San Francisco–Oakland Bay Bridge
East Span Seismic Safety Project

Marine Foundation Removal Project
2017 Post-Blast Marine Mammal Report

EA 04-013574

EFIS#: 0416000287

04-SF-80 KP 12.2/KP 14.3

04-ALA-80 KP 0.0/KP 2.1

May 2018

California Department of Transportation

Caltrans

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California Department of Transportation

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The environmental review, consultation, and any other actions required by applicable Federal environmental laws for this project are being, or have been, carried out by Caltrans pursuant to 23 U.S.C. 327 and the Memorandum of Understanding dated December 23, 2016 and executed by FHWA and Caltrans.

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List of Abbreviated Terms

°C	degrees Celsius
°F	degrees Fahrenheit
µPa	micro Pascal
BAS	blast attenuation system
Bay	San Francisco Bay
BCDC	San Francisco Bay Conservation and Development Commission
BO	Biological Opinion
CCSF	City and County of San Francisco
CDFW	California Department of Fish and Wildlife
cSEL	cumulative sound exposure level
dB	decibel(s)
Delta	Sacramento–San Joaquin Delta
Demonstration Project	Pier 3 Demonstration Project
Department	California Department of Transportation
FESA	Federal Endangered Species Act
GPS	Global Positioning System
IHA	Incidental Harassment Authorization
ITP	Incidental Take Permit
mg/L	milligrams per liter
mm	millimeter
MMEZ	Marine Mammal Exclusion Zone
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
mph	miles per hour
ms	millisecond(s)
NGVD29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
NMFS-OPR	National Marine Fisheries Service Office of Protected Resources
OTD	Oakland Touchdown
psi	pound per square inch
psi-ms	pounds per square inch-milliseconds
PTS	permanent threshold shift
RWQCB	Regional Water Quality Control Board
SFOBB	San Francisco–Oakland Bay Bridge
SFOBB Project	San Francisco–Oakland Bay Bridge East Span Seismic Safety Project
SWPPP	Storm Water Pollution Prevention Plan
TMMC	The Marine Mammal Center
TTS	temporary threshold shift
UAV	unmanned aerial vehicle
USACE	United States Army Corps of Engineers

USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
YBI	Yerba Buena Island
ZOI	zone of influence

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Chapter 1. Project Description and Background

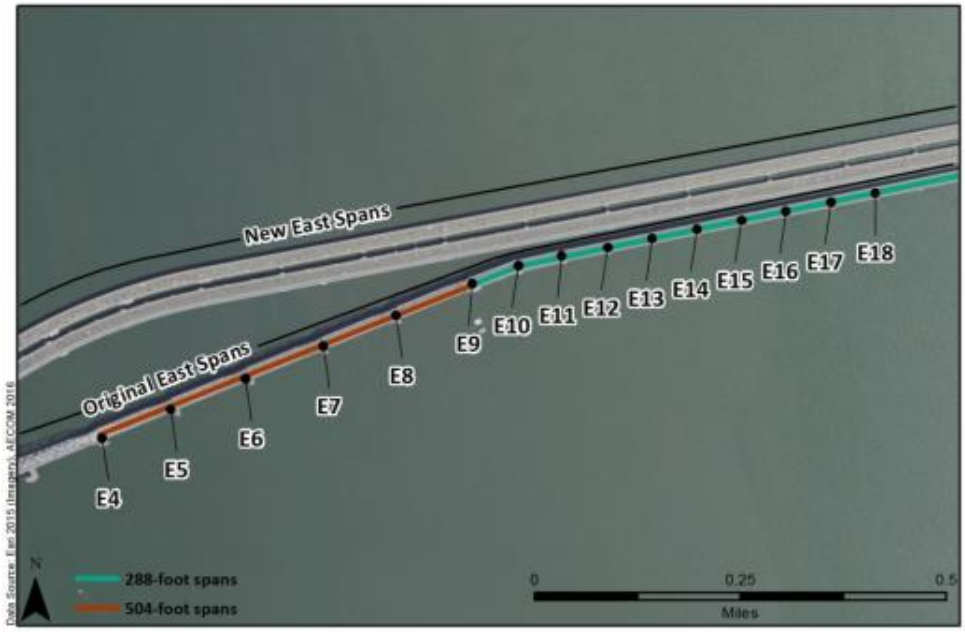
1.1. SFOBB Project Background Summary

The Department, as part of the San Francisco–Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project (SFOBB Project), is in the final stage of dismantling the original east span of the SFOBB. The Department successfully imploded Pier E3 in 2015 and Piers E4 and E5 in 2016 with highly controlled charges. Piers E6 through E18 were successfully imploded in 2017. Controlled implosion was implemented as an alternate method to the originally permitted mechanical methods for dismantling the remaining marine foundations, because it resulted in fewer in-water work days, reduced impact on environmental resources of the San Francisco Bay, and required a shorter time frame for completion. The successful implosion of the piers, as well as the results from hydroacoustic, biological, and water quality monitoring that was conducted during and following the implosions, demonstrated that the use of highly controlled charges was an effective and efficient method for removal of these types of marine foundations, with the least impact on the environment and biological resources. Based on the positive results from the removal of Piers E3, E4, and E5, the Department used controlled implosions in 2017 to implode Piers E6 through E18. This removal method reduced the originally proposed in-water work duration by a year. In 2017 some piers were imploded as multiple-pier implosion events such that thirteen piers were imploded during a total of six events within the implosion work window. During multiple-pier implosion events, two to three piers were imploded sequentially.

The project area is located in the Central Bay, between Yerba Buena Island (YBI) and the City of Oakland. The western limit of the SFOBB Project area is the east portal of the YBI tunnel, located in the City of San Francisco. The eastern limit is approximately 1,300 feet (396 meters) west of the SFOBB toll plaza at the Oakland Touchdown (OTD) in the City of Oakland.

Removal of the marine foundations of the original east span occurred within the jurisdictions of the City and County of San Francisco (CCSF) and the City of Oakland in Alameda County. Piers E4 and E5 were located within CCSF jurisdiction and were removed in October 2016. Pier E6 straddled the border that delineates the CCSF from the city of Oakland. Piers E7 through E18 were located in the city of Oakland. All piers were located between the OTD and YBI, and were situated south of the new east span bridge

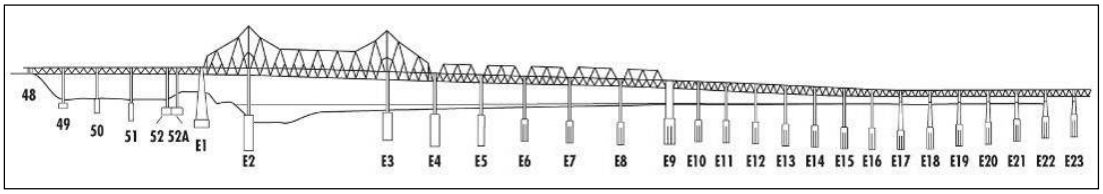
(Figure 1-1). The elevation of the new east span in relation to the original east span is shown in Figure 1-2. Approximate locations of each pier are shown in Table 1-1.



Source: Compiled by AECOM in 2016

Figure 1-1. Locations of Original East Span Marine Foundations, Piers E4 to E18

Original East Span



New East Span

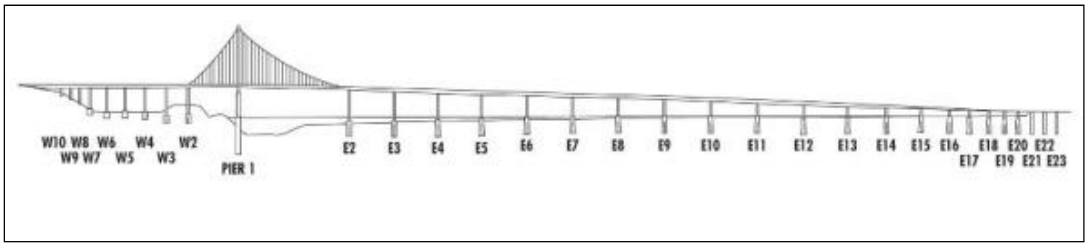


Figure 1-2. San Francisco–Oakland Bay Bridge Pier Locations

Table 1-1. Location Details for Remaining Marine Foundations of the SFOBB Original East Span

Pier Number	Approximate Distance to YBI		Approximate Distance to OTD		Approximate Coordinates
	Feet	Meters	Feet	Meters	
E6	3,058	932	5,511	1,680	37º 49' 02.38"N, 122º 20' 56.93"W
E7	3,580	1,091	5,008	1,526	37º 49' 04.23"N, 122º 20' 50.90"W
E8	4,070	1,241	4,504	1,373	37º 49' 06.18"N, 122º 20' 45.14"W
E9	4,590	1,399	4,001	1,220	37º 49' 08.13"N, 122º 20' 39.17"W
E10	4,897	1,493	3,688	1,124	37º 49' 09.24"N, 122º 20' 35.57"W
E11	5,185	1,580	3,404	1,038	37º 49' 09.83"N, 122º 20' 31.97"W
E12	5,478	1,670	3,110	948	37º 49' 10.43"N, 122º 20' 28.43"W
E13	5,765	1,757	2,818	859	37º 49' 11.00"N, 122º 20' 24.90"W
E14	6,053	1,845	2,526	770	37º 49' 11.56"N, 122º 20' 21.25"W
E15	6,343	1,933	2,232	680	37º 49' 12.06"N, 122º 20' 17.69"W
E16	6,628	2,020	1,951	595	37º 49' 12.64"N, 122º 20' 14.19"W
E17	6,923	2,110	1,666	508	37º 49' 13.24"N, 122º 20' 10.68"W
E18	7,216	2,199	1,376	419	37º 49' 13.75"N, 122º 20' 06.97"W

Note:
OTD = Oakland Touchdown; YBI = Yerba Buena Island
Source: Compiled by AECOM in 2016

1.2. Physical Conditions

1.2.1. Climate and Topography

The Bay is the largest estuary along the West Coast of the United States and is characterized by a Mediterranean climate. Generally, the climate is defined as having a dry season in summer and fall, followed by a wet winter. However, a variety of features—ranging from coastal mountain ranges, inland valleys, and smaller bays within the larger Bay—create unique local climates. Coastal areas typically are cooler than inland areas, and northern portions of the Bay generally receive more rainfall than southern areas. The average high temperature in San Francisco is 63.7 degrees Fahrenheit (°F) (17.6°Celsius [°C]) and the average low temperature is 51.1°F (10.6°C).

1.2.2. Hydrology

The SFOBB Project area is located within the Bay's hydrological region. Fresh water from the Sacramento and San Joaquin rivers enter the Bay at the Sacramento–San Joaquin Delta (Delta) before being carried into the Pacific Ocean through other portions

of the Bay. Outflow from these rivers varies seasonally with rainfall and releases of managed reservoirs and diversions located upstream.

Generally, freshwater outflow into the Delta (and into the Bay) is greatest in spring and lowest in late summer and fall. Furthermore, this interaction between freshwater outflow from the Delta and tidal conditions influence the salinity gradient in the Bay. In turn, numerous fish and wildlife species change their spatial distribution in the Bay, in response to changes in this salinity gradient.

The SFOBB Project area is located in what generally is considered to be the Central Bay. The Central Bay is the deepest basin, is most influenced by the ocean, and has the saltiest water (on average) in the Bay. The deepest point is over 300 feet (100 meters) deep, near the Golden Gate Bridge. The Central Bay has the most marine species in the Bay and likely has the highest species diversity.

1.2.3. **Substrate/Sediments**

The sandy sediments in this portion of the Bay are understood to be sourced from shoreline sediments from outside the Bay, or from the Sierras via San Pablo Bay. Sediments in the Central Bay are estimated to be up to 100 meters thick. Most of the Bay in the vicinity of Piers E6 through E18 is made up of small, soft particles that can be moved by tidal currents. The sediments range in size, from clay (0.001 to 0.0039 millimeter [mm]) to silt (0.0039 to 0.0625 mm) to sand (0.0625 to 2 mm). Larger particles, including gravel (2 to 64 mm) and cobble (64 to 256 mm) also can be found in the soft-bottomed habitats. Sand deposits can be found throughout the deeper parts of the Central Bay and the main channel through San Pablo Bay. Strong tidal currents along the Bay floor make it a dynamic environment, with significant alteration and movement of sediments over time.

1.3. Regulatory Context

The original approvals for the SFOBB Project authorized and required dismantling of the original east span and were obtained in 2001 from the United States Coast Guard (USCG), the United States Army Corps of Engineers (USACE), , the California Department of Fish and Wildlife (CDFW), the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Regional Water Quality Control Board (RWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC). The initially proposed method of removal included traditional mechanical dismantling only. Removal of marine foundations to 1.5 feet below the mudline is required by the USCG, in Bridge Permit 3-01-11, condition number 7 and the

BCDC Permit (Permit No. 2001.008 [formerly Permit No. 8-01]). The Federal Environmental Impact Statement (FEIS), completed by the Department in 2001, stated that the marine foundations would be removed.

In 2012, the Department requested and received authorizations from regulatory agencies that included driving piles to build temporary trestles and falsework and facilitate dismantling of the original east span. Discussions with regulatory agencies were initiated in 2012 and to address potential removal of the marine foundations using controlled blasting.

1.3.1. **2015 authorizations for the Pier E3 Demo Project**

In 2015, the Department requested and received regulatory agency approvals and authorizations from the USACE, USCG, CDFW, the RWQCB, and BCDC for the use of controlled blasting to dismantle the Pier E3 marine foundation as a demonstration project (Demonstration Project). As part of these approvals, federal Endangered Species Act (Section 7) consultation was reinitiated by the Department with the NMFS, to determine and obtain coverage for potential impacts on federally protected fish species. A new Biological Opinion (BO) (NMFS 2015) was issued to cover potential impacts to listed species, their critical habitat, and Essential Fish Habitat from the Demonstration Project. This BO was in addition to the SFOBB Project's pre-existing BO (NMFS 2012). Furthermore, the Department requested and received from NMFS Office of Protected Resources (NMFS-OPR) a new Marine Mammal Protection Act Incidental Harassment Authorization (IHA), specifically for the Demonstration Project. Two letters of Modification to the original USACE Individual Permit were issued by the USACE for the project. CDFW issued the Project an amendment to the original Incidental Take Permit (ITP). Water Quality impacts from the Pier Demonstration Project were covered under a RWQCB accepted Storm Water Pollution Prevention Plan (SWPPP). The Project's BCDC permit was also amended for the Demonstration Project.

