving would be approximately one and a half times the area of the controlled implosion scenario (147 acres [59.5 hectares] versus 109 acres [44.1 hectares]). The actual risk of Level A Harassment exposure to individual marine mammals from either demolition method is unlikely given the implementation of exclusion zones and monitoring. Exposure to Level B (TTS) Harassment of three harbor seals may occur from the controlled implosion. In contrast, the increased time (months to years) required to install the cofferdam, along with historical monitoring data, suggest there is a potential for equal, or greater, TTS exposure under this method. This could occur even with effective monitoring, because current regulations allow for continued pile driving if an individual enters the exclusion zone after work has commenced.

AVOIDANCE AND MINIMIZATION MEASURES

Blast Plan:

The Blast Plan presented in Appendix A is designed to meet Demonstration Project goals while minimizing, to the degree practical, the potential for unnecessary sound exposure to marine mammals. This is accomplished by using specific borehole patterns and the minimum required charge weights to fragment the pier while reducing harmful sound exposure. In addition, the Blast Plan describes a Marine Mammal Exclusion Zone (MMEZ), which will be monitored to ensure no individuals are subject to Level A Harassment or greater exposure.

Blast Attenuation System:

As described previously in this application, a BAS will be employed around Pier E3 during the implosion. Appendix B provides additional, technical information on various design elements of this system. BAS performance is anticipated to provide approximately 80% attenuation, or better, of implosion-related pressure waves. This conclusion is based upon the performance of similar systems when used during similar underwater implosion events.

Monitoring Plan:

During the Pier E3 implosion, a project-specific monitoring plan (Section 13) will be employed to avoid the potential for individual exposure to Level A Harassment and to document the number and species potentially exposed to Level B Harassment. In particular, monitors will observe the MMEZ and delay the implosion if any individuals are within this zone.

Real Time Acoustic Monitoring:

While bottlenose dolphins and harbor porpoises are not expected to be within the Demonstration Project area in November, real time acoustic monitoring to confirm species absence is proposed as an additional avoidance measure to active monitoring by trained observers. Bottlenose dolphins and harbor porpoises vocalize frequently with other animals within their group, and use echolocation to navigate and locate prey. As an avoidance tool, a real time acoustic monitoring system will be used to detect this species. This proposed acoustic monitoring may provide additional benefits in detecting other cetaceans such as humpback, gray, and minke whales (unlikely to be in the Bay) that do not vocalize as often using the same monitoring system.

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.

Non-Applicable, there will be no activities within Arctic subsistence hunting areas.

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.

Monitoring Plan

Monitoring for implosion impacts to marine mammals will be based on the SFOBB pile driving monitoring protocol. Pile driving has been conducted for the SFOBB construction project since 2000 with development of several NMFS-approved marine mammal monitoring plans (Department 2004; 2013a). Most elements of these marine mammal monitoring plans are similar to what would be required for underwater implosions. These monitoring plans would include exclusion and behavioral monitoring zones extending out to a pre-determined distance from Pier E3 depending on the hydroacoustic modeling of current NMFS acoustic threshold criteria.

The following are the general elements of the plan; a detailed monitoring plan would be developed, in cooperation with NMFS, as more specific information becomes available or modeling of the implosion effects are revised.

Marine Mammal Exclusion Zone - Level A Harassment/Injury or Mortality Zone: This will cover the area through both the mortality and Level A harassment zone (PTS, GI track injury, and slight lung injury), using the criteria threshold that extends out the furthest. Estimates are that the isopleth for PTS would extend out to a radius of 1,160 feet (354 meters) for pinnipeds to 5,800 feet (1,768 meters) for harbor porpoise; (Table 4) covering the entire areas for both Level A Harassment and Mortality (Figures 23 and 24). As harbor porpoises are unlikely to be in the area in November, the exclusion zone boundaries would be set around the calculated distance to Level A Harassment for pinnipeds, including harbor seals and sea lions. However, real-time acoustic monitoring (i.e., active listening for vocalizations with hydrophones) also will be utilized to provide an additional level of confidence that harbor porpoises are not in the affected area. Adherence to calculated distances to Level A Harassment for pinnipeds indicates that the radius of the MMEZ would be 1,160 feet (354 meters). The MMEZ will be monitored by marine mammal observers (MMOs) and if any marine mammals are observed inside the MMEZ, the implosion will be delayed until the animal leaves the area or at least 15 minutes have passed since the last observation for cetaceans and sea lions or 20 minutes for harbor and elephant seals.

