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Making Conservation
a California Way of Life.

July 26, 2017

Mr. Shane Guan
Fishery Biologist
National Marine Fisheries Service, Office of Protected Resources
1315 East-West Highway, Suite 13826
Silver Spring, MD 20910

Dear Mr. Guan:

The California Department of Transportation (Department), as part of the San Francisco-Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project (SFOBB Project), will be removing marine foundations of the former SFOBB east span, Piers E6 to E18, via controlled implosions. On June 23, 2017, the Department distributed its 2017 Marine Foundation Removal Project Biological Monitoring Programs to the SFOBB Project's state and federal environmental regulatory partners for review and comment. I am writing now to thank you for your time and thoughtful contributions; your efforts make the SFOBB Project a world-class project and are greatly appreciated. I am also writing to provide to you the Final Biological Monitoring Programs that have addressed and incorporated your valued input.

Please find enclosed with this letter two items. The first is a comment matrix that tracks and addresses each agency comment received by the Department (Enclosure 1). The second is the *2017 Marine Foundation Removal Project: Final Biological Monitoring Programs* document for your project records (Enclosure 2). Please note that edits to the text in the final monitoring programs are shown in ~~strikethrough~~ (deletion) or underline (addition). Thanks to your help in shaping this project in advance, there are minimal edits to the final document from the draft that was sent for your review and nearly all edits are provided for further clarification on items that were already addressed.

Thank you for your continued effort on the SFOBB Project and in maintaining our shared goal of protecting the environmental resources of San Francisco Bay. I look forward to providing you the results of this year's efforts. Should you have any questions please feel free to reach out to me at (510) 867-6785, or my project representative, Dillon Lennebacker, at (510) 874-3035.

Sincerely,

STEFAN GALVEZ-ABADIA
SFOBB Environmental Manager

Enclosure 1: Response to Comments Matrix
Enclosure 2: 2017 Marine Foundation Removal Project: Final Biological Monitoring Programs

cc: Katerina Galacatos/ Janelle Leeson, USACE
Darren Howe, NMFS
Dale Youngkin, NMFS-OPR
Arn Aarreberg/ Bill Paznokas, CDFW
Jaime Michaels/ Tinya Hoang/ Rafael Montes, BCDC
Derek Beauduy/ Dale Bowyer, RWQCB

Enclosure 1:

Response to Comments Matrix

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Comment No.	Agency	Date	Agency Question/Comment	Caltrans' Response to Comments	Response Addressed in Final E6-E18 Report? (Y/N)
1	BCDC	7/7/2017	To establish marine mammal monitoring and exclusion zones in the monitoring programs, the Deparment added an additional 20% distance to the estimated thresholds for marine mammal criteria. These calculations for the monitoring zones distances are based off of and the same distances to criteria in the IHA that was issued.The IHA was issued on July 13, 2017. The Department will has already transmitted the final IHA to BCDC for their records. The Department will monitor in accord with the monitoring zones in the monitoring programs. You are correct that Pier E9 is likely to be paired with E10, however, should the Department need to address this as a single pier event it was included in the monitoring program.	To establish marine mammal monitoring and exclusion zones in the monitoring programs, the Deparment added an additional 20% distance to the estimated thresholds for marine mammal criteria. These calculations for the monitoring zones distances are based off of and the same distances to criteria in the IHA that was issued.The IHA was issued on July 13, 2017. The Department will has already transmitted the final IHA to BCDC for their records. The Department will monitor in accord with the monitoring zones in the monitoring programs. You are correct that Pier E9 is likely to be paired with E10, however, should the Department need to address this as a single pier event it was included in the monitoring program.	No
2	BCDC	7/7/2017	- **Special Condition II.I.4.b. (Bird Exclusion Zone)**: The proposed bird exclusion zone distances are 300 feet for E6 and 200 feet for E7-E18. The permit requires that the exclusion zone is consistent with CDFW recommendations or approvals. Please confirm whether these distances are okay with CDFW.	The proposed exclusion zones for listed diving birds are based on conservative estimates that used the results of the Piers E3, E4 and E5 implosions. The Department does not anticipate listed birds to be diving in the project area during blast events, but recognizes that there is some possibility this could occur. The proposed monitoring is in accord with project authorizations. In accordance with the SFOBB Project's CDFW ITP, CDFW has been provided a copy of the same biological monitoring programs for review and approval. On July 24, 2017 CDFW provided a response that they have no additional comments to the 2017 Monitoring Programs.	No
3	BCDC	7/7/2017	- **Special Condition II.I.4.e (Bird Predation Monitoring and Fish Salvage)**: The permit requires that all federally- and state-listed and EFH species are collected and preserved. On page 63 of the monitoring program, it says non-listed species will be discarded after they are recorded and photographed. It is unclear if there are non-listed, EFH species that would be discarded.	The Project's Biological Opinion from NMFS requires that, if feasible, any green sturgeon, salmonids, longfin smelt, or EFH species be preserved and transferred to NMFS or CDFW. In accordance with the SFOBB Project's BO and ITP the Department will record all species collected and preserve and transfer all federally listed or EFH species to NMFS or CDFW.	Yes Page 64
4	BCDC	7/7/2017	- **Special Condition II.I.4.f (Hydroacoustic Monitoring)**: From the monitoring program, it is my understanding that hydroacoustic monitoring will no longer take place within the BAS, and that monitoring will take place at three locations within 800 feet, and at 1,500 feet, 3,000 feet and 6,000 feet. These would be located in a north or south array, at mid-water column depth. The specific positions, depths, distances and orientations have not been determined yet. When will these specifics be determined? Do CDFW and NMFS need to know the specifics before the blasts? Please provide confirmation from CDFW and NMFS that the monitoring program is acceptable and consistent with their approvals.	The Department has provided the biological monitoring programs for review and approval to NMFS and CDFW. General parameters including distances (i.e., 3 sensors within 800 feet for all events and 3 sensors from 1,500 to 6,000 feet for 3 of the events) and nominal water depths (mid-water column) are provided in the monitoring programs. Specific monitoring locations within these parameters will be determined prior to each blast and included in the final report. The Department is clarifying that the monitoring far-field will be conducted to the north. This change is made because the locations beyond 1,500 to the south of the Piers would either be obstructed or would occur on land and conlcluded this is not a feasible option. Near field monitoring will likely be likely be done to the south for each event. This does not change the Department's ability to monitor the hydroacoustic impacts and are not anitcipated to significantly effect the results of the monitoring.	No
5	NMFS	7/14/2017	Presently, some monitoring is proposed to be limited to 800 feet from the source. I'd like to discuss the methods for hydroacoustic monitoring to ensure that distances to thresholds if beyond 800-ft, will be captured. I understand from talking with DJ that this may be able to capture, by extrapolation from recorded data, where the threshold was met. However clarification in the document may be needed.	Sections 7.3.1 and 7.1.3.2 clarify how the Deparement has considered these issues. On July 17, 2017, the Department and NMFS discussed this item and provided clarification to NMFS. The Department clarified that during three blast events there will be monitoring conducted at, and beyond, 1,500 feet. Additionally, the Department clarified reporting on events where monitoring would only occur to 800 feet, and would use that data along with the fall off rates collected during previous blast events to calculate impacts at greater distances to regulatory thresholds. NMFS found this clarification acceptable. Several paragraphs summarizing this clarification was added to the monitoring programs.	Yes Page 64
6	NMFS	7/14/2017	Similarly, the use of hydrophones vs. transducers and their respective ability to capture peak pressure, and the identification of which method will be used and why may require clarification. The document seems to assess equipment ability in relation to cSEL, but not peak pressure. It may be that peak pressure is easily measured by both methods, but this is unclear (or I missed it in the text). Clarification may be warranted.	Text has been added to the monitoring program to clarify this issue.	Yes Page 56-57
7	NMFS	7/14/2017	Finally, water quality monitoring - it was not entirely clear why different methods are being used for different piers. This may be appropriate; however, some further clarification may be warranted.	On July 17, 2017, the Department and NMFS discussesd this item and provided clarification to NMFS. Plans for monitoring change for each event based on the event location and on its proximity to eelgrass beds. Piers that are closer to these environmentally sensitive areas require additional monitoring as described in the monitoring programs.	No
	USACE		No Comments	Caltrans recived confirmation of review and no additional comments from U.S. Army Corps of Engineers on July 19, 2017	No
	NMFS-OPR		No Comments	Caltrans recived confirmation of review and no additional comments from National Marine Fisheries Service - Office of Protected Resources on July 17, 2017	No
	CDFW		No Comments	Caltrans recived confirmation of review and no additional comments from California Department of Fish and Wildlife on July 24, 2017.	No
	RWQCB		No Comments	Caltrans recived confirmation of review and no additional comments from San Francisco Bay Regional Water Quality Control Board on July 24, 2017.	No