1.3.2. **2016 authorizations for the use of Pier E4-18 in 3 seasons**

On February 29, 2016, the Department received concurrence in a letter from USCG for proposed limits of removal of Piers E2 and E4 through E22. In spring 2016, the Department requested and received approval to remove Piers E4 to E18, using similar methods from the same agencies listed above. Approvals included a new consultation and BO from NMFS, a new IHA from NMFS-OPR for the removal of Piers E4 and E5 in 2016, a Letter of Modification to its USACE Individual Permit, and an amendment to its existing CDFW ITP. Water Quality impacts were covered under the RWQCB accepted SWPPP. Two amendments were issued to the SFOBB Project's existing BCDC permit.

1.3.3. **2017 amendments and approvals for Piers E6 through E18**

In 2017, the Department requested and received approval from the agencies to conduct multiple blast events to dismantle Piers E6 to E18, during which multiple piers (up to four) would be removed in sequence during the same event, and to extend the approved post-blast clean-up window from December 15 to December 31. These approvals included a letter of concurrence from NMFS and an errata sheet to the 2016 NMFS BO, a new IHA from NMFS-OPR for removal of Piers E6 through E18, a Depredation Permit (MB57490C-0) from USFWS to use an unmanned aerial vehicle (UAV) (e.g., drone) as a pre-blast bird deterrent, a Letter of Modification to the USACE Individual Permit, an amendment (No. 6) to the existing CDFW ITP, and an amendment to the SWPPP. This effort was covered by the existing BCDC permit, as amended.

1.4. Mechanical Preparation and Removal

The first step in the pier removal process required mechanical removal of above-water pedestals that sat atop each of the remaining pier's caps, above the water. Mechanical removal operations for Piers E6 through E18 differed from the previously completed mechanical dismantling (Piers E3 to E5) because these piers did not have support aprons, fender systems, and/or did not require lowering of structural walls. The concrete pedestals were dismantled mechanically using wire saws, excavators mounted with hoe rams, drills, torches, and cutting tools, to an approximate elevation of +9 feet National Geodetic Vertical Datum of 1929 (NGVD29). Each remaining pier contained two hollow concrete pedestals, with the exception of Pier E9. Pier E9 contained four solid concrete pedestals. After the above water pedestals were removed, all remaining structures had vertical boreholes drilled into them, where the charges were loaded for controlled blasting.

1.5. Pier Implosions

Before the blast events, controlled charges were loaded into the bore holes of the pier to be removed. The boreholes varied in diameter and depth, and were designed to provide optimal efficiency in transferring the energy created by the controlled charges to dismantle the piers. Charges were arranged in different levels (decks) and were separated in the boreholes by stemming. Stemming is the insertion of inert materials, such as sand or gravel, to insulate and retain charges in an enclosed space. Stemming allowed more efficient transfer of energy into the structural concrete for fracturing and further reduced the release of potential energy into the adjacent water column. Individual cartridge charges, using electronic blasting caps, were selected to provide greater control and accuracy in determining the individual and total charge weights. Use of individual

cartridges allowed a refined blast plan that efficiently broke the concrete while minimizing the amount of charges needed. Maximum individual charge weights used at each pier ranged from approximately 20 to 35 pounds. The total charge weights for each controlled blast event varied and are shown in Table 1-2.

Table 1-2. Pier Implosion Details for Piers E6 through E18

Blast Event	Piers	Blast Date	Blast Time	Approximate Explosive Charge Weight per Event (pounds)	Approximate Blast Event Duration per Event (seconds)
1	E7+E8	September 2, 2017	10:36 a.m.	8,880	5
2	E6	September 16, 2017	10:00 a.m.	15,500	7
3	E9+E10	September 30, 2017	9:23 a.m.	8,120	4
4	E11+E12+E13	October 14, 2017	8:51 a.m.	5,680	4
5	E14+E15+E16	October 28, 2017	7:49 a.m.	5,520	4
6	E17+E18	November 11, 2017	7:27 a.m.	4,000	3
Source: Compiled by AECOM in 2017					

To minimize impacts on biological resources, controlled blasting events to remove Piers E6 through E18 were conducted during high slack tide in the fall months of each construction season (i.e., September, October, or November), using a blast attenuation system (BAS). As shown during the Pier E3 Demonstration Project (Demonstration Project) and the subsequent implosions of Piers E4 and E5, the BAS decreased noise and pressure waves, generated during each controlled blast, and minimized potentially adverse effects on nearby biological resources. The BAS is a modular system of pipe manifold frames, placed around each pier and fed by air compressors to create a curtain of air bubbles.

Between September 2 and November 11, 2017, the Department successfully executed the controlled implosions of Piers E6 through E18. Blast events, including timed delays between pier implosions for multiple-implosion events, lasted approximately 3 to 7 seconds, depending on the pier being removed or pier grouping. During multiple pier blast events, the spacing between the last charge on one pier and the first charge on the next pier was approximately one-half of a second, providing enough time between blasts to avoid accumulating peak sound pressure waves. Details for each blast event are shown in Table 1-2.

Public safety measures were implemented during the controlled implosion events. Safety zones were established and enforced, in conjunction with the California Highway Patrol and CDFW to exclude marine traffic not directly involved in the implosion. Safety procedures, roadway traffic management in both directions on the SFOBB, and complete closure of public access to the bike path/pedestrian walkway in advance of each controlled implosion were implemented successfully.

1.6. Post-Implosion Cleanup and Demobilization

Following each controlled blasting event and after receiving confirmation that the area was safe for work, construction crews removed all associated equipment, including barges, compressors, the BAS, and blast mats. Rubble from Piers E6 through E18 was removed down to each pier's respective, planned, debris removal limit elevation by a barge-mounted crane with a clamshell bucket. The clamshell bucket was equipped with a Global Positioning System (GPS) unit, to accurately guide the movement of the bucket during underwater operation. Post-blast debris management for all piers was completed before November 30, 2017.

Chapter 2. Marine Mammal Monitoring Program Background

The Department was issued an IHA from NMFS (2017 IHA), pursuant to the MMPA, for behavioral harassment of and temporary injury impacts to California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina richardii*), northern elephant seal (*Mirounga angustirostris*), northern fur seal (*Callorhinus ursinus*), harbor porpoise (*Phocoena phocoena*), and common bottlenose dolphin (*Tursiops truncatus*), incidental to the controlled implosion of Piers E6 through E18 (NMFS 2017).

The Marine Mammal Monitoring Program was implemented to minimize injury and harassment to marine mammals, establish injury and harassment threshold criteria zones, and specify methods for monitoring and reporting marine mammal activity near the implosion area. The Marine Mammal Monitoring Plan, as part of the 2017 Biological Monitoring Program, was prepared in compliance with the requirements for implosion of Piers E6 through E18 under the 2017 IHA.

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Chapter 3. Marine Mammal Monitoring Results

Underwater blasting has the potential to result in the incidental take of marine mammals. On July 13, 2017, the Department was issued its 2017 IHA from NMFS, pursuant to the MMPA for the take of six species: California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina richardii*), northern elephant seal (*Mirounga angustirostris*), northern fur seal (*Callorhinus ursinus*), harbor porpoise (*Phocoena phocoena*), and common bottlenose dolphin (*Tursiops truncatus*), by Level B harassment incidental to the controlled implosions of 13 piers of the SFOBB original east span (NMFS 2017; 82 Federal Register 35510).

The 2017 IHA allowed incidental take of the above species by Level B Harassment—Behavioral Response as well as Temporary Threshold Shift (TTS) at the quantities shown in Table 4-1. The number of marine mammals, by species, that may be taken was calculated based on distance to the threshold criteria, duration of the activity, and the estimated density of each species in the zone of influence (ZOI). Take of marine mammals by Level A Harassment–Permanent Threshold Shift (PTS), injury, or mortality was prohibited.

Table 3-1. Marine Mammal Take Allowed under the 2017 Incidental Harassment Authorization

Species	Level B Take	
	Behavioral	Temporary Threshold Shift
Pacific harbor seal	66	48
California sea lion	18	12
Northern elephant seal	6	3
Harbor porpoise	18	9
Bottlenose dolphin	6	3
Northern fur seal	6	3
Source: NMFS 2017; 82 Federal Register 35510, July 31, 2017		

3.1. Monitoring Methods

The 2017 IHA prescribed marine mammal monitoring requirements to be implemented before, during, and after underwater blasting activities. The goals of monitoring were to

avoid Level A take of marine mammals, document Level B take within authorized take limits, and document any disturbance, harassment, or injury of marine mammals. In compliance with requirements of the 2017 IHA, the Department prepared a Marine Mammal Monitoring Plan, included in the 2017 Biological Monitoring Program.

3.1.1. **Marine Mammal In-Water Threshold Criteria**

NMFS has established sound threshold criteria for take of marine mammals from underwater blasting (Table 4-2). Hydroacoustic monitoring results from the implosions of Piers E3 in 2015 and Piers E4 and E5 in 2016 were used to estimate sound pressure and exposure levels, as well as to conservatively estimate the distances to these threshold criteria for the 2017 implosions of Piers E6 through E18. Methods to estimate and monitor the 2017 exclusion zones are described in Section 4.1.2 of this chapter. Hydroacoustic monitoring methods are described above in Chapter 3, and hydroacoustics monitoring results related to marine mammal thresholds are presented below in Section 4.3.

Table 3-2. Intermit Sound Threshold Criteria for Take of Marine Mammals from Underwater Blasting

Group/ Species	Behavior		Slight Injury			Mortality
	Behavioral (for ≥ 2 pulses/ 24 hours)	TTS	PTS	Gastro Intestinal Tract	Lung	
Low- frequency Cetaceans/ humpback whale	163 dB cSEL (LF_{II})	168 dB cSEL (LF_{II}) or 213 dB peak SPL	183 dB cSEL (LF_{II}) or 219 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/ bottlenose dolphin	165 dB cSEL (MF_{II})	170 dB cSEL (MF_{II}) or 224 dB peak SPL	185 dB cSEL (MF_{II}) or 230 dB peak SPL			
High-frequency Cetaceans/ harbor porpoise	135 dB cSEL (HF_{II})	140 dB cSEL (HF_{II}) or 196 dB peak SPL	155 dB cSEL (HF_{II}) or 202 dB peak SPL			
Pinnipeds–Phocidae/ harbor seal and elephant seal	165 dB cSEL (P_{WI})	170 dB cSEL (P_{WI}) or 212 dB peak SPL	185 dB cSEL (P_{WI}) or 218 dB peak SPL			
Pinnipeds-Otariidae/ sea lion and northern fur seal	183 dB cSEL (O_{WI})	188 dB cSEL (O_{WI}) or 226 dB peak SPL	203 dB cSEL (O_{WI}) or 232 dB peak SPL			

Notes:
dB = decibel(s); cSEL = cumulative sound exposure level; Pa-sec = Pascal-second; PTS = Permanent Threshold Shift; RMS = root-mean-square; SPL = sound pressure level; TTS = Temporary Threshold Shift
All decibels are referenced to 1 micro Pascal (re: 1µPa).
Groups associated with cumulative sound exposure level thresholds indicate the designated marine animal auditory weighting function.
Source: Finneran and Jenkins 2012; NMFS 2016

3.1.2. **Monitoring Zones**

The hydroacoustic monitoring results from the implosions of Piers E3, E4, and E5 were used to calculate distances to these thresholds for the implosions of Piers E6 through E18 (Department 2016, 2017a). Based on the calculated distances and in coordination with NMFS, the Department established specific Marine Mammal Exclusion Zones (MMEZs) and monitoring zones for each species group (or combined groups) for each type of blast event scenario. Level A MMEZs and Level B TTS and behavioral response monitoring zones were designed to be larger than the furthest calculated threshold distances (ZOI) appropriate to specific marine mammal functional hearing groups to create more conservative monitoring zones. These MMEZ and monitoring zone distances are shown in Tables 4-3 and 4-4.

Table 3-3. Pinniped and Bottlenose Dolphin Level A MMEZs and Level B TTS and Behavioral Response Monitoring Zones for 2017 Blast Events

Blast Scenario	Level B Harassment Monitoring Zones		Level A Harassment MMEZ
	Behavioral	TTS	PTS
Pier E6	2,664 ft (812 m)	1,781 ft (543 m)	532 ft (162 m)
Two 504-foot-span piers	2,148 ft (655 m)	1,423 ft (434 m)	400 ft (122 m)
Two 288-foot-span piers	1,631 ft (497 m)	1,080 ft (329 m)	367 ft (112 m)
Three 288-foot-span piers	1,896 ft (578 m)	1,254 ft (382 m)	367 ft (112 m)

Note: MMEZ = marine mammal exclusion zone; TTS = Temporary Threshold Shift; PTS = Permanent Threshold Shift ; ft = feet; m = meters

Source: Compiled by AECOM in 2017

Table 3-4. Harbor Porpoise MMEZs and Level B TTS and Behavioral Response Monitoring Zones for 2017 Blast Events

Blast Scenario	Level B Harassment Monitoring Zones		Level A Harassment MMEZ
	Behavioral	TTS	PTS
Pier E6	15,080 ft (4,596 m)	10,030 ft (3,057 m)	2,951 ft (899 m)
Two 504-foot-span piers	12,360 ft (3,767 m)	8,160 ft (2,487 m)	2,359 ft (719 m)
Two 288-foot-span piers	9,240 ft (2,816 m)	6,168 ft (1,880 m)	1,877 ft (572 m)
Three 288-foot-span piers	11,284 ft (3,439 m)	7,080 ft (2,158 m)	2,066 ft (630 m)

Note:

MMEZ = marine mammal exclusion zone; TTS = Temporary Threshold Shift; PTS = Permanent Threshold Shift ; ft = feet; m = meters

Source: Compiled by AECOM in 2017

A minimum of ten NMFS-approved marine mammal observers (MMOs) conducted monitoring before, during, and after each blast event for the implosions of Piers E6 through E18. MMO positions were designated ahead of time, near the edge of each MMEZ and within monitoring zones. Monitoring stations included boats, bridge piers, the new SFOBB, and on locations at Treasure Island and YBI. Monitoring began a minimum of 30 minutes before the anticipated blast time, and continued for 60 minutes after the implosion.