Level B Harassment/TTS Zone: For harbor seals and sea lions, this will cover the area out to 212 dB peak SPL or 177 dB SEL, whichever extends out the furthest. Hydroacoustic modeling indicates this isopleth would extend out to 5,700 feet (1,737 meters) from Pier E3. For harbor porpoises, this will cover the area out to 195 dB peak SPL or 146 dB SEL, whichever extends out the furthest. Hydroacoustic modeling indicates this isopleth would extend out to 26,500 feet (8,077 meters) from Pier E3. As discussed previously, the presence of harbor porpoises in this area is unlikely but monitoring (including real-time acoustic monitoring) will be employed to confirm their absence. For northern elephant seals, the distance to the Level B Harassment / TTS Zone will cover the area out to 212 dB peak SPL or 200 dB SEL. This distance was calculated at 470 feet (143 meters) from Pier E3, well within the MMEZ previously described. .

Level B Harassment/Behavioral Response Zone: For harbor seals and sea lions, this will cover the area out to 172 dB SEL. Hydroacoustic modeling indicates this isopleth would extend out to 9,700 feet (2,957 meters) from Pier E3. For harbor porpoises, this will cover the area out to 141 dB SEL. Hydroacoustic modeling indicates this isopleth would extend out to 44,500 feet (13,564 meters) from Pier E3. As discussed previously, the presence of harbor porpoises in this area is unlikely but monitoring (including real-time acoustic monitoring) will be employed to confirm their absence. For northern elephant seals, the distance to the Level B Harassment/Behavioral Response Zone will cover the area out to 195 dB SEL. This distance was calculated at 800 feet (244 meters) from Pier E3, well within the MMEZ previously described.

Marine Mammal Observers: A minimum of 8-10 MMOs would be required during the Pier E3 controlled implosion so that the MMEZ, Level B Harassment TTS/Behavioral Zones, and surrounding area can be monitored. The size of this area may be revised as further information is obtained regarding the amount of charges and from corresponding changes in the size of the Level A and Level B Harassment zones from hydroacoustic modeling. One MMO would be designated as the Lead MMO and would be located with the Department Engineer and the Blasting Supervisor (or person that will be in charge of detonating the charges) during the implosion. The Lead MMO would receive updates from other MMOs on the presence or absence of marine mammals within the MMEZ and would notify the Blasting Supervisor of a cleared MMEZ prior to the implosion.

Monitoring Protocol: Implosion of Pier E3 would only be conducted during daylight hours and with enough time for pre and post implosion monitoring, and with good weather (i.e., clear skies and no high winds). This would be completed to ensure that MMOs will be able to detect marine mammals within the MMEZ and beyond. The Lead MMO will be in contact with other MMOs and the acoustic monitors. As the time for the implosion approaches, any marine mammal sightings would be discussed between the Lead MMO, the Resident Engineer, and the Blasting Supervisor. If any marine mammals enter the MMEZ within 20 minutes of blasting, the Lead MMO will notify the Resident Engineer and Blasting Supervisor that the implosion may need to be delayed. The Lead MMO will keep them informed of the disposition of the animal. If the animal remains in the MMEZ, blasting will be delayed until it has left the MMEZ. If the animal dives and is not seen again, blasting will be delayed at least 15 minutes for a cetacean or sea lion, or 20 minutes for a harbor seal or elephant seal. Once the implosion has occurred, the MMOs will continue to monitor the area for at least 60 minutes.

Although any injury or mortality from the implosion of Pier E3 is very unlikely, boat or shore surveys will be conducted for the three days following the event to determine if there are any injured or stranded marine mammals in the area. If an injured or dead animal is discovered during these surveys or by other means, the NMFS-designated stranding team will be contacted to pick up the animal. Veterinarians will treat the animal or conduct a necropsy to attempt to determine if it stranded was a result of the Pier E3 implosion.

Data Collection: Each MMO will record their observation position, start and end times of observations, and weather conditions (sunny/cloudy, wind speed, fog, visibility). For each marine mammal sighting, the following will be recorded, if possible:

1. Species
2. Number of animals (with or without pup/calf)
3. Age class (pup/calf, juvenile, adult)
4. Identifying marks or color (scars, red pelage, damaged dorsal fin, etc.)
5. Position relative to Pier E3 (distance and direction)
6. Movement (direction and relative speed)
7. Behavior (logging [resting at the surface], swimming, spyhopping [raising above the water surface to view the area], foraging, etc.)
8. Duration of sighting or times of multiple sightings of the same individual

Communication: All MMOs will be equipped with mobile phones and a VHF radio as a backup. One person will be designated as the Lead MMO and will be in constant contact with the Resident Engineer on site and the blasting crew. The Lead MMO will coordinate marine mammal sightings with the other MMOs and the real time acoustic monitor. MMOs will contact the other MMOs when a sighting is made within the MMEZ or near the MMEZ so that the MMOs within overlapping areas of responsibility can continue to track the animal and the Lead MMO is aware of the animal. If it is within 20 minutes of blasting and an animal has entered the MMEZ or is near it, the Lead MMO will notify the Resident Engineer and blasting crew. The Lead MMO will keep them informed of the disposition of the animal.