Contributing Agencies:
BCDC - San Francisco Bay Conservation and Development Commission
CDFW - California Department of Fish and Wildlife
NOAA - National Oceanic & Atmospheric Administration - National Marine Fisheries Service (Fisheries) RWQCB - San Francisco Bay Regional Water Quality Control Board
USACE - United States Army Corps of Engineers

Enclosure 2:

2017 Marine Foundation Removal Project: Final Biological Monitoring Programs

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San Francisco–Oakland Bay Bridge
East Span Seismic Safety Project

2017 Marine Foundation Removal Project
Final Biological Monitoring Programs

EA 04-013574

EFIS#: 0416000287

04-SF-80 KP 12.2/KP 14.3

04-ALA-80 KP 0.0/KP 2.1

June 2017

California Department of Transportation

Caltrans

For individuals with sensory disabilities, this document is available in Braille, large print, on audiocassette, or computer disk. To obtain a copy in one of these alternate formats, please call or write to Caltrans, Attn: Stefan Galvez-Abadia, District Office Chief, Environmental Analysis, 111 Grand Avenue, Oakland, CA 94612; (510) 867-6785 Voice, or use the California Relay Service TTY number (800) 735-2929 or 711.

San Francisco–Oakland Bay Bridge
East Span Seismic Safety Project

2017 Marine Foundation Removal Project
Final Biological Monitoring Programs

EA 04-013574

EFIS#: 0416000287

04-SF-80 KP 12.2/KP 14.3

04-ALA-80 KP 0.0/KP 2.1

July 2017

California Department of Transportation

Reviewed By: ______________________ Date: _6/23/2017__

Melinda Schulze, Senior Environmental Planner
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Reviewed By: ______________________ Date: _7/25/2017__

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Approved By: ______________________ Date: 7/25/2017

Stefan Galvez-Abadia
Chief – Office of Environmental Analysis
Environmental Manager – San Francisco–Oakland Bay Bridge Project
Caltrans District 4

The environmental review, consultation, and any other action required in accordance with applicable federal laws for this project is being, or has been, carried-out by the Department under its assumption of responsibility pursuant to 23 USC 327.

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List of Abbreviated Terms

AMP	Avian Monitoring Plan
BAS	blast attenuation system
Bay	San Francisco Bay
BCDC	San Francisco Bay Conservation and Development Commission
BMMP	Bird Monitoring and Management Plan
BMP	Bird Management Plan
CCSF	City and County of San Francisco
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
cSEL	cumulative sound exposure level
dB	decibel(s)
Department	California Department of Transportation
ESA	environmentally sensitive area
FESA	Federal Endangered Species Act
FHWG	Fisheries Hydroacoustic Working Group
GI	gastrointestinal
Hz	hertz
IHA	Incidental Harassment Authorization
ITP	Incidental Take Permit
kHz	kilohertz
L_{pk}	single strike peak level
MBTA	Migratory Bird Treaty Act
MMC	Marine Mammal Center
MMEZ	marine mammal exclusion zone(s)
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
MTSZ	Marine Traffic Safety Zone
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
OTD	Oakland Touchdown
Psi	pound per square inch
PTS	Permanent Threshold Shift
QA/QC	quality assurance/quality control

re 1 µPa	reference 1 micropascal
RMS	root mean square
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SEL	sound exposure level
SFOBB	San Francisco–Oakland Bay Bridge
SFOBB Project	San Francisco–Oakland Bay Bridge East Span Seismic Safety Project
SMP	Self-Monitoring Program
SPL	sound pressure level
S/s	samples per second
SWPPP	Storm Water Pollution Prevention Plan
TTS	Temporary Threshold Shift
USFWS	United States Fish and Wildlife Service
WDR	Waste Discharge Requirement
WQO	water quality objectives
YBI	Yerba Buena Island
ZOI	Zone of Influence

Chapter 1. Introduction

The California Department of Transportation (Department), as part of the San Francisco–Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project (SFOBB Project), is 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. Controlled implosion is proposed as an alternate method to the originally permitted mechanical methods for dismantling the remaining marine foundations, because it is expected to result in fewer in-water work days, have a reduced impact on environmental resources of the San Francisco Bay (Bay), and require 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 were conducted during and following the implosions, demonstrated the use of highly controlled charges to be 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 will continue to use controlled implosions to remove the remaining marine foundations of the original east span under the next phase of work. In 2017, the Department is proposing to implode Piers E6 through E18 thus reducing the original in-water work duration by a year. To accomplish this goal, the piers will be imploded as multiple-pier implosion events over the course of five to six events within the implosion work window. One to four piers will be imploded sequentially during a single implosion event. Additional details are provided in Chapter 2.

To minimize impacts on biological resources and determine the level of hydroacoustic noise from the anticipated upcoming implosions, the Department will be implementing several monitoring efforts. The purpose of this document is to provide a compendium of the biological monitoring programs that are proposed for removal of the remaining marine foundations. The following chapters describe the project background and biological monitoring programs for each natural resource. The measures to minimize and avoid impacts on species are described in each chapter, and the reporting timelines are summarized in Chapter 12.

The biological monitoring programs described herein are related to the next piers to be removed in 2017: Piers E6 through E18. Piers E2 and Piers E19 through E23 are currently not scheduled for removal.

Chapter 2. Background

2.1. Original East Span Bridge and Piers E4 to E18

Construction of the original east span of the SFOBB was completed in 1936, connecting Yerba Buena Island (YBI) and the Oakland shoreline. The original east span was a double-deck structure, 12,127 feet (3,696 meters) in length and approximately 58 feet (18 meters) wide. It was constructed and opened with six traffic lanes on the upper deck; the lower deck had two rail lines, one lane for large trucks, and two lanes for traffic. From 1963 to the time of its decommission, the original east span carried five traffic lanes on each of the upper and lower decks. The original east span was supported by 21 water bridge piers, as well as by land-based bridge piers and bents on both YBI and the Oakland shoreline. Figure 1a shows the elevation view of the new east span and the original east span.