Each MMO recorded his/her observation position, start and end times of observations, and weather conditions (e.g., sunny/cloudy, wind speed, fog, visibility). For each marine mammal sighting, the following items were recorded, if possible:

- species, number of animals (i.e., include with or without a dependent pup/calf);
- age class (i.e., pup/calf, juvenile, adult);
- identifying marks or color (e.g., scars, red pelage, damaged dorsal fin);
- position relative to pier implosion (i.e., distance and direction);
- movement (i.e., direction and relative speed);
- behavior (e.g., logging [resting at the surface], swimming, spy-hopping [raising above the water surface to view the area], foraging);

- signs of injury, stress, or other unusual behavior; and
- duration of sighting or times of multiple sightings of the same individual.

All MMOs were equipped with radios, using a dedicated marine mammal monitoring channel and with mobile phones as a back-up. One MMO, designated as the Lead MMO, was in constant contact with the Environmental Compliance Manager, who was with the Department's Resident Engineer and Blaster-in-Charge. The Lead MMO coordinated marine mammal sightings with the other MMOs. Each MMO contacted the other MMOs when a sighting was made within or near the MMEZs, so that the MMOs with overlapping areas of responsibility could continue to track the animal and the Lead MMO was aware of the animal's position.

If a sighting was within 30 minutes of the scheduled blast and an animal had entered an MMEZ or was near it, the Lead MMO was to notify the Department Environmental Compliance Manager and a delay protocol was to be implemented. If an animal was identified within the MMEZ or approaching the MMEZ, the animal was to be tracked until it left the zone. If it dove within the MMEZ and was not seen again, a 15-minute delay was to be implemented for pinnipeds and small cetaceans or a 30-minute delay for whales or other non-IHA listed species. The Lead MMO kept everyone informed of the location and disposition of the animal and was to notify the Department Environmental Compliance Manager if and when the MMEZs were clear before the implosion.

3.1.3. **Stranding Survey**

A stranding plan was prepared, in cooperation with the NMFS-designated marine mammal stranding, rescue, and rehabilitation center for central California. Although avoidance and minimization measures were anticipated to prevent any injuries from the implosions, preparations were made in the unlikely event that marine mammals were injured. Because sick, injured, or dead marine mammals could strand in the Bay for various reasons unrelated to the implosion activities, it was necessary to determine the cause of stranding for any marine mammals that appeared within 3 days after the implosion. Therefore, plans were made to examine sick or injured individuals that were observed after the implosion more thoroughly, to determine the cause of the stranding.

A stranding team member and a veterinarian for The Marine Mammal Center (TMMC) were staged near the project site at the time of the implosions to quickly recover any injured marine mammals, provide emergency veterinary care, and transport individuals to the stranding facility. In accordance with the 2017 IHA, NMFS (both the regional office and headquarters) were to be notified within the required timelines if any injured or dead

animals were found, even if the animal appeared to be sick or injured from a cause other than the implosion.

Post-implosion stranding surveys were conducted immediately after the pier implosion events and over the following 3 days, to identify any injured or deceased marine mammals. The surveys were conducted by the Lead MMO; TMMC's stranding team was present only during the first survey, conducted immediately following each pier implosion. Surveys began within 90 minutes after the implosion event, and each took approximately 4 hours to complete. TMMC's stranding team was staged on the survey boat with nets, animal carriers, and a medical kit during the initial stranding survey.

Stranding surveys were conducted by boat and along the shoreline in the vicinity of the SFOBB new and original east spans (Figure 4-1). Boat surveys were conducted from Oakland Outer Harbor Berth 9 to Clipper Cove, counter-clockwise around Treasure Island and YBI. From YBI, the boat surveys included the moored barges on the north side of the new span, along the old east span piers, northeast toward Richmond, the Emeryville breakwater, and the Emeryville Crescent, before returning to Berth 9. Each survey path varied slightly, depending on field and tide conditions. Land surveys were conducted along the shoreline at the OTD, at the Emeryville Crescent, and along the shoreline north of the Oakland toll plaza and SFOBB approaches. The shoreline includes two stretches of sandy beach, riprap, and portions of Radio Road, which runs parallel to the north side of Highway 80 west-bound.

Figure 3-1. Stranding Survey Area

3.2. Monitoring Summary and Results

3.2.1. Piers E7 and E8

Implosion Monitoring

The implosion of Piers E7 and E8 occurred at 10:36 a.m. on September 2, 2017. Marine mammal monitoring was conducted from 7:35 to 11:40 a.m. A total of 78 harbor seals, 10 harbor porpoises, and three unidentified porpoises or dolphins were observed during the monitoring period on September 2. One harbor seal was observed within the Pinniped Level B TTS monitoring zone, and five harbor seals were observed within the Pinniped Level B behavioral response monitoring zone, within 15 minutes before the time of the blast. A summary of marine mammal take is shown in Table 4-5. A complete table showing all marine mammal sightings during the monitoring period for the September 2 implosions of Piers E7 and E8 is provided in Appendix A.

Table 3-5. Summary of Marine Mammal Take for the September 2, 2017 Implosions of Piers E7 and E8

Species Name	Level A Harassment	Level B Harassment	
	Permanent Threshold Shift	Temporary Threshold Shift	Behavioral Monitoring
Harbor seal	0	1	5
Source: Compiled by AECOM in 2017			

Stranding Surveys

The stranding surveys for the implosions of Piers E7 and E8 were conducted with TMMC immediately following the blast event on September 2, 2017; and then subsequently from September 3 to 5 by the Lead MMO only (Figure 4-1).

On September 2, 2017, the team observed five harbor seals in the water, and nine to 11 harbor seals at the YBI haul-out site during the post-implosion boat survey. No abnormal behavior or injuries were observed. One unknown animal dove near the out-of-range marker, west of Berth 9. On this day, no marine mammals were rescued by TMMC that showed any evidence of blast trauma in the Central Bay (TMMC, pers. comm., 2017). On September 3, the Lead MMO observed eight harbor seals in the water, with no abnormal behavior or injuries. No animals were hauled out at the YBI site, which was attributed to the survey occurring close to high tide. No marine mammals were observed during the land survey. On September 4, the Lead MMO observed five to six harbor seals in the water and 69 at the YBI haul-out site, during the boat survey. No marine mammals were observed during the land survey, and no marine mammals were reported to be stranded. On September 5, two harbor seals were observed in the water with normal behavior, during the boat survey. No marine mammals were observed during the land survey, and no marine mammals were reported to be stranded.

One moderately to advanced decomposed phocid was found on the beach on the west side of YBI (37.80999 N, 122.37190) on September 2, 2017. Per Section 8(f) and Section 9(b) of the IHA, notification was sent to NMFS. The veterinarian from TMMC and the Lead MMO determined the cause of death was unrelated to the implosion activities because the body was in a moderate to advanced state of decomposition. One sea lion was reported to TMMC at Hyde Street Pier in San Francisco, because of emaciation, and was being tracked on the morning of September 3 (TMMC, pers. comm., 2017). The emaciated sea lion at the Hyde Street Pier most probably was not related to the implosion activity, because one day would not be enough time for a sea lion to

become emaciated as a result of pier implosion activities. No other animals with abnormal behavior or injuries were observed between September 2 and 5.

3.2.2. **Pier E6**

Implosion Monitoring

The Pier E6 implosion occurred at 10 a.m. on September 16, 2017. Marine mammal monitoring was conducted from 7:31 to 11:03 a.m. A total of 35 harbor seals, three California sea lions, and eight harbor porpoises were observed during the monitoring period on September 16. Five harbor seals were observed within the Pinniped Level B TTS monitoring zone, and three harbor porpoises were observed milling just on the Harbor Porpoise Level B TTS monitoring zone border, within 15 minutes of the blast. An additional seven harbor seals that were not observed within this zone before the blast surfaced immediately following the blast within the Pinniped Level B TTS monitoring zone. A summary of marine mammal take is shown in Table 4-6. A complete table showing all marine mammal sightings during the monitoring period for the September 16 implosion of Pier E6 is provided in Appendix A.

Table 3-6. Summary of Marine Mammal Take for the September 16, 2017 Implosion of Pier E6

Species Name	Level A Harassment	Level B Harassment	
	Permanent Threshold Shift	Temporary Threshold Shift	Behavioral Monitoring
Harbor seal	0	12	0
Harbor porpoise	0	3	0
Source: Compiled by AECOM in 2017			

Stranding Surveys

The stranding surveys for the implosion of Piers E6 was conducted with TMMC immediately following the blast event on September 16, 2017; and then subsequently from September 17 to 19 by the Lead MMO only (Figure 4-1).

On September 16, 2017, the stranding team observed six harbor seals in the water, and three to four harbor seals at the YBI haul-out site during the boat survey. No abnormal behavior or injuries were observed. No stranded marine mammals were discovered along any of the shore areas. During that same time, no marine mammals were rescued by TMMC from any location in the Bay that showed any evidence of blast trauma (TMMC, pers. comm., 2017). On September 17, the Lead MMO observed seven harbor seals in the water, and 59 hauled out at YBI with no abnormal behavior or injuries. No strandings

were reported to TMMC (TMMC, pers. comm., 2017). On September 18, the Lead MMO observed six harbor seals in the water with normal behavior near the USCG marina during the boat survey. No marine mammals were observed during the land survey. No marine mammals were reported to be stranded. On September 19, 12 harbor seals were observed in the water with normal behavior during the boat survey. Eight harbor seals were observed along the SFOBB new east span, near Piers E2 through E4. No marine mammals were observed during the land survey. No marine mammals were reported to be stranded.

One dead harbor seal was observed during the land survey on Toll Plaza Beach (37.82613, -122.31668) at 14:50 on September 17, 2017. TMMC's Stranding Team and NMFS were notified, per Section 8(f) and Section 9(b) of the IHA. The Lead MMO, in conjunction with TMMC, determined the time of death likely occurred more than a week and possibly several weeks earlier. Based on the advanced state of decomposition, it was determined that the cause of death of the animal was not likely related to implosion events. TMMC opted not to pick up the carcass, as a necropsy would not have been likely to yield any results because of its state. No other animals with abnormal behavior or injuries were observed between September 16 and 19.

3.2.3. Piers E9 and E10

Implosion Monitoring

The implosion of Piers E9 and E10 occurred at 9:23 a.m. on September 30, 2017. Marine mammal monitoring was conducted from 7:13 to 10:26 a.m. A total of 23 harbor seals, three California sea lions, and three harbor porpoise were observed during the monitoring period on September 30. Three harbor seals were observed within the Pinniped Level B TTS monitoring zone within 15 minutes of the blast. A summary of marine mammal take is shown in Table 4-7. A complete table showing all marine mammal sightings during the monitoring period for the September 30, 2017 implosions of Piers E9 and E10 is provided in Appendix A.

Table 3-7. Summary of Marine Mammal Take for the September 30, 2017 Implosion of Piers E9 and E10

	Level A Harassment	Level B Harassment	
Species Name	Permanent Threshold Shift	Temporary Threshold Shift	Behavioral Monitoring
Harbor seal	0	3	0
Source: Compiled by AECOM in 2017			

Stranding Surveys

A pre-blast land survey was conducted by the Lead MMO on September 29, 2017. Locations surveyed included the Emeryville Crescent, the shoreline of Radio Road east of the SFOBB toll plaza, and under the OTD (Figure 4-1). The dead harbor seal first observed on September 17 still was on the toll plaza beach. No new stranded animals and no live marine mammals were seen during the survey.

The stranding surveys for the implosion of Piers E9 were conducted with TMMC immediately following the blast event on September 30, and then subsequently from October 1 to 3 by the Lead MMO only.

On September 30, 2017, the team observed seven harbor seals in the water and three harbor seals at the YBI haul-out site during the boat survey. One harbor seal was observed feeding on fish at the opening of the Emeryville Crescent at 12:20 p.m. No abnormal behavior or injuries were observed. No stranded marine mammals were discovered along any of the shore areas. During that same time, no marine mammals were rescued by TMMC that showed any evidence of blast trauma (TMMC, pers. comm., 2017). On October 1, the Lead MMO observed five harbor seals in the water, with no abnormal behavior or injuries. No animals were hauled out at the YBI site. No marine mammals were observed during the land survey. On October 3, 13 harbor seals were observed in the water with normal behavior during the boat survey. Ten of the seals were seen together between the SFOBB new east span Piers E2 and E3. No animals were observed on or around the YBI haul-out site. No marine mammals were observed during the land survey. No marine mammals were reported to be stranded.

A dead harbor seal with degraded body parts was seen during the boat survey on October 3, 2017, floating near the Berth 9 channel, south of Interstate 80 and north of the Port of Oakland (37.81711 N, -122, 32594 W). TMMC was notified immediately, and the TMMC pathologist, in conjunction with the Lead MMO, determined that it had been dead approximately 7 to 10 days (TMMC, pers. comm., 2017). TMMC opted not to pick up the carcass because of its advanced decomposed state and determined it highly unlikely to be related to the Department's implosion activities. NMFS was notified about the animal, per Section 8(f) and Section 9(b) of the IHA. No other strandings, injuries, or animals with abnormal behavior were observed between September 29 and October 3.

Two bottlenose dolphins were observed off Alameda Island on October 3, 2017 (GGCR 2017). No other cetacean sightings were reported between September 29 and October 3.

3.2.4. **Piers E11, E12 and E13**

Implosion Monitoring

The implosion of Piers E11, E12, and E13 occurred at 8:51 a.m. on October 14, 2017. Marine mammal monitoring was conducted from 7:04 to 09:53 a.m. A total of 43 harbor seals, two California sea lions, and two harbor porpoise were observed during the monitoring period on October 14. There was one harbor seal observed within the Pinniped Level B TTS monitoring zone, and two harbor seals observed within the Pinniped Level B behavioral response monitoring zone within 15 minutes prior to the blast. These animals were presumed to be present during the blast and were counted as take. Two additional harbor seals, one observed within the Level B TTS zone and one within the Level B behavioral zone, surfaced immediately after the blast. These animals were also counted as take. A summary of marine mammal take is shown in Table 4-8. A complete table showing all marine mammal sightings during the monitoring period for the October 14 implosions of Piers E11, E12, and E13 is provided in Appendix A.