Figure 23. Estimated pinniped mortality and Level A Marine Mammal Exclusion Zone (MMEZ; red line), TTS Level B zone (orange line) and Level B behavioral response zone (yellow line).

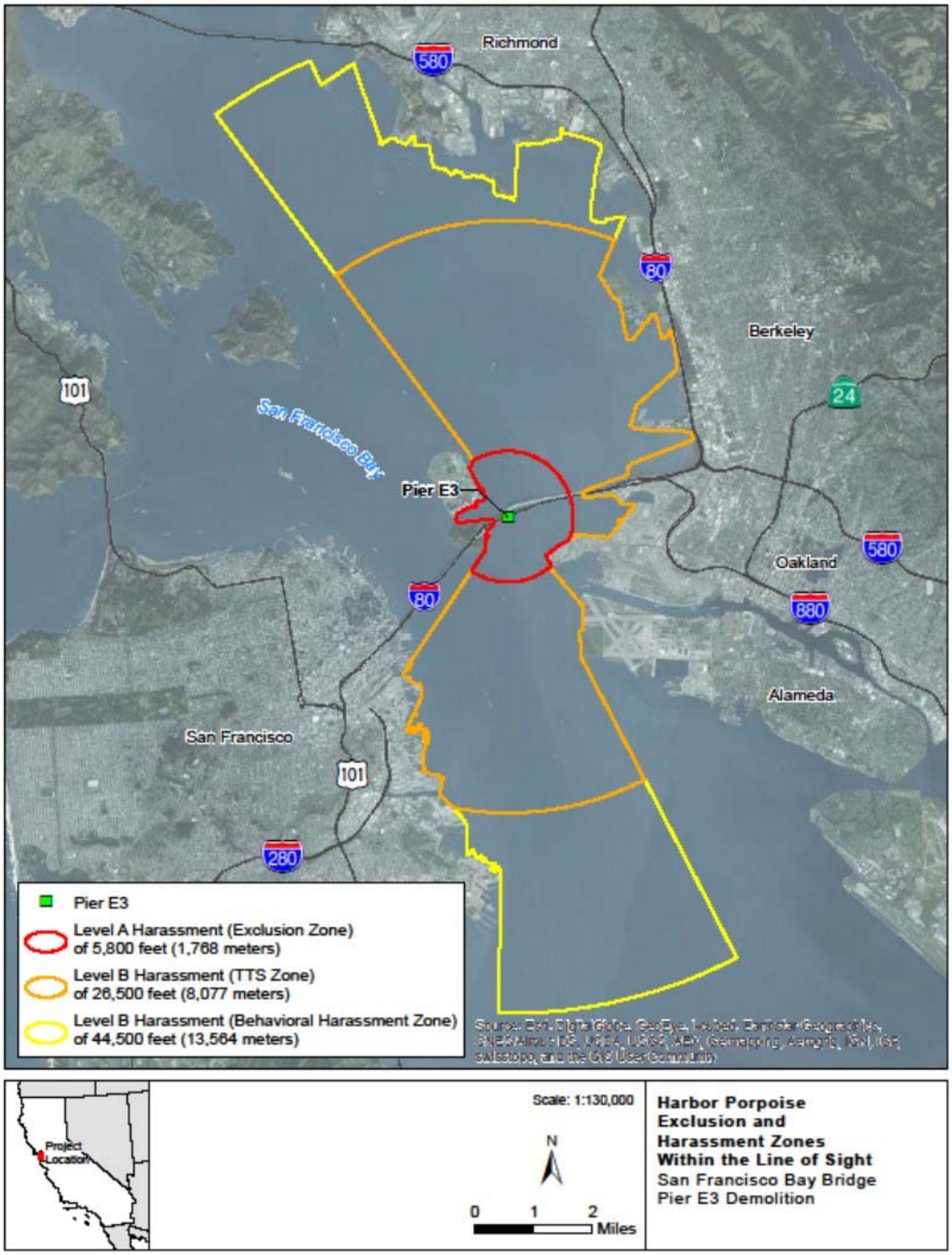

Figure 24. Estimated harbor porpoise mortality and Level A Marine Mammal Exclusion Zone (MMEZ; red line), TTS Level B zone (orange line) and Level B behavioral response zone (yellow line).