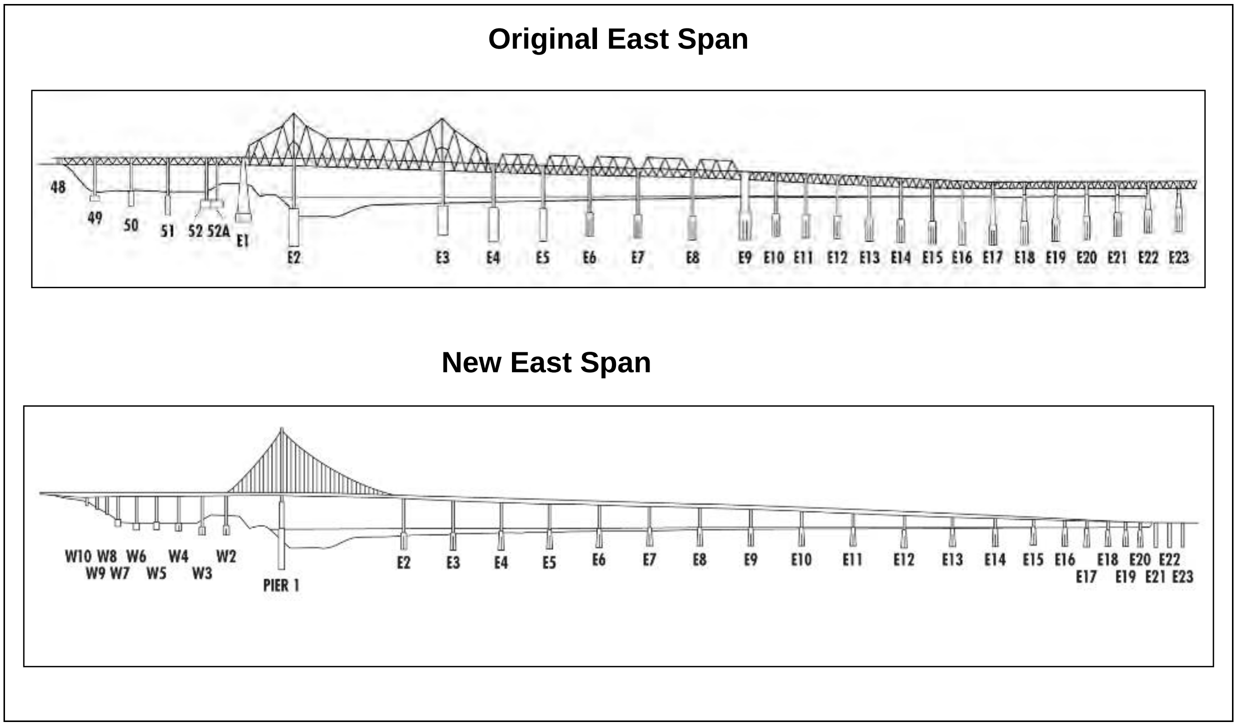
Removing the marine foundations of the original east span will occur within the jurisdictions of the City and County of San Francisco (CCSF) and the City of Oakland in Alameda County. Piers E4 and E5 were located within CCSF jurisdiction and were removed in October 2016. Pier E6 straddles the border that delineates the CCSF from the City of Oakland. Piers E7 to E18 are located in the City of Oakland. All remaining piers are located between the Oakland Touchdown (OTD) and YBI, and are situated south of the new east span bridge (Figure 1b).

Piers E6 to E18 are located on the original east span, west of the OTD and east of YBI. The approximate water depth varies by pier location. Approximate location information for each pier is shown in Table 1.

2.1. Summary of Project Activities

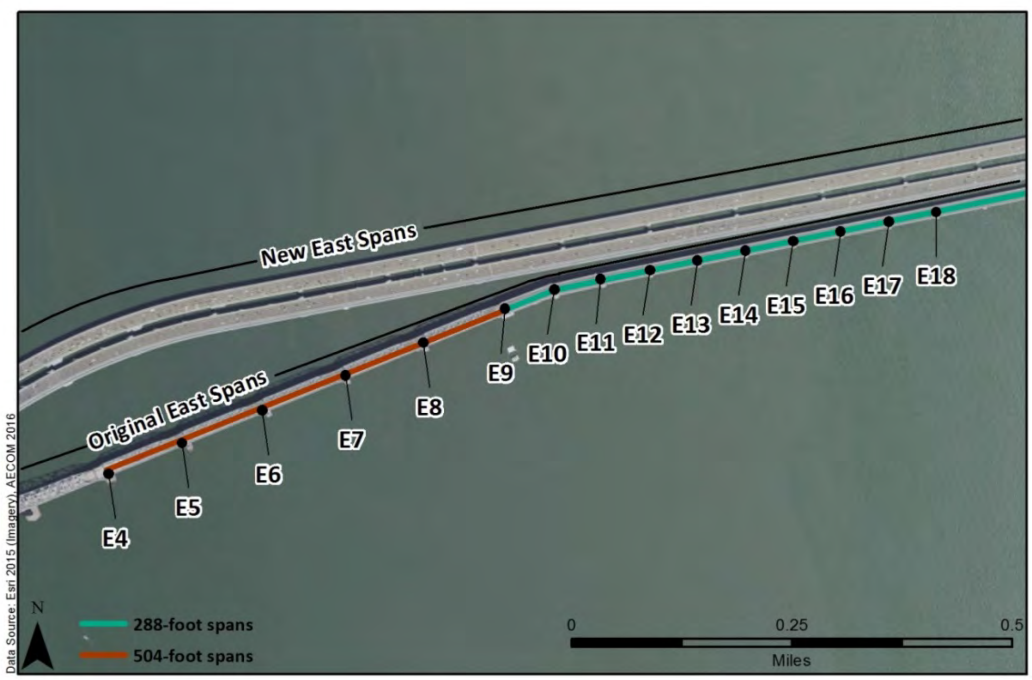
Dismantling of Piers E5 and E4 began in July 2016, and was completed on October 15 and October 29, 2016, respectively. The steel superstructure of the original SFOBB was removed earlier than scheduled, and thus the plan for removing the remaining marine foundations of Piers E6 through E18 is anticipated to be completed in 2017, thereby eliminating most, if not all of the remaining in-water work that currently is scheduled for 2018.

Project activities related to removal of Piers E6 through E18 are described in the following sections.