Table 3-8. Summary of Marine Mammal Take for the October 14, 2017 Implosion of Piers E11, E12, and E13

	Level A Harassment	Level B Harassment	
Species Name	Permanent Threshold Shift	Temporary Threshold Shift	Behavioral Monitoring
Harbor seal	0	2	3
Source: Compiled by AECOM in 2017			

Stranding Surveys

A pre-blast land survey was conducted by the Lead MMO on October 13, 2017. The Emeryville Crescent west of Interstate 580, the shoreline at the end of Radio Road, the shoreline at the SFOBB toll plaza, and under the OTD were surveyed (Figure 4-1). No new stranded or live animals were observed. Two sea lions were reported to be stranded on Alameda Island before October 14 (TMMC, pers. comm., 2017). One of the animals was near Jack London Square, and the other, with a head injury, was at Ballena Isle Marina.

The stranding surveys for the implosions of Piers E11, E12, and E13 were conducted with TMMC immediately following the blast event on October 14, 2017, and then subsequently from October 15 to 17 by the Lead MMO only.

On October 14, 2017, the team observed 19 harbor seals in the water and three harbor seals at the YBI haul-out site during the boat survey. One of the 19 observed harbor seals

displayed abnormal behavior. This seal was observed on the west side of Treasure Island, floating with its back high in the water and tilting slightly to one side, which TMMC staff thought looked abnormal. The seal did not immediately dive when the survey boat passed within 20 feet (6 meters) of the individual, but did dive and resurface several times as the survey vessel tracked the animal. The team could not have caught the harbor seal to better assess its condition. However, the veterinarian noted that it could have been a number of conditions that they are currently seeing in harbor seals, including: toxoplasmosis, lungworm, meningitis, sarcocystis, or possibly head trauma. Considering how far this seal was from the pier it is unlikely to have been injured by the blast. No stranded marine mammals were discovered along any of the shore areas. During that same time, no marine mammals that showed any evidence of blast trauma were rescued by TMMC (TMMC, pers. comm., 2017).

On October 15, the Lead MMO observed three harbor seals in the water, one showing similar abnormal behavior to the one observed on October 14. However, this seal dove when the survey boat came within 50 feet (15 meters) of it, and appeared healthy. No animals were hauled out at the YBI site.

On October 16, the Lead MMO observed 17 harbor seals in the water and 32 to 38 at the YBI haul-out site during the boat survey. No marine mammals were observed during the land survey. No harbor seals that were observed on October 16 displayed abnormal behavior. On October 17, seven harbor seals were observed in the water during the boat survey.

No new marine mammals were observed during the land survey, but the dead animal that first was observed on October 3, floating near the Berth 9 channel, was observed on the beach west of the construction contractor's yard. The animal was confirmed to be the same because of coat color pattern, sloughing of skin, and location. NMFS was notified, per Section 8(f) and Section 9(b) of the IHA.

Two harbor porpoises (a potential calf-cow pair) were observed approximately one-half nautical mile (926 meters) north of Treasure Island during the boat survey on October 15, 2017. No other cetacean sightings were reported between October 14 and 17.

3.2.5. **Piers E14, E15 and E16**

Implosion Monitoring

The implosion of Piers E14, E15, and E16 occurred at 7:49 a.m. on October 28, 2017. Marine mammal monitoring was conducted from 7 to 8:50 a.m. A total of 15 harbor seals

were observed during the monitoring period on October 28. No marine mammals were observed in any of the marine mammal monitoring zones within 15 minutes before the time of the implosion, and thus no Level B take occurred during this implosion event. A complete table showing all marine mammal sightings during monitoring for the October 28, 2017 blast of Piers E14, E15, and E16 is provided in Appendix A.

Stranding Surveys

A pre-blast land survey was conducted by the Lead MMO on October 27, 2017. The Emeryville Crescent west of Interstate 580, the shoreline at the end of Radio Road, the shoreline at the SFOBB toll plaza, and under the OTD were surveyed (Figure 4-1). No new stranded animals or live animals were observed.

The stranding surveys for the implosions of Piers E14, E15, and E16 were conducted with TMMC immediately following the blast event on October 28, 2017, and then subsequently between October 29 and 31 by the Lead MMO only.

On October 28, 2017, the team observed eight harbor seals in the water and two harbor seals at the YBI haul-out site during the boat survey. No abnormal behavior or injuries were observed. No stranded marine mammals were discovered along any of the shore areas. During that same time, no marine mammals that showed any evidence of blast trauma were rescued by TMMC (TMMC, pers. comm., 2017). On October 29, the Lead MMO observed nine harbor seals in the water and 46 at the YBI haul-out site, with no abnormal behavior or injuries. No marine mammals were observed during the land survey. No animals were reported to be stranded. On October 30, the Lead MMO observed one harbor seal in the water and 56 at the YBI haul-out site. No marine mammals were observed during the land survey. No marine mammals were reported to be stranded. On October 31, four harbor seals were observed in the water with normal behavior during the boat survey. One harbor seal was observed during the land and boat survey, floating with its back above the water approximately 600 feet (183 meters) off the Emeryville Crescent. It dove and resurfaced normally. No marine mammals were reported to be stranded. No other animals with abnormal behavior or injuries were observed between October 27 and October 31.

Two harbor porpoises (cow-calf pair) were observed near Channel Marker 9 near the entrance to Oakland Outer Harbor on October 30, 2017. The (presumed) same pair was seen approximately 500 feet (152 meters) west of Treasure Island during the boat survey on October 31. No other cetacean sightings were reported.

3.2.6. **Piers E17 and E18**

Implosion Monitoring

The implosion of Piers E17 and E18 occurred at 07:27 a.m. on November 11, 2017. Marine mammal monitoring was conducted from 6:10 to 8:28 a.m. A total of 21 harbor seals were observed during the monitoring period on November 11. All marine mammal sightings during monitoring for the November 11 implosions of Piers E17 and E18 are shown in Table 4-9. A complete table showing all marine mammal sightings during the monitoring period for the November 11 implosions of Piers E17 and E18 is provided in Appendix A.

Table 3-9. Summary of Marine Mammal Take for the November 11, 2017 Implosion of Piers E17 and E18

	Level A Harassment	Level B Harassment	
Species Name	Permanent Threshold Shift	Temporary Threshold Shift	Behavioral Monitoring
Harbor seal	0	2	1
Source: Compiled by AECOM in 2017			

Harbor seal activity within the Level A Harassment Exclusion Zone delayed the blast from its original scheduled time of 07:10 a.m. One harbor seal surfaced approximately 150 feet south of Pier E18 at 06:57 a.m. The IHA delay protocol (described in detail in Section 2.1.2) was implemented and the blast time was moved to 07:13 a.m. Another harbor seal surfaced at 07:12 a.m. along the southern edge of the exclusion zone. The blast was further delayed until 07:27 a.m., according to delay protocol. Time was precisely kept by the Lead MMO and was communicated to the Department Environmental Compliance Manager in order to notify the Department Environmental Compliance Manager and Blaster in Charge if and when the MMEZs were clear before the implosion. No marine mammals were observed in the Level A Harassment Exclusion Zone within 15 minutes of the blast. One harbor seal was observed within the Pinniped Level B TTS monitoring zone, and one harbor seal was observed within the Pinniped Level B behavioral response monitoring, within 15 minutes of the blast.

An additional harbor seal was seen just inside the 367-foot (112-meter) Pinniped Level A PTS MMEZ, at a distance of 300 feet (91 meters) just after the blast. However, based on hydroacoustic measurements collected in the field during the implosion, the actual distance to the Level A PTS threshold was 221 feet (67 meters). Therefore, the animal would not have been exposed to sound levels resulting in a Level A PTS take but is

counted as a TTS take. Measured hydroacoustic results for the pier implosion events relative to implemented exclusion and monitoring zone are discussed further in Section 4.3 of this chapter.

Stranding Surveys

A pre-blast land survey was conducted by the Lead MMO on November 10, 2017. The Emeryville Crescent west of Interstate 580, the shoreline at the end of Radio Road, the shoreline at the SFOBB toll plaza, and under the OTD were surveyed (Figure 4-1). No new stranded or live animals were observed.

The stranding surveys for the implosions of Piers E17 and E18 were conducted with TMMC immediately following the blast event on November 11, 2017; and then subsequently between November 12 and 14 by the Lead MMO only.

On November 11, 2017, the team observed four harbor seals in the water and 20 harbor seals at the YBI haul-out site during the boat survey. No abnormal behavior or injuries were observed. No other stranded marine mammals were discovered along any of the shore areas. During that same time, no marine mammals that showed any evidence of blast trauma were rescued by TMMC (TMMC, pers. comm., 2017). On November 12, the Lead MMO observed 16 harbor seals in the water and 39 at the YBI haul-out site, with no abnormal behavior or injuries. No marine mammals were observed during the land survey. On November 13, the Lead MMO observed four harbor seals in the water and six at the YBI haul-out site. No marine mammals were observed during the land survey. No marine mammals were reported to be stranded. On November 14, 13 harbor seals were observed in the water and four were hauled out at the YBI haul-out site with normal behavior and no visible injuries. No marine mammals were reported to be stranded.

TMMC received reports of a lethargic sea lion at Candlestick Cove on November 12, 2017, but was unable to verify the report. An entangled sea lion also was reported at Pier 39 on the same day but was inaccessible for rescue (TMMC, pers. comm., 2017). One unidentified pinniped was reported with a bite wound at Rincon Park on November 13, but returned to the water on its own and was not rescued.

A lone harbor porpoise was observed approximately 1 nautical mile north of Treasure Island, as well as a group of three porpoises (two adults, one juvenile) approximately 1,000 feet (304 meters) west of the junction of Treasure Island and YBI during the boat survey on November 13, 2017. No other cetacean sightings were observed or reported between November 10 and November 13.

3.3. Hydroacoustic Monitoring Results

Hydroacoustic monitoring was conducted during the implosions of Piers E6 through E18, to verify distances to the MMEZs and monitoring zones. As previously discussed, measured distances to marine mammal threshold criteria from the implosions of Pier E3 in 2015 and the implosions of Piers E4 and E5 in 2016 were used to estimate the distances to these threshold criteria for the implosions of Piers E6 through E18. The Level A PTS MMEZ and Level B TTS and behavioral response monitoring zones were intentionally designed to be larger than the furthest calculated threshold distances (ZOI) appropriate to specific marine mammal functional hearing groups to create more conservative monitoring zones (Table 4-2). The pinniped and dolphin exclusion and monitoring zones were based on estimated distances to threshold criteria for phocids (harbor seal and elephant seal). The distances to the Level A and Level B threshold criteria for otariids (sea lion and fur seal) and the mid-frequency cetaceans (bottlenose dolphin) are less than the distance to the phocids (harbor seal and elephant seal) threshold criteria. As the exclusion zones for otariids (sea lions and northern fur seals) and bottlenose dolphin would be in the near field of the implosion and to simplify monitoring procedures, the Department elected to monitor a larger Level A exclusion zone and Level B TTS and behavioral monitoring zones for otariids and bottlenose dolphin.

The measured distances to Level A PTS and Level B TTS and behavioral threshold criteria from the implosions of Pier E6 to E18 were variable. The estimated distances to marine mammal threshold criteria, distances to exclusion and monitoring zones implemented during the pier implosions, and measured distances to threshold criteria are shown in Tables 4-10 through 4-15. For implosion events involving one pier (Pier E6), two 288-foot-span piers (Piers E17 and E18), two 504-foot-span piers (Piers E7 and E8) measured distances to marine mammal threshold criteria were less than the estimated distances and implemented exclusion and monitoring zones. Instances in which measured distances to marine mammal threshold criteria were greater than the estimated distances and/or implemented exclusion or monitoring zones are noted in the tables. Instances were measured distances exceeded modeled distances are shown in bold. Instances were measured distances exceeded implemented exclusion or monitoring zones are shown in bold and underlined.

For the pier implosion event involving one 288-foot span pier (Pier E10) and one 504-foot-span pier (Pier E9) measured distances to marine mammal threshold criteria exceeded some of the estimated distances and implemented exclusion and monitoring zones that had been developed for the implosion of two 504-foot-span piers.

For both pier implosion events involving three 288-foot-span piers, measured distances to marine mammal threshold criteria exceeded some of the estimated distances and implemented exclusion and monitoring zones.