Real Time Acoustic Monitoring: Bottlenose dolphins and harbor porpoises vocalize frequently with other animals within their group, and use echolocation to navigate and to locate prey. Therefore, as an additional monitoring tool, a real time acoustic monitoring system will be used to detect the presence or absence of cetaceans as a supplement to visual monitoring. In addition, other cetaceans such as humpback, gray, and minke whales (unlikely to be in the Bay) that do not vocalize as often but may also be detected using the same monitoring system. The system would involve 1-2 bio-acousticians monitoring the site in real time. A calibrated hydrophone or towed array would be suspended from a boat (Rankin et al. 2008), or a moored hydrophone with cable to shore or a boat (Norris, Pers. Comm. 2015), and several sonobuoys (acoustic information sent via telemetry; McDonald and Moore 2002) may be deployed at the edge of the monitoring area of Pier E3. A towed array or moored hydrophone system would be able to give relative distance and direction so that visual observers could search for the cetaceans and determine if those animals have or may enter the monitoring zone. The lack of vocalizations would also provide further confirmation that there are no cetaceans in the Pier E3 area if the visual observations also document that no animals are present. The sonobuoys may detect cetaceans out to approximately 5 km, would last for up to eight hours, and with the radio signal extending out to 18 km (McDonald and Moore 2002).

The acoustician would be positioned in a boat northeast of Treasure Island and sonobuoys would be dropped south of Yerba Buena Island (Figure 24). Generally harbor porpoises move south along Treasure Island (initially would be detected by the deployed hydrophone) and continue south around Yerba Buena Island (detected by the sonobuoys) so that the two acoustic stations would be able to detect cetaceans moving into and through the Pier E3 monitoring area. The bio-acoustician would be in communication with the Lead MMO and would alert the crew to the presence of any cetacean approaching the monitoring area.

Stranding Plan: A stranding plan will be prepared in cooperation with the local NMFS-designated marine mammal stranding, rescue, and rehabilitation center. Although mitigation measures would likely prevent any injuries, preparations will be made in the unlikely event that marine mammals are injured. Elements of that plan would include the following:

1. The stranding crew would prepare treatment areas at the NMFS-designated facility for cetaceans or pinnipeds that may be injured from the implosion. Preparation would include equipment to treat lung injuries, auditory testing equipment, dry and wet caged areas to hold animals, and operating rooms if surgical procedures are necessary. Equipment to conduct auditory brainstem response hearing testing would be available to determine if any inner ear threshold shifts (TTS or PTS) have occurred (Thorson et al. 1999).
2. A stranding crew and a veterinarian would be on call near the Pier E3 site at the time of the implosion to quickly recover any injured marine mammals, provide emergency veterinary care, stabilize the animal’s condition, and transport individuals to the NMFS-designated facility. If an injured or dead animal is found, NMFS (both the regional office and headquarters) will be notified immediately even if the animal appears to be sick or injured from other than blasting.

3. Post-implosion surveys would be conducted immediately after the event and over the following three days to determine if there are any injured or dead marine mammals in the area.
4. Any veterinarian procedures, euthanasia, rehabilitation decisions and time of release or disposition of the animal will be at the discretion of the NMFS-designated facility staff and the veterinarians treating the animals. Any necropsies to determine if the injuries or death of an animal was the result of the blast or other anthropogenic or natural causes will be conducted at the NMFS-designated facility by the stranding crew and veterinarians. The results will be communicated to both the Department and to NMFS as soon as possible with a written report within a month.

14. Suggested Means Of Learning Of, Encouraging, And Coordinating Research Opportunities, Plans, And Activities Relating To Reducing Such Incidental Taking And Evaluating Its Effects.

A Marine Mammal Monitoring Plan for pile driving and mechanical demolition was developed by the Department and submitted to NMFS in 2004 and a revised plan was submitted to NMFS in 2013. This plan provides information on the required monitoring methods as well as reporting requirements. An additional study of the removal of the cement bridge piers using implosion was submitted to NMFS in March 2014. The study provided detailed information on the use of implosion to remove the pier, estimated distances to the NMFS impulse sound criteria thresholds, and an expanded monitoring plan to further mitigate impacts to marine mammals.

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APPENDIX A: Pier E3 Blast Plan

APPENDIX B: Blast Attenuation System Details

APPENDIX C: Alternatives Analysis