Source: Compiled by AECOM in 2016

Figure 1a. Elevations of the Original East Span and New East Span



Source: Compiled by AECOM in 2016

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

Table 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

2.1.1. Mechanical Demolition Work

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

2.1.2. Pier Implosions

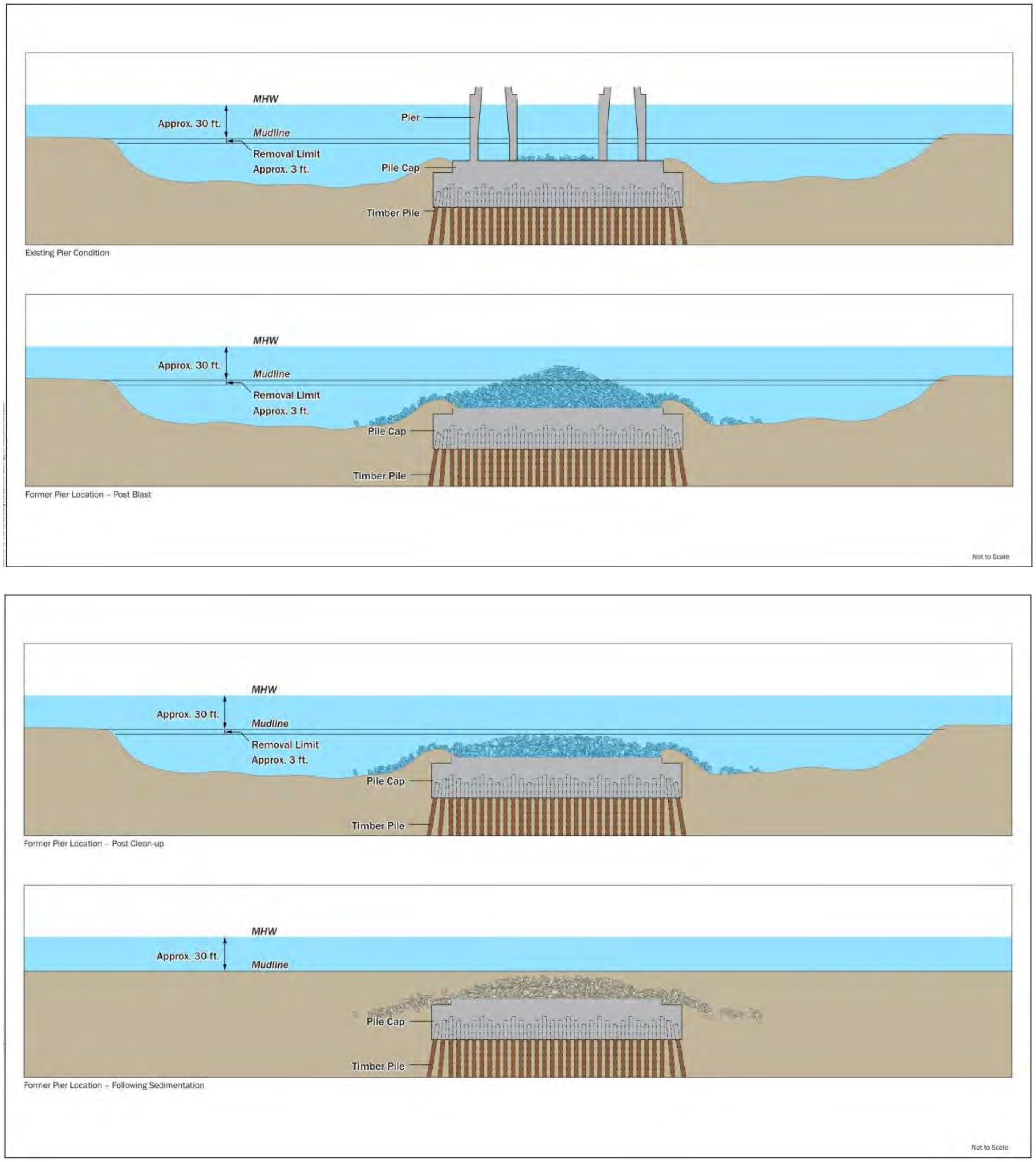
Controlled blasting will be accomplished using hundreds of small charges for each pier, with delays between individual charges. Each controlled blast sequence will last approximately 1 to 5 seconds, depending on the pier being removed or pier grouping as described below. Individual cartridge charges using electronic blasting caps versus pumpable liquid blasting agents have been selected to provide greater control and accuracy in determining the individual and total charge weights. Use of individual cartridges will allow a refined blast plan to efficiently break the concrete while minimizing the number of charges needed. These demolitions will remove the piers to at least 1.5 feet below the mudline using controlled implosion, as required by agency permits. However, the Department has elected to remove the piers to at least 3 feet below the mudline. For this project, the mudline is defined as the lowest elevation of the natural mudline adjacent to and outside any scoured pit surrounding an object in the Bay (see Figure 2 and Figure 3 for a conceptual schematic of the removal limits for a typical pier).

As shown during the Pier E3 Demonstration Project and the subsequent implosions of Piers E4 and E5, a blast attenuation system (BAS) decreases noise and pressure waves generated during each controlled blast, and minimizes 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. The BAS will be activated before and during each controlled blast to remove each pier and during all test blasts, if performed this season.

To complete the removal of Piers E6 through E18 in 2017, the Department proposes to implode multiple piers in a single day, which will reduce the overall number of pier implosion events. When conducting a multiple pier implosion event, the piers will be imploded in sequence, not simultaneously. The spacing between the last charge on one pier and the first charge on the next pier will be approximately one half second or less, with enough temporal space to avoid the potential for accumulating peak pressure waves that can occur from simultaneous pier implosions.

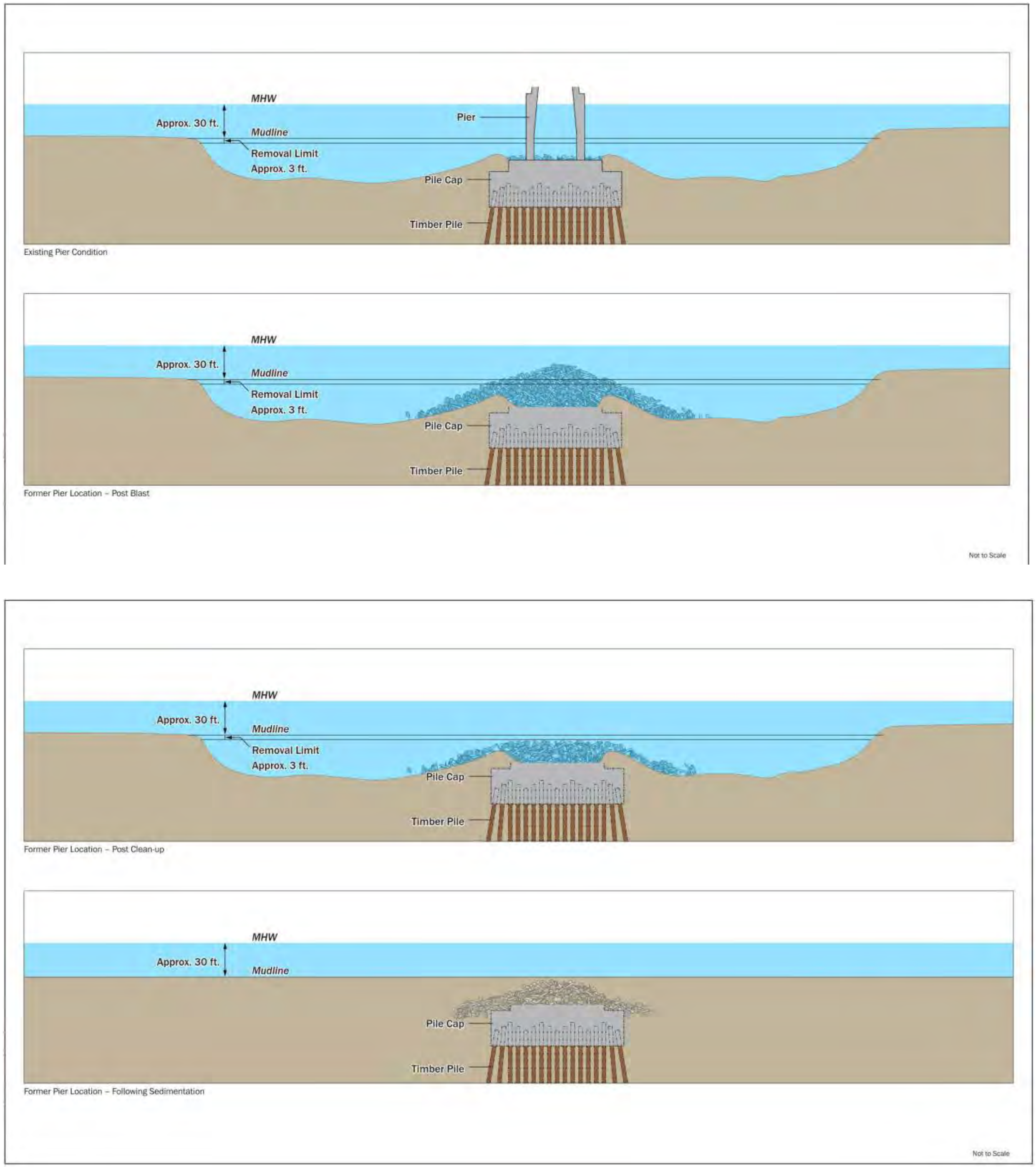
A maximum of four piers will be removed in a single day. The largest remaining pier (Pier E6) will be removed in a single implosion event. Up to two piers that formerly supported either the 504-foot or 288-foot spans of the bridge may be imploded on the same day. Two to four small piers that formerly supported the 288-foot spans of the bridge may be imploded on the same day. A total of five to six pier implosion events, consisting of the implosion of one to four piers, may be required to remove Piers E6 through E18.