Table 3-10. Measured Distances to Underwater Blasting Threshold Criteria Compared to Estimated Distances and Implemented Exclusion and Monitoring Zones for Implosion of Piers E7 and E8

Species Group		Behavioral	TTS		PTS	
Mid-Frequency Cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB peak	170 dB cSEL	230 dB peak	185 dB cSEL
	Two 504-foot-span Pier Estimated Distances	1,055 ft (322 m)	166 ft (51 m)	685 ft (209 m)	90 ft (27 m)	190 ft (58 m)
	Exclusion and Monitoring Zones	2,148 ft (655 m)	1,423 ft (434 m)		400 ft (122 m)	
	Piers E7–E8 Measured Distances	504 ft (154 m)	91 ft (28 m)	354 ft (108 m)	60 ft (18 m)	123 ft (37 m)
High-Frequency Cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB peak	140 dB cSEL	202 dB peak	155 dB cSEL
	Two 504-foot-span Pier Estimated Distance	10,300 ft (3,139 m)	2,882 ft (878 m)	6,800 ft (2,073 m)	1,564 ft (477 m)	1,966 ft (599 m)
	Exclusion and Monitoring Zones	12,360 ft (3,767 m)	8,160 ft (2,487 m)		2,359 ft (719 m)	
	Piers E7–E8 Measured Distances	3,694 ft (1,126 m)	619 ft (189 m)	2,596 ft (791 m)	410 ft (125 m)	901 ft (275 m)
Phocid Pinnipeds (seals)	Threshold	165 dB cSEL	212 dB peak	170 dB cSEL	218 dB peak	185 dB cSEL
	Two 504-foot-span Pier Estimated Distances	1,790 ft (546 m)	565 ft (172 m)	1,186 ft (361 m)	306 ft (93 m)	333 ft (101 m)
	Exclusion and Monitoring Zone Distances	2,148 ft (655 m)	1,423 ft (434 m)		400 ft (122 m)	
	Piers E7–E8 Measured Distances	901 ft (275 m)	206 ft (63 m)	632 ft (193 m)	137 ft (42 m)	218 ft (66 m)
Otariid Pinnipeds (sea lions)	Threshold	183 dB cSEL	226 dB peak	188 dB cSEL	232 dB peak	203 dB cSEL
	Two 504-foot-span Pier Estimated Distances	421 ft (128 m)	136 ft (41 m)	274 ft (84 m)	74 ft (23 m)	78 ft (24 m)
	Exclusion and Monitoring Zone Distances	2,148 ft (655 m)	1,423 ft (434 m)		400 ft (122 m)	
	Piers E7–E8 Measured Distances	245 ft (75 m)	79 ft (24 m)	172 ft (52 m)	52 ft (16 m)	59 ft (18 m)

Notes: ft = feet; m = meters
Source: Compiled by AECOM in 2017

Table 3-11. Measured Distances to Underwater Blasting Threshold Criteria Compared to Estimated Distances and Implemented Exclusion and Monitoring Zones for Implosion of Pier E6

Species Group		Behavioral (Monitoring Zone)	TTS (Monitoring Zone)		PTS (Exclusion Zone)	
Mid-Frequency Cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB Peak	170 dB cSEL	230 dB Peak	185 dB cSEL
	Pier E6 Estimated Distances	1,330 ft (405 m)	180 ft (55 m)	881 ft (269 m)	98 ft (30 m)	256 ft (78 m)
	Exclusion and Monitoring Zone Distances	2,664 ft (812 m)	1,781 ft (543 m)		532 ft (162 m)	
	Pier E6 Measured Distances	473 ft (144 m)	93 ft (28 m)	332 ft (101 m)	62 ft (19 m)	115 ft (35 m)
High-Frequency Cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB peak	140 dB cSEL	202 dB peak	155 dB cSEL
	Pier E6 Estimated Distances	12,567 ft (3,830 m)	3,127 ft (953 m)	8,358 ft (2,548 m)	1,697 ft (517 m)	2,459 ft (750 m)
	Exclusion and Monitoring Zone Distances	15,080 ft (4,596 m)	10,030 ft (3,057 m)		2,951 ft (899 m)	
	Pier E6 Measured Distances	3,467 ft (1,057 m)	637 ft (194 m)	2,436 ft (742 m)	422 ft (129 m)	845 ft (258 m)
Phocid Pinnipeds (seals)	Threshold	165 dB cSEL	212 dB peak	170 dB cSEL	218 dB peak	185 dB cSEL
	Pier E6 Estimated Distances	2,220 ft (677 m)	613 ft (187 m)	1,484 ft (452 m)	332 ft (101 m)	443 ft (135 m)
	Exclusion and Monitoring Zone Distances	2,664 ft (812 m)	1,781 ft (543 m)		532 ft (162 m)	
	Pier E6 Measured Distances	846 ft (258 m)	212 ft (65 m)	593 ft (181 m)	141 ft (43 m)	204 ft (62 m)
Otariid Pinnipeds (sea lions)	Threshold	183 dB cSEL	226 dB peak	188 dB cSEL	232 dB peak	203 dB cSEL
	Pier E6 Estimated Distances	554 ft (169 m)	147 ft (45 m)	367 ft (112 m)	80 ft (24 m)	106 ft (32 m)
	Exclusion and Monitoring Zone Distances	2,664 ft (812 m)	1,781 ft (543 m)		532 ft (162 m)	
	Pier E6 Measured Distances	230 ft (70 m)	81 ft (245 m)	161 ft (49 m)	54 ft (16 m)	55 ft (17 m)

Notes: ft = feet; m = meters
Source: Compiled by AECOM in 2017

Table 3-12. Measured Distances to Underwater Blasting Threshold Criteria Compared to Estimated Distances and Implemented Exclusion and Monitoring Zones for Implosion of Piers E9 and E10

Species Group		Behavioral	TTS		PTS	
Mid-Frequency Cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB peak	170 dB cSEL	230 dB peak	185 dB cSEL
	Two 504-foot-span Pier Estimated Distances (feet)	1,055 ft (322 m)	166 ft (51 m)	685 ft (209 m)	90 ft (27 m)	190 ft (58 m)
	Exclusion and Monitoring Zones (feet)	2,148 ft (655 m)	1,423 ft (434 m)		400 ft (122 m)	
	Piers E9–E10 Measured Distances (feet)	918 ft (280 m)	**199 ft (61 m)**	645 ft (197 m)	**132 ft (40 m)**	**224 ft (68 m)**
High-Frequency Cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB peak	140 dB cSEL	202 dB peak	155 dB cSEL
	Two 504-foot-span Pier Estimated Distance (feet)	10,300 ft (3,139 m)	2,882 ft (878 m)	6,800 ft (2,073 m)	1,564 ft (477 m)	1,966 ft (599 m)
	Exclusion and Monitoring Zones (feet)	12,360 ft (3,767 m)	8,160 ft (2,487 m)		2,359 ft (719 m)	
	Piers E9–E10 Measured Distances (feet)	6,730 ft (2,051 m)	1,364 ft (416 m)	4,729 ft (1,441 m)	904 ft (276 m)	1,641 ft (500 m)
Phocid Pinnipeds (seals)	Threshold	165 dB cSEL	212 dB peak	170 dB cSEL	218 dB peak	185 dB cSEL
	Two 504-foot-span Pier Estimated Distances (feet)	1,790 ft (546 m)	565 ft (172 m)	1,186 ft (361 m)	306 ft (93 m)	333 ft (101 m)
	Exclusion and Monitoring Zone Distances (feet)	2,148 ft (655 m)	1,423 ft (434 m)		400 ft (122 m)	
	Piers E9–E10 Measured Distances (feet)	1,660 ft (506 m)	455 ft (139 m)	1,164 ft (355 m)	301 ft (92 m)	**401 ft (122 m)**
Otariid Pinnipeds (sea lions)	Threshold	183 dB cSEL	226 dB peak	188 dB cSEL	232 dB peak	203 dB cSEL
	Two 504-foot-span Pier Estimated Distances (feet)	421 ft (128 m)	136 ft (41 m)	274 ft (84 m)	74 ft (23 m)	78 ft (24 m)
	Exclusion and Monitoring Zone Distances (feet)	2,148 ft (655 m)	1,423 ft (434 m)		400 ft (122 m)	
	Piers E9–E10 Measured Distances (feet)	**455 ft (139 m)**	**174 ft (53 m)**	**319 ft (97 m)**	**115 ft (47 m)**	**110 ft (34 m)**

Source: Compiled by AECOM in 2017
Note: ft = feet; m = meters
Instances where measured distances exceeded estimated distances, values are shown in **bold**.
Instances where measured distances exceeded implemented exclusion and monitoring zone distances, values are shown in **bold and underlined**..

Table 3-13. Measured Distances to Underwater Blasting Threshold Criteria Compared to Estimated Distances and Implemented Exclusion and Monitoring Zones for Implosion of Piers E11, E12 and E13

Species Group		Behavioral	TTS		PTS	
Mid-Frequency Cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB peak	170 dB cSEL	230 dB peak	185 dB cSEL
	Three 288-foot-span Pier Estimated Distances	920 ft (280 m)	166 ft (51 m)	588 ft (179 m)	90 ft (27 m)	132 ft (40 m)
	Exclusion and Monitoring Zones	1,896 ft (578 m)	1,254 ft (382 m)		367 ft (112 m)	
	Piers E11–E13 Measured Distances	**1,200 ft (366 m)**	**212 ft (65 m)**	**843 ft (257 m)**	**141 ft (43 m)**	**292 ft (89 m)**
High-Frequency Cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB peak	140 dB cSEL	202 dB peak	155 dB cSEL
	Three 288-foot-span Pier Estimated Distance	9,403 ft (2,866 m)	2,882 ft (878 m)	5,900 ft (1,798 m)	1,564 ft (477 m)	1,722 ft (525 m)
	Exclusion and Monitoring Zones	11,284 ft (3,439 m)	7,080 ft (2,158 m)		2,066 ft (630 m)	
	Piers E11–E13 Measured Distances	8,801 ft (2,683 m)	1,451 ft (442 m)	6,184 ft (1,885 m)	961 ft (293 m)	**2,146 ft (654 m)**
Phocid Pinnipeds (seals)	Threshold	165 dB cSEL	212 dB peak	170 dB cSEL	218 dB peak	185 dB cSEL
	Three 288-foot-span Pier Estimated Distances (feet)	1,580 ft (482 m)	565 ft (172 m)	1,045 ft (319 m)	306 ft (93 m)	258 ft (79 m)
	Exclusion and Monitoring Zone Distances	1,896 ft (578 m)	1,254 ft (382 m)		367 ft (112 m)	
	Piers E11–E13 Measured Distances	**2,144 ft (653 m)**	484 ft (148 m)	**1,503 ft (458 m)**	**320 ft (98 m)**	**518 ft (158 m)**
Otariid Pinnipeds (sea Lions)	Threshold	183 dB cSEL	226 dB peak	188 dB cSEL	232 dB peak	203 dB cSEL
	Three 288-foot-span Pier Estimated Distances	339 ft (103 m)	136 ft (41 m)	201 ft (61 m)	74 ft (23 m)	52 ft (16 m)
	Exclusion and Monitoring Zone Distances	1,896 ft (578 m)	1,254 ft (382 m)		367 ft (112 m)	
	Piers E11–E13 Measured Distances	**588 ft (179 m)**	**185 ft (56 m)**	**412 ft (126 m)**	**122 ft (37 m)**	**142 ft (43 m)**

Source: Compiled by AECOM in 2017
Note: ft = feet; m = meters
Instances where measured distances exceeded estimated distances, values are shown in **bold**.
Instances where measured distances exceeded implemented exclusion and monitoring zone distances, values are shown in **bold and underlined.**

Table 3-14. Measured Distances to Underwater Blasting Threshold Criteria Compared to Estimated Distances and Implemented Exclusion and Monitoring Zones for Implosion of Piers E14, E15, and E16

Species Group		Behavioral	TTS		PTS	
Mid-Frequency Cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB peak	170 dB cSEL	230 dB peak	185 dB cSEL
	Three 288-foot-span Pier Estimated Distances	920 ft (280 m)	166 ft (51 m)	588 ft (179 m)	90 ft (27 m)	132 ft (40 m)
	Exclusion and Monitoring Zones	1,896 ft (578 m)	1,254 ft (382 m)		367 ft (112 m)	
	Piers E14–E16 Measured Distances	**1,028 ft (313 m)**	**189 ft (58 m)**	**722 ft (220 m)**	**125 ft (38 m)**	**250 ft (76 m)**
High-Frequency Cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB peak	140 dB cSEL	202 dB peak	155 dB cSEL
	Three 288-foot-span Pier Estimated Distance	9,403 ft (2,866 m)	2,882 ft (878 m)	5,900 ft (1,798 m)	1,564 ft (477 m)	1,722 ft (525 m)
	Exclusion and Monitoring Zones	11,284 ft (3,439 m)	7,080 ft (2,158 m)		2,066 ft (630 m)	
	Piers E14–E16 Measured Distances	7,482 ft (2,281 m)	1,291 ft (393 m)	5,257 ft (1,602 m)	855 ft (261 m)	**1,824 ft (556 m)**
Phocid Pinnipeds (seals)	Threshold	165 dB cSEL	212 dB peak	170 dB cSEL	218 dB peak	185 dB cSEL
	Three 288-foot-span Pier Estimated Distances	1,580 ft (482 m)	565 ft (172 m)	1,045 ft (319 m)	306 ft (93 m)	258 ft (79 m)
	Exclusion and Monitoring Zone Distances	1,896 ft (578 m)	1,254 ft (382 m)		367 ft (112 m)	
	Piers E14–E16 Measured Distances	**1,834 ft (559 m)**	430 ft (131 m)	**1,286 ft (391 m)**	285 ft (87 m)	**443 ft (135 m)**
Otariid Pinnipeds (sea lions)	Threshold	183 dB cSEL	226 dB peak	188 dB cSEL	232 dB peak	203 dB cSEL
	Three 288-foot-span Pier Estimated Distances	339 ft (103 m)	136 ft (41 m)	201 ft (61 m)	74 ft (23 m)	52 ft (16 m)
	Exclusion and Monitoring Zone Distances	1,896 ft (578 m)	1,254 ft (382 m)		367 ft (112 m)	
	Piers E14–E16 Measured Distances	**503 ft (153 m)**	**165 ft (50 m)**	**352 ft (107 m)**	**109 ft (33 m)**	**121 ft (37 m)**

Source: Compiled by AECOM in 2017
Note: ft = feet; m = meters
Instances where measured distances exceeded estimated distances, values are shown in **bold**.
Instances where measured distances exceeded implemented exclusion and monitoring zone distances, values are shown in **bold and underlined**.

Table 3-15. Measured Distances to Underwater Blasting Threshold Criteria Compared to Estimated Distances and Implemented Exclusion and Monitoring Zones for Implosion of Piers E17 and E18

Species Group		Behavioral	TTS		PTS	
Mid-Frequency Cetaceans (dolphins)	Threshold	165 dB cSEL	224 dB peak	170 dB cSEL	230 dB peak	185 dB cSEL
	Two 288-foot-span Pier Estimated Distances	798 ft (243 m)	166 ft (51 m)	517 ft (158 m)	90 ft (27 m)	126 ft (38 m)
	Exclusion and Monitoring Zones	1,631 ft (497 m)	1,080 ft (329 m)		367 ft (112 m)	
	Piers E17–E18 Measured Distances	511 ft (156 m)	134 ft (41 m)	359 ft (109 m)	89 ft (27 m)	124 ft (38 m)
High-Frequency Cetaceans (porpoises)	Threshold	135 dB cSEL	196 dB peak	140 dB cSEL	202 dB peak	155 dB cSEL
	Two 288-foot-span Pier Estimated Distance	7,700 ft (2,347 m)	2,882 ft (878 m)	5,140 ft (1,567 m)	1,564 ft (477 m)	1,493 ft (455 m)
	Exclusion and Monitoring Zones	9,240 ft (2,816 m)	6,168 ft (1,880 m)		1,877 ft (572 m)	
	Piers E17–E18 Measured Distances	3,747 ft (1,142 m)	916 ft (279 m)	2,633 ft (803 m)	607 ft (185 m)	913 ft (278 m)
Phocid Pinnipeds (seals)	Threshold	165 dB cSEL	212 dB peak	170 dB cSEL	218 dB peak	185 dB cSEL
	Two 288-foot-span Pier Estimated Distances	1,359 ft (414 m)	565 ft (172 m)	900 ft (274 m)	306 ft (93 m)	232 ft (71 m)
	Exclusion and Monitoring Zone Distances	1,631 ft (497 m)	1,080 ft (329 m)		367 ft (112 m)	
	Piers E17–E18 Measured Distances	914 ft (279 m)	305 ft (93 m)	641 ft (195 m)	202 ft (62 m)	221 ft (67 m)
Otariid Pinnipeds (sea lions)	Threshold	183 dB cSEL	226 dB peak	188 dB cSEL	232 dB peak	203 dB cSEL
	Two 288-foot-span Pier Estimated Distances	304 ft (92.7 m)	136 ft (41 m)	185 ft (56 m)	74 ft (23 m)	51 ft (16 m)
	Exclusion and Monitoring Zone Distances	1,631 ft (497 m)	1,080 ft (329 m)		367 ft (112 m)	
	Piers E17–E18 Measured Distances	249 ft (76 m)	117 ft (36 m)	174 ft (53 m)	77 ft (23 m)	60 ft (18 m)

Source: Compiled by AECOM in 2017
Note: ft = feet; m = meters

Table 3-16: Measured Distances to Underwater Blasting Threshold Criteria for Level A GI Tract and Lung Injury and Mortality for Implosion of Piers E7/E8, Pier E6, Piers E9/E10, Piers E11-E13, Piers E14-E16 and Piers E17/E18

Species		GI Tract		Lung[1]	Mortality[1]
All Species	Threshold	237 dB Peak	104 psi	39.1 (15 kg)$^{1/3}$ (1+[6/10.081])$^{1/2}$ = 122 Pa-sec	91.4 (15 kg)$^{1/3}$ (1+[6/10.081])$^{1/2}$ = 285 Pa-sec
	Piers E7/E8	37 ft (11.3 m)	37 ft (11.3 m)	< 40 ft (< 12.2 m)	< 40 ft (< 12.2 m)
	Pier E6	38 ft (11.5 m)	38 ft (11.5 m)	< 40 ft (< 12.2 m)	< 40 ft (< 12.2 m)
	Piers E9/E10	82 ft (25 m)	82 ft (25 m)	< 40 ft (< 12.2 m)	< 40 ft (< 12.2 m)
	Piers E11-E13	87 ft (26.5 m)	87 ft (26.5 m)	< 40 ft (< 12.2 m)	< 40 ft (< 12.2 m)
	Piers E14-E16	77 ft (23.5 m)	77 ft (23.5 m)	< 40 ft (< 12.2 m)	< 40 ft (< 12.2 m)
	Piers E17-E18	55 ft (16.8 m)	55 ft (16.8 m)	< 40 ft (< 12.2 m)	< 40 ft (< 12.2 m)

Notes: ft = feet; m = meters
Lung injury and mortality threshold calculations are for a 15 kg juvenile fur seal, the smallest marine mammal with the potential to be present in the project area.
Threshold Source: Finneran and Jenkins 2012
Measured Distance Sources: Measured distances to threshold criteria where determined based on hydroacoustic monitoring performed during pier implosions.

As discussed above the model was based on measured levels from three previous single-pier implosion events that removed large cellular structures that had voids extending deep into the Bay mud (Piers E3, E4 and E5). The variables used to calculate distances to threshold criteria for piers E6 to E18 were (1) total weight of explosives; and (2) number of detonations (this is correlated with the duration of the event). The model estimated greater sound levels at greater distances for implosion events involving greater amounts (weight) of explosives and number of detonations.

The Department has not identified a specific mechanism(s) that definitively illustrates what caused the observed exceedances for blast events that were expected to have impacts less than what was modeled. However, multiple factors that have potential to influence the measured results were either not recognized when the model was generated, or are too complex to feasibly incorporate into a model at this time. These include effects from a difference in the types of structures used in the model (that had slightly thicker and additional internal cellular walls) that may have caused a potential change in the confinement factor, directional behaviors of the blast events, difference in water column depth for each blast event, and reflections from water surfaces and nearby structures. In regards to confinement, energy that is not used to break the pier walls during the implosion would be transferred to water column. For this reason a confinement factor was assumed based on previous blast events and historical blasting data. It is possible that modeling for the smaller piers with much fewer and slightly thinner walls could be improved by incorporating a confinement factor that assumes less insulation from the individual charges into the water column which was not fully accounted for in the previous model.

Lessons learned include, that structural differences in the marine foundations that were used to generate the model may be a more important factor when calculating sound pressure levels than originally considered. For the 2018 IHA application measured levels from the implosion of Piers E17 and E18 were used to estimate distances to threshold criteria for the implosion of Piers E19 and E20. The size of the estimated zones for the implosion of Pier E19 and E20 were selected to be slightly larger than the measured distances from the implosion of Piers E17 and E18. Piers E17 to E20 are similar structures, located adjacent to each other; therefore resulting sound pressure levels from these events should be similar.

As summarized in the tables above, instances occurred where the estimated threshold distances were exceeded. In these cases, the number of Level B behavioral takes and Level B TTS takes were determined based on measured distances to threshold criteria.

During the last blast event (Piers E17 and E18), one harbor seal was observed immediately after the implosion, within the Level A exclusion zone (367-foot [111-meter] zone), approximately 300 feet (91 meters) from the pier being imploded. In generally, harbor seals travel with their heads below the surface and can travel at a rate of up to 12 miles per hours (19.3 kilometers per hour), equating to 1,056 feet per minute (321.9 meters per minute); therefore it is possible for a seal to enter the Level A zone undetected. Under most circumstance, due to the number of monitors with overlapping areas of responsibility in the near field, a seal would be detected before entering the Level A zone. Although this would have been considered a Level A PTS take according to conservatively implemented monitoring zones, the measured hydroacoustic results for the Level A PTS threshold recorded the actual distances at 202 feet (61.5 meters) for the peak threshold and 212 feet (64.6 meters) for the cSEL threshold. Based on the measured results, the harbor seal was technically outside the physical impact zone. The harbor seal was monitored after the blast and did not exhibit any obvious behavioral changes and immediately dove after being sighted. No stranded animals or animals exhibiting abnormal behavior consistent with PTS impacts were observed during the subsequent stranding surveys for this blast event. Therefore, this harbor seal was not counted as a Level A PTS take and was instead counted as a Level B TTS take.

For the instances when the Level B behavioral or TTS threshold distances were exceeded based on measured results, these take numbers were adjusted accordingly based on measured results as changes in behavior or TTS impacts are harder to discern in the field because they are considered only slight harassment. The level of take was adjusted based on the distance of the animal from the pier being imploded and how it related to the measured distance.

3.4. Conclusions

Marine mammal observers were present for each of the blasts to carefully monitor marine mammal species, before, during, and after each implosion event. Monitoring began at least 30 minutes before, and ended 60 minutes after each event. No animals were found dead, injured, or were reported to be stranded in relation to implosion events. A summary of authorized and total Level B Harassment marine mammal take for all 2017 implosions is shown in Tables 4-16a and 4-16b.

Table 3-16a. Summary of Level B TTS Harassment Take for 2017 Implosions Events

Pier Implosion	TTS (Monitoring Zone)					
	HASE	CASL	HAPO	BODO	NOFS	NOES
E7, E8	1	0	0	0	0	0
E6	12	0	3	0	0	0
E9, E10	3	0	0	0	0	0
E11, E12, E13	2	0	0	0	0	0
E14, E15, E16	0	0	0	0	0	0
E17, E18	1	0	0	0	0	0
Total Take Authorized	48	12	9	3	3	3
Total Take Observed	19	0	3	0	0	0

Notes:

Take numbers were tallied according to the measured hydroacoustic distances, as shown in Tables 4-10 through 4-15. Although measured threshold distances exceeded estimated threshold distances in some instances, no Level A take was observed, and the observed Level B harassment take numbers did not exceed authorized limits.

Species Codes:

HASE = harbor seal; CASL = California sea lion; HAPO = harbor porpoise; BODO = bottlenose dolphin; NOFS = northern fur seal; NOES = northern elephant seal

Table 3-16b. Summary of Level B Behavioral Harassment Take for 2017 Implosions Events

Pier Implosion	Behavioral (Monitoring Zone)					
	HASE	CASL	HAPO	BODO	NOFS	NOES
E7, E8	5	0	0	0	0	0
E6	0	0	0	0	0	0
E9, E10	0	0	0	0	0	0
E11, E12, E13	3	0	0	0	0	0
E14, E15, E16	0	0	0	0	0	0
E17, E18	1	0	0	0	0	0
Total Take Authorized	66	18	18	6	6	6
Total Take Observed	9	0	0	0	0	0

Notes:

Take numbers were tallied according to the measured hydroacoustic distances, as shown in Tables 4-10 through 4-15. Although measured threshold distances exceeded estimated threshold distances in some instances, no Level A take was observed, and the observed Level B harassment take numbers did not exceed authorized limits.

Species Codes:

HASE = harbor seal; CASL = California sea lion; HAPO = harbor porpoise; BODO = bottlenose dolphin; NOFS = northern fur seal; NOES = northern elephant seal

Chapter 4. References

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PERSONAL COMMUNICATIONS

Keener, W. Researcher, Golden Gate Cetacean Research, San Francisco, California. September–November 2017—personal communications to AECOM's SFOBB Project team.

The Marine Mammal Center (TMMC). Sausalito, California. D. Zahniser, Operations Manager; E. Hanahoe, Stranding Coordinator; staff veterinarian; stranding volunteers. September–November 2017—personal communications to AECOM's SFOBB Project team.

Appendix A
Marine Mammal Sightings Summary Tables

Table A-1. Summary of Marine Mammal Sightings during Monitoring for the September 2, 2017 Blasts of Piers E7 and E8

Times	(No.) Species*	Distance/Direction from Pier E7/E8[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
07:35 Observations Began					
07:39 – 07:47	(1) unk-D	8,500ft south	southwest	177 minutes pre-blast	300ft south of vessel 8,160ft south
07:50	(1) HASE	8,200ft south	west	166 minutes pre-blast	300 to 500ft west of vessel 8,160ft south
07:52 – 07:58	(2) HAPO	8,160ft southwest	west	158 minutes pre-blast	15ft southwest from vessel 8,160ft southwest
07:53	(1) HASE	6,880ft northwest	north	163 minutes pre-blast	50ft off the northeast corner of Treasure Island
08:06 – 08:09	(1) HASE	2,050ft northwest	north	147 minutes pre-blast	45ft south of new span Pier E2
08:06 – 08:39	(1) HASE	1,600ft northwest	north	117 minutes pre-blast	200ft from new span Pier E3
08:07 – 08:08	(1) HASE	8,200ft southwest	south	148 minutes pre-blast	100ft southeast from vessel 8,160ft southwest
08:12 – 08:24	(2) HAPO	7,900ft southwest	north	132 minutes pre-blast	300ft east from vessel 8,160ft southwest; cow-calf pair
08:14	(2) HASE	1,600ft northwest	south	142 minutes pre-blast	40 to 100ft south of new span Pier E3
08:14 – 09:04	(2) HASE	1,700ft northwest	north	92 minutes pre-blast	20ft north/northwest of new span Pier E3
08:15 – 08:24	(2) HASE	1,700ft northwest	surface	132 minutes pre-blast	10ft north of new span Pier E3
08:17 – 08:35	(2) HASE	7,900ft southwest	south	121 minutes pre-blast	300ft northeast of vessel 8,160ft southwest
08:24	(3) HASE	1.750ft northwest	north	132 minutes pre-blast	15 – 45ft north of new span Pier E3
08:19	(1) HASE	960ft west	east	137 minutes pre-blast	200ft east of bike path at new span Pier E4
08:20	(1) HASE	8,160ft northeast	surface	136 minutes pre-blast	200ft east of vessel 8,160ft north
08:27 – 08:30	(1) HASE	4,000ft west	southwest	126 minutes pre-blast	150ft from old span Pier E2
08:28	(2) HASE	2,000ft west	south	128 minutes pre-blast	600-700ft south of new span Pier E2
08:32 – 09:46	(4) HASE	1,700ft northwest	surface	50 minutes pre-blast	milling just north of new span Pier E3
08:40	(1) HASE	1,900ft northwest	south	116 minutes pre-blast	200ft north of new span Pier E3
08:43 – 08:45	(1) HASE	1,600ft northwest	south	113 minutes pre-blast	30ft south of new span Pier E3
08:44 – 08:48	(1) HASE	6,880ft northwest	north	112 minutes pre-blast	200ft off the northeast corner of Treasure Island
08:45	(1) HASE	3,500ft south	south	109 minutes pre-blast	more than 2,000ft south of vessel 1,500ft south
08:45 – 08:46	(1) HASE	1,775ft northwest	north	114 minutes pre-blast	75ft north of new span Pier E3

Table A-1. Summary of Marine Mammal Sightings during Monitoring for the September 2, 2017 Blasts of Piers E7 and E8