To help minimize impacts on biological resources, controlled blasting events will be conducted at a slack tide in the fall months of each construction season (September, October, or November), as was done for removal of Piers E4 and E5. Each individual pier will be encircled by its own BAS, similar to the operations used for Piers E3, E4, and E5. For example, a three-pier implosion event will involve the use of three unique BAS systems, each with dedicated frames



Source: Compiled by AECOM in 2016

Figure 2. North-South Cross Sections–Conceptual Removal Limits of a Typical Pier



Source: Compiled by AECOM in 2016

Figure 3. East-West Cross Sections–Conceptual Removal Limits of a Typical Pier

and air compressors. The BAS to be used at Piers E6 through E18 will be a system similar to that successfully used for the Pier E3 Demonstration Project and in the demolitions of Piers E4 and E5.

Public safety measures will be implemented continuously during each controlled blast. Safety zones will be established and enforced to exclude any marine traffic that is not directly involved in the controlled blast(s). Marine traffic and recreational boating activities will be restricted from a radius of 1,500 feet (457 meters) around each pier and will be designated as the Marine Traffic Safety Zone (MTSZ). Safety procedures may be implemented on the new east span bridge, including roadway traffic management in both directions and complete closure of public access to the bike path/pedestrian walkway in advance of each controlled implosion.

2.1.3. Post Blast Clean-up

Following each controlled blasting event and after receiving confirmation that the area is safe for work, construction crews will remove all associated equipment, including barges, compressors, the BAS, and blast mats. Rubble from the controlled blasting of Piers E6 through E18 will be removed down to each pier's respective planned debris removal limit elevation by a barge-mounted crane with a clamshell bucket. The clamshell bucket will be equipped with a GPS unit, to accurately guide the movement of the bucket during underwater operation.

Any portion from each pier that does not break apart during the controlled blasting and remains above the removal limits will be demolished by mechanical means. This may require use of underwater mechanical equipment, including hydraulic crushing or grinding machinery or diver-operated jackhammers. Because a greater number of piers will be removed between September 1 and November 30, 2017, clean-up activities may extend into December 2017.

Chapter 3. Marine Mammal Monitoring Program

SFOBB Project activities associated with dismantling of the original east span have the potential to result in the incidental take of marine mammals. The Department has applied for an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS), pursuant to the Marine Mammal Protection Act (MMPA)(2017 IHA), for the take of California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina richardii*), northern elephant seals (*Mirounga angustirostris*), northern fur seal (*Callorhinus ursinus*), harbor porpoises (*Phocoena phocoena*), and common bottlenose dolphins (*Tursiops truncatus*) by behavioral harassment incidental to the controlled implosion of Piers E6 through E18.

The Marine Mammal Monitoring Program presented herein has been prepared in compliance with pier implosion requirements of the anticipated 2017 IHA. The following discussion includes the use of controlled charges for demolition of Piers E6 through E18, injury and harassment threshold criteria zones, and specific methods for monitoring and reporting marine mammal activity near the implosion area.

3.1. Regulations Pertaining to Marine Mammals

Under the MMPA, "take" is defined as "harass, hurt, capture, kill or collect, or attempt to harass, hurt, capture, kill or collect." Under the 1994 Amendment to the MMPA, harassment is defined statutorily as "any act of pursuit, torment, or annoyance which has the potential to injure or disturb a marine mammal or marine mammal stock in the wild." Harassment that has the potential to injure or kill a marine mammal is defined further as Level A harassment. Harassment that has the potential to disturb a marine mammal by causing disturbance of behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal, is defined further as Level B harassment.

In 2001, in accordance with the MMPA, the Department requested authorization from NMFS for possible harassment of small numbers of two pinniped species—California sea lions and Pacific harbor seals, and one cetacean species—gray whales, incidental to conducting the SFOBB Project. On November 10, 2003, NMFS issued an IHA to the Department, authorizing the take of a small number of marine mammals incidental to the SFOBB Project. Because IHAs are valid for only 1 year, the Department requested and was issued eleven subsequent IHAs for the SFOBB Project, in 2005, 2007, 2009, 2011, January 2013, December 2013, 2014, July 2015, September 2015, September 2016, and summer 2017 (expected issuance time frame). Harbor porpoise was added to the Department's IHA authorization in 2007. Northern elephant seal was added to the Department's IHA in September 2015. Northern fur seal and bottlenose dolphin were added to the Department's 2016 IHA. The first five IHAs (2003, 2005, 2007, 2009, and 2011) addressed potential impacts on marine mammals and monitoring requirements associated with pile driving for construction of the new east span. The 2013, 2014, and July 2015 IHAs addressed activities associated with both construction of the new east span and dismantling of the original east span. The September 2015 IHA addressed the Pier E3 Demonstration Project. The 2016 IHA also addressed pile driving activities associated with dismantling of the original east span and implosion of Piers E4 and E5. The 2017 IHA will cover only implosion activities in 2017.

Hydroacoustic and marine mammal monitoring has been performed during all activities authorized under the Department's IHAs. Based on the monitoring results, the Department and NMFS determined that in-water mechanical dismantling of marine foundations via drilling, sawing, cutting, cracking, breaking, and pulverizing will not result in the incidental take of marine mammals as defined under the MMPA. Therefore, the 2016 and 2017 IHA do not include mechanical dismantling. The Marine Mammal Monitoring Plan presented herein has been prepared in compliance with the requirements for implosion of Piers E6 through E18 under the 2017 IHA.

3.2. Marine Mammal Species of Concern

Seven species of marine mammals regularly inhabit seasonally or infrequently enter the Bay. The two most common species in the Bay are the Pacific harbor seal and the California sea lion. Northern elephant seal and northern fur seal seasonally enter the Bay during spring and fall, but both species tend to occur along the western margin of the Bay (west of Treasure Island) and rarely are observed near the east span of the SFOBB. Harbor porpoise and bottlenose dolphin enter the Bay throughout the year; however, these species also tend to occur along the western margin of the Bay and rarely are observed near the SFOBB east span. Gray whale may enter the Bay during its northward migration in the spring and potentially could occur near the SFOBB east span in February, March, and April. Gray whale is not expected to be within the SFOBB Project area between September and December, when the pier implosion activities are scheduled to occur. Therefore, no take of gray whale is anticipated and no incidental take of this species has been authorized under the 2017 IHA. None of these species are listed as endangered or threatened under the Federal Endangered Species Act (FESA), or as depleted or a strategic stock under the MMPA.

3.2.1. California Sea Lion (United States Stock)

Status: California sea lion is protected under the MMPA, but it is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2012), or listed as endangered or threatened under the FESA. The United States stock increased between 1975 and 2008, with an estimated population of 296,750 sea lions (Carretta et al. 2015).