Times	(No.) Species*	Distance/Direction from Pier E7/E8[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
08:49 – 08:59	(1) HASE	8,300ft southwest	surface	97 minutes pre-blast	100ft southwest from vessel 8,160ft southwest
08:54	(2) HASE	3,500ft west	east	102 minutes pre-blast	2,500ft west of bike path at new span Pier E4
09:03	(1) HASE	8,050ft south	east	93 minutes pre-blast	100ft north of vessel 8,160ft south
08:57 – 09:20	(1) HASE	1,775ft northwest	east	76 minutes pre-blast	75ft northwest of new span Pier E3
09:07 – 09:08	(1) HASE	1,800ft northwest	west	88 minutes pre-blast	100ft northwest of new span Pier E3
09:07 – 09:15	(2) HAPO	8,200ft southwest	east	81 minutes pre-blast	50ft from vessel 8,160ft southwest
09:10 – 09:13	(1) HASE	1,500ft west	south	83 minutes pre-blast	45ft southeast of new span Pier E3
09:10 – 09:20	(2) HASE	1,850ft northwest	west	76 minutes pre-blast	150ft northwest of new span Pier E3
09:17-09:18	(1) HASE	1,600ft northeast	surface	78 minutes pre-blast	50m northeast of vessel 1,500ft north
09:22 – 09:23	(1) HASE	1,600ft northeast	north	63 minutes pre-blast	25ft from new span Pier E3
09:28 – 09:33	(1) HASE	1,725ft northwest	west	63 minutes pre-blast	25ft northwest of new span Pier E3
09:30	(1) HASE	6,880ft northwest	surface	66 minutes pre-blast	150ft off the northeast corner of Treasure Island
09:30 – 09:35	(1) HASE	8,160ft south	west	61 minutes pre-blast	300 - 500ft west of vessel 8,160ft south
09:33	(1) HASE	1,370ft northwest	east	63 minutes pre-blast	between new span Piers E3 E4, under bridge
09:39 – 10:20	(4) HAPO	8,300ft southwest	southeast	14 minutes pre-blast	100ft southeast of vessel 8,160ft southwest; seen again at 10:55 – 11:21 post-blast
09:43 – 09:47	(1) HASE	2,100ft northwest	west	49 minutes pre-blast	400ft northwest of new span Pier E3
09:46 – 09:52	(2) HASE	1,700ft northwest	surface	44 minutes pre-blast	north of new span Pier E3
09:53	(1) HASE	3,600ft southwest	west	43 minutes pre-blast	500ft south/southwest of old span Pier E2
09:55	(1) HASE	1,720ft northwest	west	41 minutes pre-blast	20ft north of new span Pier E3
09:59 – 10:39	(4) HASE	1,700ft northwest	surface	37 minutes pre- to 3 minutes post-blast	milling north of new span Pier E3; observed at surface during the blast, dove immediately after; seen again at 10:39
10:07 - 10:23	(1) HASE	1,150ft northwest	north	13 minutes pre-blast	100ft south of new span Pier E4
10:07 – 10:34	(1) HASE	1,200ft northwest	north	3 minutes pre-blast	under the bridge between new span Piers E3 E4
10:18 – 10:20	(1) HASE	8,300ft southwest	south	16 minutes pre-blast	100ft south of vessel 8,160ft southwest
10:21	(1) unk-D	8,300ft south	south	15 minutes pre-blast	100ft south of vessel 8,160ft south
10:27 – 10:28	(3) HASE	1,735ft northwest	west	8 minutes pre-blast	35ft north of new span Pier E3

Table A-1. Summary of Marine Mammal Sightings during Monitoring for the September 2, 2017 Blasts of Piers E7 and E8

Times	(No.) Species*	Distance/Direction from Pier E7/E8[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
10:36 Piers E7/E8 Blast					
10:38	(4) HASE	1,750ft northwest	north	2 minutes post-blast	35 – 100ft north of new span Pier E3
10:40	(1) HASE	8,300ft southwest	southwest	4 minutes post-blast	100ft southeast of vessel 8,160ft southwest
10:42	(1) unk-D	8,160ft north	east	6 minutes post-blast	300ft from vessel 8,160ft north
10:42 – 11:33	(1) HASE	3,400ft east	west	6 minutes post-blast	200ft south of new span Pier E14
10:53	(1) HASE	1,700ft northwest	surface	17 minutes post-blast	just off the northeast corner of new span Pier E3
10:59 – 11:29	(3) HASE	1,775ft northwest	west	23 minutes post-blast	75ft north of new span Pier E3
11:00	(1) HASE	6,880ft northwest	north	24 minutes post-blast	200ft off the northeast corner of Treasure Island
11:01 – 11:06	(1) HASE	1,300ft northwest	east	25 minutes post-blast	15 – 300ft (moderate travel) from new span Pier E3
11:11 – 11:31	(1) HASE	8,160ft north	surface	35 minutes post-blast	100-150ft from vessel 8,160ft north
11:21	(1) HASE	1,500ft west	surface	25 minutes post-blast	500ft south of new span Pier E3
11:23 – 11:30	(1) HASE	3,250ft east	west	47 minute post-blast	10ft south, between new span Piers E14 E15
11:25 – 11:26	(1) HASE	8,300ft south	south	51 minutes post-blast	100ft south of vessel 8,160ft south
11:30	(1) HASE	500ft west	surface	54 minute post-blast	east of new span Pier E3; near implosion debris curtain
11:32	(1) HASE	1,600ft northwest	surface	56 minutes post-blast	40ft from new span Pier E3
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS Monitoring Zone: 1 HASE					
Total Marine Mammals Observed within Level B Behavioral Response Monitoring Zone: 5 HASE					
Notes					
***Species Codes:** California Sea Lion = CASL; Pacific Harbor Seal = HASE; Northern Elephant Seal = NOES; Northern Fur Seal = NOFS; Harbor Porpoise = HAPO; Bottlenose Dolphin = BD; unknown HAPO or BD = unk-D; unknown pinniped = unk-P					
[£] Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					
Source: Compiled by AECOM in 2017					

Table A-2. Summary of Marine Mammal Sightings during Monitoring for the September 16, 2017 Blast of Pier E6

Times	(No.) Species*	Distance/Direction from Pier E6[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
07:31 Observations Began					
08:02	(1) HASE	5,000ft south	surface	117 minutes pre-blast	1mi north of vessel located 10,030ft southeast
08:09 - 08:11	(1) HASE	3,080ft northwest	north	108 minutes pre-blast	40m northwest of vessel located 2,951ft northwest
08:13	(3) HAPO	10,030ft southwest	surface	105 minutes pre-blast	2 adults, 1 juv. milling on the edge of the HAPO Level B TTS monitoring zone
08:13	(1) HASE	2,800ft east	surface	105 minutes pre-blast	150ft south of new span Pier E1
08:24	(1) HASE	10,030ft southwest	surface	94 minutes pre-blast	One surface near the edge of the HAPO Level B TTS monitoring zone
08:25 - 08:30	(1) HASE	2,800ft northeast	surface	88 minutes pre-blast	15ft NNW new span Pier E1
08:49	(1) HASE	13,000ft south	northwest	70 minutes pre-blast	2.5mi south of Pier E6
08:49	(3) CASL	10,030ft southwest	southeast	70 minutes pre-blast	2 adults, 1 juv. near the edge of the HAPO Level B TTS monitoring zone
08:46 - 08:50	(1) HASE	1,600ft northeast	west	69 minutes pre-blast	500ft north of new span service platform
08:45 - 08:52	(2) HASE	1,600ft northwest	surface	67 minutes pre-blast	Between new span Piers E2/E3; 5m from E2
08:49 - 08:57	(1) HASE	1,780ft south	west	62 minutes pre-blast	15ft west of vessel located 1,781ft south
08:29 - 09:04	(1) HASE	2,850ft east	north	55 minutes pre-blast	45ft east of new span E1
09:05	(1) HASE	3,780ft south	south	54 minutes pre-blast	2,000ft south of vessel located 1,781ft south
09:20	(1) HAPO	8,700ft northwest	northwest	39 minutes pre-blast	100ft from northeast corner of Treasure Island
09:26 - 09:27	(1) HAPO	10,000ft north	southwest	32 minutes pre-blast	Fast travel near vessel located 10,030ft north
09:36 – 10:01	(1) HASE	1,700ft southeast	surface	20 minutes pre- to1 minute post-blast	Same animal observed by multiple observers before and after blast between old span Piers E9, E10 and east of utility sheds
09:38 - 09:49	(1) HASE	1,550ft northeast	south	10 minutes pre-blast	90ft south of E2 in Level B Pinniped TTS zone
09:49	(1) HASE	1,500ft northeast	east	10 minutes pre-blast	100ft SW of new span service platform
09:49 – 10:49	(1) HAPO	10,030 southwest	north	10 minutes pre- to 50 post-blast	1 lone adult near the edge of the HAPO Level B TTS zone; seen again at 10:10 – 10:49 post-blast milling

Table A-2. Summary of Marine Mammal Sightings during Monitoring for the September 16, 2017 Blast of Pier E6					
Times	**(No.) Species***	**Distance/Direction from Pier E6[£]**	**Surface or Travel Direction**	**Time Pre- (last sighting) or Post- (first sighting) Implosion**	**Notes**
09:50	(1) HASE	2,780ft southwest	southwest	9 minutes pre-blast	1,000ft from vessel located 1,781ft south
09:55	(1) HASE	500ft northwest	west	4 minutes pre-blast	30ft west of new E5
09:57	(2) HASE	720ft north	logging	2 minutes pre-blast	just north of E5 north tower
09:58 – 10:49	(2) HAPO	10,030ft southwest	northeast	1 minute pre- to 50 minutes post-blast	1 adult, 1 juv. join the 09:49 adult HAPO; seen again at 10:10 – 10:49 post-blast milling
09:59 – 10:00 Pier E6 Blast					
10:01	(7) HASE	1,030ft northwest	east	1 minute post-blast	under bridge between new span Piers E4/E3; surfaced at the time of the blast
10:01 – 10:03	(1) HASE	1,600ft east	west	2 minutes post-blast	Between old span Piers E9/E10 south side of bridge, east of utility boxes; presumed same animal as seen at 09:49
10:01	(7) HASE	1,600ft northwest	surface	2 minutes post-blast	Between new span Piers E2/E3
10:19 – 10:20	(1) HASE	3,000ft northwest	north	20 minutes post-blast	Surfaced near vessel located 2,951ft northwest
10:24 – 10:26	(2) HASE	Within 532ft	north	25 minutes post-blast	Swimming together then dove in the Pinniped Level A PTS MMEZ; surfaced a few times slowly moving north
10:39 – 10:55	(1) HASE	1,200ft west	Surface, spy-hop	40 minutes post-blast	300ft southwest of bike path at Pier E3; resurfaced several times, spy-hopped a bit in place
10:50	(1) HASE	400ft west	Dove once	51 minutes post-blast	Dove once
10:50	(1) HASE	720ft north	surface	51 minutes post-blast	North of new span Pier E5 north tower
10:58 – 10:59	(1) HASE	750ft east	west	59 minutes post-blast	Just outside Level A Pinniped PTS MMEZ
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS Monitoring Zone: 12 HASE, 3 HAPO					
Total Marine Mammals Observed within Level B Behavioral Response Monitoring Zone: 0					
Notes					
***Species Codes:** California Sea Lion = CASL; Pacific Harbor Seal = HASE; Northern Elephant Seal = NOES; Northern Fur Seal = NOFS; Harbor Porpoise = HAPO; Bottlenose Dolphin = BD; unknown HAPO or BD = unk-D; unknown pinniped = unk-P					
[£] Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					

Table A-2. Summary of Marine Mammal Sightings during Monitoring for the September 16, 2017 Blast of Pier E6

Times	(No.) Species*	Distance/Direction from Pier E6[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					

Source: Compiled by AECOM in 2017

Table A-3. Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E9 and E10					
Times	**(No.) Species***	**Distance/Direction from Pier E9 E10[£]**	**Surface or Travel Direction**	**Time Pre- (last sighting) or Post- (first sighting) Implosion**	**Notes**
07:13 Observations Began					
07:30	(1) HASE	8,200ft north	north	115 minutes pre-blast	50ft from vessel 8,160ft north
07:37 – 08:39	(1) HASE	8,500ft south	south	56 minutes pre-blast	400ft south of vessel 8,160ft south
07:39 – 07:41	(1) HASE	4,400ft west	surface	104 minutes pre-blast	60ft north/northeast of old span Pier E2
07:47 – 07:54	(1) HASE	8,100ft southwest	surface	91 minutes pre-blast	north of vessel 8,160ft southwest
07:48	(1) CASL	3,680ft west	surface	107 minutes pre-blast	midway between new span T1 and Pier E2
07:58 – 07:59	(1) HASE	7,870ft northwest	north	86 minutes pre-blast	80ft north of the northeast corner of Treasure Island
08:04 – 08:05	(1) HASE	400ft south	west	80 minutes pre-blast	just south of utility sheds, at the edge of the Pinniped Level A PTS MMEZ
08:09 – 08:30	(3) HASE	7,800ft southwest	surface	55 minutes pre-blast	north of vessel 8,160ft southwest
08:12	(1) HASE	8,200ft north	north	73 minutes pre-blast	30ft from vessel 8,160ft north
08:27	(1) HASE	200ft west	surface	58 minutes pre-blast	200ft west of old span Pier E9
08:41 – 08:45	(1) CASL	1,200ft west	west	40 minutes pre-blast	50ft west of new span Pier E6
08:47 – 09:20	(1) HASE	3,100ft west	surface	5 minutes pre-blast	multiple surfacings around new span T1, Pier E2, and east shore of YBI
08:58	(1) HASE	4,200ft west	surface	27 minutes pre-blast	near new span T1 tower
09:02	(1) HASE	1,370ft west	surface	23 minutes pre-blast	200ft west of new span Pier E6
09:06	(2) HASE	600ft north	north	19 minutes pre-blast	200ft north of the Pinniped Level A PTS MMEZ
09:08	(1) CASL	8,200ft southwest	east	17 minutes pre-blast	southeast of vessel 8,160ft southwest
09:12	(1) HASE	8,200ft north	north	13 minutes pre-blast	50ft from vessel 8,160ft north
09:14 – 09:15	(1) HASE	1,030ft north	surface	10 minutes pre-blast	200m north of new span Pier E8
09:14 – 09:16	(1) HASE	570ft west	surface	9 minutes pre-blast	80ft south of new span Pier E7
09:24 – 09:25	(1) HASE	1,350ft north	north	0 minutes pre-blast	300m north of new span Pier E8
09:23 – 09:25 Piers E79/E10 Blast					
09:49 – 10:02	(1) HASE	1,140ft east	west	24 minutes post-blast	200ft south of old span Pier E14
09:55	(3) HAPO	8,500ft north	north	30 minutes post-blast	300ft from vessel 8,160ft north

Table A-3. Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E9 and E10

Times	(No.) Species*	Distance/Direction from Pier E9 E10[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
10:17 – 10:25	(1) HASE	8,050ft south	surface	52 minutes post-blast	100ft northwest of vessel 8,160ft south
10:18	(1) HASE	7,500ft southwest	west	53 minutes post-blast	northwest of vessel 8,160ft southwest
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS Monitoring Zone: 3 HASE					
Total Marine Mammals Observed within Level B Behavioral Response Monitoring Zone: 0					
Notes					
***Species Codes:** California Sea Lion = CASL; Pacific Harbor Seal = HASE; Northern Elephant Seal = NOES; Northern Fur Seal = NOFS; Harbor Porpoise = HAPO; Bottlenose Dolphin = BD; unknown HAPO or BD = unk-D					
[£] Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					
Source: Compiled by AECOM in 2017					