Use of the Bay and SFOBB Project Area: During past monitoring for the SFOBB Project, 80 California sea lions were observed between 2000 and 2016. The number of sea lions sighted in the SFOBB Project area decreased in 2015 and 2016. The sea lions appeared to be travelling mainly through the SFOBB Project area rather than feeding, although two exceptions were noted. In 2004, several sea lions were observed following a school of Pacific herring that moved through the SFOBB Project construction area, and one sea lion was observed eating a large fish in 2015.

The occurrence of sea lions in the Bay typically is lowest in June (breeding season) and highest in August. Since at least 1987, sea lions have been observed occupying the docks near Pier 39 in San Francisco, about 3.2 miles (5.2 kilometers) from Piers E6 through E18. The highest number of sea lions recorded at Pier 39 was 1,701 individuals in November 2009 (De Rango, per comm., 2013). The number of sea lions at the haul-out site fluctuates throughout the year and even from one week to the next. For example, in June 1998, approximately 574 sea lions were observed on June 7, while a lower count of just 63 were observed on June 25 (Lander, pers. comm., 1999). The sea lions typically appear at Pier 39 after returning from the Channel Islands at the beginning of August (Bauer 1999). Around late winter, sea lions start to disperse down the coast and their numbers at Pier 39 decline. The lowest numbers of sea lions usually are observed from May through July.

Approximately 85 percent of the animals that haul out at this site are males, and no pupping has been observed here or at any other site in the Bay (Lander, pers. comm., 1999). Pier 39 is the only regularly used haul-out site around the SFOBB Project area, but sea lions occasionally haul out on human-made structures, such as bridge piers, jetties, or navigation buoys (Riedman 1990).

Diving and Foraging: Although little information is available on the foraging patterns of California sea lion in the Bay, individual sea lions have been observed feeding in the shipping channel south of YBI on a fairly regular basis (Grigg, pers. comm., 1999, 2001). Foraging by sea lions that use the Pier 39 haul-out site primarily occurs in the Bay, where they feed on Pacific herring (*Clupea harengus*), northern anchovy (*Engraulis mordax*), sardines (*Sardinops sagax caerulea*), and other prey (Hanni and Long 1995).

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

Source: ESRI 2015 (imagery); compiled by AECOM in 2016

Figure 4. Bridge Spans and Piers E6 to E18 Relative to Marine Mammal Feeding Areas and Haul-Out Site

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

3.2.2. Pacific Harbor Seal (California Stock)

Status: Pacific harbor seal is protected under the MMPA, but it is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the FESA. The California stock of harbor seals increased from 1972 through 2004, but showed a decline from 2009 through 2012 (Carretta et al 2015). The population size for the California stock during the last count in 2012 was estimated at 30,968 seals (CV=0.157; Carretta et al. 2015).

Use of the Bay and SFOBB Project Area: Pacific harbor seal is the most common marine mammal species observed in the Bay, and it also commonly is seen near the SFOBB east span (Department 2013a, 2013b). Tagging studies have shown that most seals tagged in the Bay remain in the Bay (Harvey and Goley 2011; Manugian 2013). In 251 days of SFOBB Project monitoring, 958 harbor seals were observed in the vicinity of the SFOBB east span. Pacific harbor seal has made up 90 percent of the marine mammals observed during monitoring for the SFOBB Project. In 2015 and 2016, the number of Pacific harbor seals sighted in the SFOBB Project area increased (in 8 days of monitoring, 95 sightings were made). Pacific harbor seal is present in the Bay year-round and uses it for foraging, resting, and reproduction.

Pacific harbor seal is the only species of marine mammal that breeds and bears young in the Bay. Its pupping season in the Bay begins in mid-March and continues until about mid-May. Pups nurse for only 4 weeks, and mating begins after the pups are weaned. In the Bay, mating occurs from April to July, and the molting season is from June until August (Schoenherr 1995; Kopec and Harvey 1995). Twelve haul-out sites and rookeries are in the Bay, but only three sites in the Bay regularly host more than 40 harbor seals at any one time; these are Mowry Slough in the South Bay, and YBI and Castro Rocks in the Central Bay (Spencer 1997).

Pacific harbor seals tend to forage at night and haul out during the day. Results of a study of 39 radio-tagged harbor seals in the Bay found that the most active diving occurred at night. Mean haul-out periods ranged from 80 minutes to 24 hours (Harvey and Torok 1994). Pacific harbor seals predominately haul out from 10:00 through 19:00, with a peak in the afternoon between 13:00 and 16:00 (Yochem et al. 1987; Stewart and Yochem 1994, Grigg et al. 2002; London et al. 2012). Pacific harbor seals in the Bay typically haul out in groups ranging from a few individuals to several hundred seals. One known haul-out site is on the south side of YBI, approximately 5,250 feet (1,600 meters) from Pier E6 and approximately 9,190 feet (2,800 meters) from Pier E18 (Figure 4.). Tides likely affect haul-out behavior by exposing and submerging preferred haul out sites, but time of day and the season have the greatest influence on haul-out behavior (Stewart and Yochem 1994; Patterson and Acevedo-Gutiérrez 2008). The YBI haul-out site had a daily range of zero to 109 harbor seals hauling out in September, October and November, with the highest numbers hauling out during afternoon low tides (Department 2004). The maximum reported number of seals that hauled out at this site at one time is 344, counted in January 1992 (Kopec and Harvey 1995). The abundance of Pacific harbor seals at this site during the winter months likely coincides with the presence of spawning Pacific herring near the island. Re-sightings at the haul-out site indicate long-term usage of the site (Spencer 1997).

Diving and Foraging: Pacific harbor seals generally are shallow divers, with about 90 percent of dives lasting less than 7 minutes (Gjertz et al. 1991; Eguchi and Harvey 2005), and with a maximum recorded dive time of 32 minutes (Eguchi and Harvey 2005).

Foraging often occurs in the Bay, as noted by observations of seals exhibiting foraging behavior (i.e., short dives less than 5 minutes, moving back and forth in an area, and sometimes tearing up prey at the surface). Foraging near the SFOBB Project area is common, particularly in the coves adjacent to the YBI U.S. Coast Guard Station and in Clipper Cove between YBI and Treasure Island (Figure 4). Foraging also occurs in a shallow trench area southeast of YBI (Department 2013a, 2013b). These sites are more than 3,000 to 5,000 feet (900 to 1,525 meters) west of Pier E6. In 2015, juvenile Pacific harbor seals began foraging around Piers E2W and E2E of the new SFOBB east span, and in 2016, this extended east around Piers E3 to E5 of the new SFOBB east span (Department 2017a). Foraging can occur throughout the Bay, and prey abundance and distribution affect where Pacific harbor seal will forage. Many of the Pacific harbor seal sightings are animals transiting the area, likely moving from haul-out sites or from foraging areas.

Acoustics: The Bay's Pacific harbor seals likely are accustomed to a noisy environment because of construction, vessel traffic, Bay Area Rapid Transit, and mechanical noise (i.e., machinery, generators). Male harbor seals produce sounds in the frequency range of 100 to 1,000 Hz (Richardson et al. 1995). Generally, Pacific harbor seal does not vocalize while traveling or feeding; therefore, attempts to acoustically detect the species before underwater implosions will not be useful. Pacific harbor seal hears at frequencies from 1 to 180 kHz (Møhl 1968); however, the species' hearing is most acute below 60 kHz, with peak hearing sensitivity at 32 kHz in water and 12 kHz in air (Terhune 1968; Terhune and Turnball 1995; Kastak and Schusterman 1998; Wolski et al. 2003).

3.2.3. Northern Elephant Seal (California Breeding Stock)

Status: The northern elephant seal is protected under the MMPA, but it is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the FESA. The population of the California breeding stock is estimated at 179,000 seals and is increasing (Lowry et al. 2010, 2014; Carretta et al. 2015).

Use of the Bay and SFOBB Project Area: Near the Bay, elephant seals breed, molt, and haul out at Año Nuevo Island, the Farallon Islands, and Point Reyes National Seashore. Generally, only juvenile elephant seals enter the Bay, and they do not remain long. The most recent sighting was in 2012, on the beach at Clipper Cove on Treasure Island, when a healthy yearling elephant seal hauled out for approximately 1 day. Approximately 100 juvenile northern elephant seals strand in the Bay each year, including individual strandings at YBI and Treasure Island (less than 10 seals per year).

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

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

3.2.4. Harbor Porpoises (San Francisco–Russian River Stock)

Status: The harbor porpoise is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2013), or listed as endangered or threatened under the FESA. Harbor porpoises that occur in the Bay are part of the San Francisco–Russian River stock. The harbor porpoise population has been increasing since 1993. The population of the San Francisco–Russian River stock is estimated at 9,886 porpoises (CV= 0.51) and is increasing (Carretta et al. 2014; Forney et al. 2013).

Use of the Bay and SFOBB Project Area: Harbor porpoises frequently are seen outside the Bay, and they began to re-enter the Bay in 2008. Keener et al. (2012) reports sightings of harbor porpoises from just inside the Bay northeast to Tiburon and south to the SFOBB west span. Harbor porpoises have been observed only on six occasions (all single animals or one mother with calf), swimming near the SFOBB east span. Those observations were made during spring to early fall and occurred near YBI (May to October; Department 2013c, 2014, 2015a). Rather than a pod of porpoises entering the SFOBB Project area, only single porpoises apparently move through the area, possibly searching for prey before returning to their pods. The rare occurrence of harbor porpoise near the SFOBB east span makes it unlikely that the species will be exposed to implosion activities.

Diving and Foraging: Harbor porpoise generally are shallow, short duration divers. A study that evaluated the dive duration and depth of 2,878 dives made by a free-swimming harbor porpoise found that 90 percent of its dives were within the upper 32 feet (10 meters) of the water column and 80 percent were less than 1 minute in duration (Otani et al 2000). In Canadian waters, the maximum dive depth was 676 feet (206 meters) and maximum duration was 5.5 minutes (Westgate et al. 1995).

Foraging often occurs in the western portion of the Bay, as noted by large aggregations of porpoise near the Golden Gate Bridge and observations of foraging behavior (i.e., repeated short dives in one spot, circling an area, and sometimes visual chasing of prey near the surface). Foraging activity and porpoise presence in the west portion of the Bay is tide-dependent, with increased sightings at the turn of an ebb tide near areas with reliable patterns of tidal fronts (Johnston et al. 2005; Duffy 2015). Underwater activity of tagged porpoises shows that the animals travel at about 1.5 meters per second and commonly stay within the upper 32 feet (10 meters) of the water column (Otani et al. 2000; Allen et al. 2011). Porpoises feed at a daily rate of 10 percent of their body weight, and movements likely rely on patches of prey aggregations (Dorfman 1990; Calambokidis et al. 1990; Read & Hohn 1995; Johnston et al. 2005; Allen et al. 2011; Santora et al. 2012, Sveegaard et al. 2012). A relatively small body size and thick blubber layer require porpoises to feed often, which restricts long distance travel and habitat range necessitated by a constant search for prey**.** Sightings near the SFOBB Project area are not common. Porpoises occurring in the area likely are travelling to or from foraging sites. Foraging can occur throughout the Bay, but likely is dependent on prey abundance and distribution.

Acoustics: Harbor porpoise vocalizations include clicks and pulses (Ketten 1998), as well as whistle-like signals and echolocation clicks (Verboom and Kastelein 1995), and it is considered to be a high-frequency cetacean (Southall et al. 2007). Auditory sensitivity studies have shown harbor porpoise hearing ranges from 250 Hz to 180 kHz (Andersen 1970; Ketten 1998). Behavioral audiograms based on this hearing range have indicated slightly varied results in maximum sensitivity: 16 to 140 kHz between 45 and 50 dB reference 1 micropascal (re 1 μPa) meter (Andersen 1970), 16 to 180 kHz (Kastelein et al. 2002). The TTS criteria were estimated at approximately 163 dB sound exposure level (SEL) from a 4 kHz airgun blast (Lucke et al. 2009).

3.2.5. Common Bottlenose Dolphin (California Coastal Stock)

Status: The common bottlenose dolphin is protected under the MMPA, but it is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2015), or listed as endangered or threatened under the FESA. The population of the California coastal stock was estimated at 323 dolphins (CV= 0.13) in 2004–2005, but because of the limited identification of individuals in the mark/recapture surveys, the stock probably is closer to 450–500 dolphins (Carretta et al. 2015). The California coastal stock of bottlenose dolphins remained stable between 1987 and 2005 (Dudzik et al. 2006).

Use of the Bay and SFOBB Project Area: As the range of bottlenose dolphins extended north, dolphins began entering the Bay in 2010 (Szczepaniak et al. 2013). Most sightings of bottlenose dolphins in the Bay have occurred in the western Bay, from the Golden Gate Bridge to Oyster Point and Redwood City. One individual was documented regularly, through photo ID, over several months off the coast of the former Alameda Air Station (Perlman 2017). The limited number of bottlenose dolphins visiting the east Bay makes it unlikely that the species will be exposed to implosion activities.

Diving and Foraging: Reeves et al. (2002) noted that the presence of deep-sea fish in the stomachs of some offshore individual bottlenose dolphins suggests that the species dives to depths of more than 1,638 feet (500 meters). Dive durations up to 15 minutes have been recorded for trained individuals (Ridgway et al. 1969). Typical dives, however, are more shallow and of a much shorter duration. Bottlenose dolphins use the entire water column by feeding on prey that concentrate near the surface, midwater areas, and benthic areas (Hastie et al. 2005).

Acoustics: The bottlenose dolphin has a functional high-frequency hearing limit of 160 kHz (Au 1993) and can hear sounds at frequencies as low as 40 to 125 Hz (Turl 1993). The inner ear anatomy of this species has been described (Ketten 1992). The audiogram of the bottlenose dolphin shows that the lowest thresholds occurred near 50 kHz, at a level around 45 dB re 1 µPa (Nachtigall et al. 2000; Finneran and Houser 2006; Houser and Finneran 2007). Scientists have reported a range of best sensitivity between 25 and 70 kHz, with peaks in sensitivity occurring at 25 and 50 kHz, at levels of 47 and 46 dB re 1 µPa (Nachtigall et al. 2000).

3.2.6. Northern Fur Seal (California Stock)

Status: Two stocks may occur near the Bay—the California and Eastern Pacific stocks. The California stock breeds and pups at San Miguel Island (Northern Channel Islands) and the Farallon Islands off the coast of San Francisco, with an estimated population of 14,050 fur seals (Carretta et al. 2016). The California northern fur seal stock is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA (Carretta et al. 2012), or listed as endangered or threatened under the FESA.

The Eastern Pacific stock breeds and pups on the Pribilof Islands and Bogoslof Island in the Bearing Sea, with an estimated population of 648,534 (Carretta et al. 2016). The Eastern Pacific northern fur seal stock is protected under the MMPA and is listed as a strategic and depleted species (Carretta et al. 2012), but is not listed as endangered or threatened under the FESA.