Table A-4.
Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E11, E12, and E13

Times	(No.) Species*	Distance/Direction from Piers E11, E12, E13[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
07:04 Observations Began					
07:15 – 07:20	(1) HASE	7,040ft north	south	91 minutes pre-blast	40ft from vessel 7,080ft north
07:22 – 07:24	(1) HASE	5,030ft west	south	87 minutes pre-blast	90ft east/northeast of old span Pier E2
07:40	(1) HASE	3,200ft west	north	71 minutes pre-blast	200ft south of new span Pier E3
07:49 – 07:51	(1) HASE	3,100ft west	east	50 minutes pre-blast	100ft southeast of new span Pier E3
07:52 – 08:14	(1) HASE	1,550ft north	north	37 minutes pre-blast	50ft from vessel 1,500ft north
07:55 – 08:00	(1) HASE	7,080ft southwest	surface	51 minutes pre-blast	southeast of vessel 7,080ft southwest
08:14	(1) HAPO	8,000ft southwest	southwest	37 minutes pre-blast	southwest of vessel 7,080ft southwest
08:14 – 08:16	(1) HAPO	8,000ft southwest	southwest	35 minutes pre-blast	southwest of vessel 7,080ft southwest
08:16 – 08:23	(1) HASE	930ft southeast	west	28 minutes pre-blast	800ft south of new span Pier E12
08:16 – 08:23	(1) HASE	2,900ft west	surface	28 minutes pre-blast	>500ft southwest new span Pier E3
08:21	(1) CASL	350ft southeast	southeast	30 minutes pre-blast	350ft southeast of old span Pier E11
08:21	(1) CASL	740ft west	southwest	30minutes pre-blast	400ft southeast of new span Pier E8
08:23	(1) HASE	360ft south	northeast	28 minutes pre-blast	360ft south of old span Pier E12
08:23 – 08:37	(1) HASE	1,500ft south	west	14 minutes pre-blast	320ft west of vessel 1,500ft south; considered to be same animal as seen by other MMO moving southwest out of monitoring zones closer to blast time
08:26	(1) HASE	2,720ft west	surface	25 minutes pre-blast	just north of new span Pier E4
08:35 – 08:40	(1) HASE	4,360ft northwest	south	11 minutes pre-blast	just north of new span between T1 and Pier E2
08:36	(1) HASE	1,650ft north	north	15 minutes pre-blast	steady travel north of vessel 1,500ft north
08:36 – 08:37	(1) HASE	8,000ft southwest	surface	14 minutes pre-blast	southwest of vessel 7,080ft southwest
08:38 – 08:40	(1) HASE	7,080ft north	southwest	11 minutes pre-blast	100ft west of vessel 7,080ft north
08:40 – 08:42	(1) HASE	7,920ft northwest	northeast	8 minutes pre-blast	330ft north/northeast of northeast corner Treasure Island
08:42	(1) HASE	1,725ft west	west	9 minutes pre-blast	just outside of pinniped MMEZ's

Table A-4.
Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E11, E12, and E13

Times	(No.) Species*	Distance/Direction from Piers E11, E12, E13[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
08:44	(1) HASE	600ft south	west	7 minutes pre-blast	600ft south of old span Pier E11
08:47	(1) HASE	1,900ft west	east	4 minutes pre-blast	near new span Pier E5; distance estimate is the midway point between E5 & E6 to account for eastward travel
08:47	(1) HASE	2,250ft west	surface	4 minutes pre-blast	near new span Pier E5; just outside monitoring zones
08:51 Piers E11, E12, E13 Blast					
08:51	(1) HASE	550ft southeast	north	0-1 minutes post-blast	550ft south of old span Pier E12
08:51	(1) HASE	1,700ft west	east	0-1 minutes post-blast	near new span Pier E6
08:54	(1) HASE	500ft west	north	3 minutes post-blast	500ft west of old span Pier E11
08:55	(1) HASE	8,100ft southwest	surface	4 minutes post-blast	southwest of vessel 7,080ft southwest
09:01 – 09:08	(1) HASE	8,080ft northwest	east	10 minutes post-blast	490ft northeast of northeast corner Treasure Island
09:01 – 09:11	(1) HASE	4,700ft west	east	10 minutes post-blast	150 – 600ft from east YBI shore
09:04 – 09:43	(1) HASE	1,880ft west	east	13 minutes post-blast	1150ft west of vessel 1,500ft south
09:09 – 09:10	(1) HASE	8,200ft southwest	surface	18 minutes post-blast	southeast of vessel 7,080ft southwest
09:11	(1) HASE	6,000ft southwest	surface	20 minutes post-blast	northeast of vessel 7,080ft southwest
09:13 – 09:14	(2) HASE	5,030ft west	surface	22 minutes post-blast	15ft north/northeast of old span Pier E2
09:19 – 09:24	(1) HASE	4,690ft west	south	28 minutes post-blast	30ft north of new span T1
09:29	(1) HASE	7,000ft southwest	surface	38 minutes post-blast	northwest of vessel 7,080ft southwest
09:31	(1) HASE	1,450ft north	southwest	20 minutes post-blast	southwest of vessel 1,500ft north
09:31 – 09:36	(1) HASE	2,360ft northwest	north	40 minutes post-blast	off northeast corner Treasure Island
09:32 – 09:36	(1) HASE	10,000ft southwest	surface	41 minutes post-blast	northwest of vessel 7,080ft southwest
09:32 – 09:41	(1) HASE	4,000ft west	surface	41 minutes post-blast	150ft south of new span between T1 and Pier E2
09:34	(2) HASE	2,700ft west	east	43 minutes post-blast	near new span Pier E4
09:35	(1) HASE	1,730ft southwest	southeast	44 minutes post-blast	1,640ft west of vessel 1,500ft south
09:38	(1) HASE	6,000ft southwest	surface	47 minutes post-blast	northwest of vessel 7,080ft southwest

Table A-4.

Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E11, E12, and E13

Times	(No.) Species*	Distance/Direction from Piers E11, E12, E13[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
09:39 – 09:43	(1) HASE	7,880ft north	north	48 minutes post-blast	800ft northwest of vessel 7,080ft north
09:41	(1) HASE	5,370 southwest	surface	50 minutes post-blast	USCG cove, near outfall pipe
09:52	(1) HASE	3,500ft west	north	61 minutes post-blast	under new span, close to Pier E2
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS Monitoring Zone: 2 HASE					
Total Marine Mammals Observed within Level B Behavioral Response Monitoring Zone: 3 HASE					
Notes					
***Species Codes:** California Sea Lion = CASL; Pacific Harbor Seal = HASE; Northern Elephant Seal = NOES; Northern Fur Seal = NOFS; Harbor Porpoise = HAPO; Bottlenose Dolphin = BD; unknown HAPO or BD = unk-D; unknown pinniped = unk-P					
[£] Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					
Source: Compiled by AECOM in 2017					

Table A-5.
Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E14, E15, and E16

Times	(No.) Species*	Distance/Direction from Piers E14, E15, E16[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
07:05 Observations Began					
07:14	(1) HASE	4,150ft west	north	35 minutes pre-blast	300ft south of new span Pier E3
07:26 – 07:48	(1) HASE	6,500ft southwest	south	1 minute pre-blast	estimated from vessel located 7,080ft southwest
07:31	(1) HASE	2,160ft west	west	18 minutes pre-blast	100ft west of HAPO Level A PTS MMEZ
07:33	(1) HASE	1,080ft north	west	16 minutes pre-blast	north of new span E12; estimated from vessel located 1,500ft north
07:48 – 08:06	(1) HASE	7,200ft southwest	south	1 minute pre- to 17 minutes post-blast	estimated from vessel located 7,080ft southwest
07:47 – 07:48	(1) HASE	2,300ft east	southeast	1 minute pre-blast	2,300ft off northeast corner Treasure Island
07:49 Piers E14, E15, E16 Blast					
07:54 – 07:55	(1) HASE	5,850ft southwest	surface	5 minutes post-blast	≥ 450ft off east shore YBI, southeast of old span Pier E2
08:12 – 08:21	(1) HASE	1,090ft southwest	east	23 minutes post-blast	≥ 300ft south of new span Pier E9, southeast of utility sheds
08:13 – 08:14	(1) HASE	1,560ft north	west	24 minutes post-blast	north of new span Pier E11; estimated from vessel located 1,500ft north
08:15	(1) HASE	1,070ft southwest	surface	26 minutes post-blast	300ft south of new span Pier E9
08:18	(1) HASE	1,425ft north	surface	29 minutes post-blast	north of new span Pier E11; estimated from vessel located 1,500ft north
08:24	(1) HASE	800ft west	surface	35 minutes post-blast	under bridge between Piers E9, E10
08:25	(1) HASE	1,050ft west	east	36 minutes post-blast	travelling near new span between Piers E9 to E3
08:37	(1) HASE	7,000ft north	surface	48 minutes post-blast	50ft from vessel located 7,080ft north
08:45 – 08:47	(1) HASE	4,200ft west	north	54 minutes post-blast	travelling near new span between YBI to Pier E3
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS Monitoring Zone: 0					

Table A-5.

Summary of Marine Mammal Sightings during Monitoring for the September 30, 2017 Blasts of Piers E14, E15, and E16

Times	(No.) Species*	Distance/Direction from Piers E14, E15, E16[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
Total Marine Mammals Observed within Level B Behavioral Response Monitoring Zone: 0					
Notes					
***Species Codes:** California Sea Lion = CASL; Pacific Harbor Seal = HASE; Northern Elephant Seal = NOES; Northern Fur Seal = NOFS; Harbor Porpoise = HAPO; Bottlenose Dolphin = BD; unknown HAPO or BD = unk-D; unknown pinniped = unk-P					
[£] Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					
Source: Compiled by AECOM in 2017					

Table A-6.
Summary of Marine Mammal Sightings during Monitoring for the November, 11 2017 Blasts of Piers E17 and E18

Times	(No.) Species*	Distance/Direction from Piers E17, E18[£]	Surface or Travel Direction	Time Pre- (last sighting) or Post- (first sighting) Implosion	Notes
06:10 Observations Began					
06:32 – 06:33	(1) HASE	6,800ft southwest	south	54 minutes pre-blast	15ft of old span Pier E2
06:32 – 06:35	(1) HASE	1,550ft southeast	south	52 minutes pre-blast	estimated from new span Pier E15
06:41 – 06:42	(1) HASE	370ft north	east	45 minutes pre-blast	along the Pinniped Level A PTS MEEZ north of bridge
06:46 – 07:12	(1) HASE	1,500ft south	northwest	15 minutes pre-blast	tracked by multiple MMOs
06:47	(1) HASE	7,900ft southwest	east	40 minutes pre-blast	500ft east of YBI near vessel located 6,168ft southwest
06:50	(1) HASE	2,650ft northwest	east	37 minutes pre-blast	2,400ft northwest of new span Pier E13
06:52	(1) unk-P	940ft northwest	northeast	35 minutes pre-blast	only midsection of body seen; 200ft north of new span Pier E11
06:54 – 06:57	(1) HASE	8,400ft northwest	north	30 minutes pre-blast	500ft off northeast corner of Treasure Island
07:02 – 07:04	(1) HASE	670ft west	northeast	23 minutes pre-blast	400ft southeast of new span Pier E11
07:03	(1) HASE	6,970ft southwest	south/south west	24 minutes pre-blast	250ft south/southwest of old span Pier E2
07:06 – 07:15	(1) HASE	8,400ft northwest	north	12 minutes pre-blast	500ft off northeast corner of Treasure Island
07:10 – 07:44	(1) HASE	6,170ft southwest	surface	17 minutes pre-blast	near vessel located 6,168ft southwest
07:16 – 07:18	(1) HASE	1,400 southwest	south/south west	9 minutes pre-blast	tracked by multiple MMOs
07:20	(1) HASE	6,6,80ft west	north	7 minutes pre-blast	halfway between old span Pier E2 and new bridge
07:22	(1) HASE	770ft southeast	west/north west	5 minutes pre-blast	tracked by multiple MMOs; travelling/milling around the southwest area of the Pinniped Level B TTS monitoring zone, 200ft outside of Pinniped Level A PTS MMEZ
07:27 Piers E17, E18 Blast					
07:28	(1) HASE	300ft southwest	surface	0-1 minute post-blast	surfaced quickly just after blast on the southwest edge of the Pinniped Level A PTS MMEZ

07:34	(1) HASE	400ft southwest	south	7 minutes post-blast	just outside the southwest edge of the Pinniped Level A PTS MMEZ
07:42 – 08:02	(1) HASE	8,320ft northwest	north	15 minutes post-blast	300ft off southeast corner of Treasure Island
07:44	(1) HASE	2,340ft west	southwest	17 minutes post-blast	50ft north of utility sheds
08:03	(1) HASE	850ft west	east	36 minutes post-blast	less than 50ft from new span Pier E11
08:06 – 08:13	(1) HASE	950ft northwest	east	39 minutes post-blast	50ft – 100ft east of new span Pier E11
08:14	(1) HASE	6,670ft northeast	north	47 minutes post-blast	northeast side of new span T1
Summary of Take					
Total Marine Mammals Observed in the Level A PTS MMEZ: 0					
Total Marine Mammals Observed within Level B TTS MMEZ: 2 HASE					
Total Marine Mammals Observed within Level B Behavioral MMEZ: 1 HASE					
Notes					
***Species Codes:** California Sea Lion = CASL; Pacific Harbor Seal = HASE; Northern Elephant Seal = NOES; Northern Fur Seal = NOFS; Harbor Porpoise = HAPO; Bottlenose Dolphin = BD; unknown HAPO or BD = unk-D; unknown pinniped = unk-P					
[£] Distances estimated using monitoring zone distances and Google Earth measuring tool, based on observation notes					
Highlighted cells indicate marine mammals that were within a monitoring zone within 15 minutes before the time of the implosion. Take numbers were considered for each blast according to measured hydro acoustic data.					
Source: Compiled by AECOM in 2017					