Use of the Bay and SFOBB Project Area: Both the California and Eastern Pacific stocks forage in the offshore waters of California, and only sick, emaciated, or injured fur seals enter the Bay. The Marine Mammal Center (MMC) occasionally picks up stranded fur seals around

YBI and Treasure Island. The rare occurrence of northern fur seal near the SFOBB east span makes it unlikely that the species will be exposed to implosion activities.

3.3. Sound Threshold Criteria for Take of Marine Mammals for Underwater Blasting

Demolition activities for removal of marine foundations using controlled charges have the potential to result in the incidental take of marine mammals. Underwater blasting can cause behavioral disturbance (Level B harassment), slight or serious injury (Level A harassment), and mortality to marine mammals. NMFS has established sound threshold criteria for take of marine mammals from underwater blasting (Table 2). TTS in an animal's hearing for underwater blasting is a specific type of behavioral disturbance (Level B harassment). A Permanent Threshold Shift (PTS) in an animal's hearing is a specific type of slight injury (Level A harassment). Level A harassment criteria also have been established for injury to an animal's gastrointestinal (GI) tract and lungs from blasting. The specific acoustic thresholds depend on the functional group and species of marine mammal.

3.3.1. Distances to Threshold Criteria

The Department has decided to use hydroacoustic monitoring results from the implosions of Piers E3, E4, and E5 to calculate distances to marine mammal thresholds for the implosions of Piers E6 through E18 (Department 2015a, 2017). Distances to marine mammal threshold criteria were calculated for the five anticipated pier implosion scenarios as follows:

1. Implosion of Pier E6 (Table 3),
2. Implosion of two 504-foot span piers in one pier implosion event (Table 4),
3. Implosion of two 288-foot span piers in one pier implosion event (Table 5),
4. Implosion of three 288-foot span piers in one pier implosion event (Table 6), and
5. Implosion of four 288-foot span piers in one pier implosion event (Table 7).

Calculated distances to GI track injury, lung injury and mortality threshold criteria for all species for all pier implosion scenarios are within 48 feet (15 meters) of the pier to be imploded. Calculated distances to underwater blasting threshold criteria for behavioral response, TTS, and PTS for each pier implosion scenario are shown in Tables 3 through 7.

Table 2. Underwater Sound Pressure Threshold Criteria for Underwater Blasting

Species Hearing Group	Species	Level B Behavior		Level A Slight Injury			Mortality
		Behavioral	**Temporary Threshold Shift**	**Permanent Threshold Shift**	**Gastro-Intestinal Tract**	**Lung**	
Mid-frequency (MF) Cetaceans	Bottlenose Dolphin	165 dB SEL_{cum} (MF)	170 dB SEL_{cum} (MF) 224 dB peak SPL	185 dB SEL_{cum} (MF) 230 dB peak SPL	237 dB peak SPL	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
High-frequency (HF) Cetaceans	Harbor Porpoises	135 dB SEL_{cum} (HF)	140 dB SEL_{cum} (HF) 196 dB peak SPL	155 dB SEL_{cum} (HF) 202 dB peak SPL			
Phocid Pinniped (PW)	Harbor Seal and Elephant Seal	165 dB SEL_{cum} (PW)	170 dB SEL_{cum} (PW) 212 dB peak SPL	185 dB SEL_{cum} (PW) 218 dB peak SPL			
Otariid Pinniped (OW)	Sea Lion and Fur Seal	183 dB SEL_{cum} (OW)	188 dB SEL_{cum} (OW) 226 dB peak SPL	203 dB SEL_{cum} (OW) 232 dB peak SPL			

Notes:
Cumulative Sound Exposure Level (SEL_{cum})
Pascal-second (Pa-sec)
MF, HF, PW, and OW associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function.
Sources: Finneran and Jenkins 2012; NMFS 2016

Table 3. Calculated Distances to Underwater Blasting Threshold Criteria for Level B Behavioral and Temporary Threshold Shift and Level A Permanent Threshold Shift for Implosion of Pier E6

Species Hearing Group		Behavioral Response	Temporary Threshold Shift [1]		Permanent Threshold Shift [1]	
Mid-Frequency Cetaceans	Threshold	165 dB SELcum	224 dB Peak	170 dB SELcum	230 dB Peak	185 dB SELcum
	Isopleth Distance	1,330 feet	180 feet	**881 feet**	98 feet	**256 feet**
High-Frequency Cetaceans	Threshold	135 dB SELcum	196 dB Peak	140 dB SELcum	202 dB Peak	155 dB SELcum
	Isopleth Distance	12,567 feet	3127 feet	**8,358 feet**	1697 feet	**2,459 feet**
Phocid Pinnipeds	Threshold	165 dB SELcum	212 dB Peak	170 dB SELcum	218 dB Peak	185 dB SELcum
	Isopleth Distance	2,220 feet	613 feet	**1,484 feet**	332 feet	**443 feet**
Otariid Pinnipeds	Threshold	183 dB SELcum	226 dB Peak	188 dB SELcum	232 dB Peak	203 dB SELcum
	Isopleth Distance	554 feet	147 feet	**367 feet**	80 feet	**106 feet**

Note:
1. For the Temporary Threshold Shift and Permanent Threshold Shift criteria thresholds with dual criteria, the largest criteria distances (i.e., more conservative) are shown in bold.

Threshold Source: NMFS 2016
Isopleth Distance Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017

Table 4. Calculated Distances to Underwater Blasting Threshold Criteria for Level B Behavioral and Temporary Threshold Shift and Level A Permanent Threshold Shift for Implosion of Two 504-foot Span Piers

Species Hearing Group		Behavioral	Temporary Threshold Shift [1]		Permanent Threshold Shift [1]	
Mid-Frequency Cetaceans	Threshold	165 dB SELcum	224 dB Peak	170 dB SELcum	230 dB Peak	185 dB SELcum
	Isopleth Distance	1,055 feet	166 feet	**685 feet**	90 feet	**190 feet**
High-Frequency Cetaceans	Threshold	135 dB SELcum	196 dB Peak	140 dB SELcum	202 dB Peak	155 dB SELcum
	Isopleth Distance	10,300 feet	2,882 feet	**6,800 feet**	1,564 feet	**1,966 feet**
Phocid Pinnipeds	Threshold	165 dB SELcum	212 dB Peak	170 dB SELcum	218 dB Peak	185 dB SELcum
	Isopleth Distance	1,790 feet	565 feet	**1,186 feet**	306 feet	**333 feet**
Otariid Pinnipeds	Threshold	183 dB SELcum	226 dB Peak	188 dB SELcum	232 dB Peak	203 dB SELcum
	Isopleth Distance	421 feet	136 feet	**274 feet**	74 feet	**78 feet**

Note:
1. For the Temporary Threshold Shift and Permanent Threshold Shift criteria thresholds with dual criteria, the largest criteria distances (i.e., more conservative) are shown in bold.

Threshold Source: NMFS 2016
Isopleth Distance Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017

Table 5. Calculated Distances to Underwater Blasting Threshold Criteria for Level B Behavioral and Temporary Threshold Shift and Level A Permanent Threshold Shift for Implosion of Two 288-foot Span Piers

Species Hearing Group		Behavioral	Temporary Threshold Shift [1]		Permanent Threshold Shift [1]	
Mid-Frequency Cetaceans	Threshold	165 dB SELcum	224 dB Peak	170 dB SELcum	230 dB Peak	185 dB SELcum
	Isopleth Distance	798 feet	166 feet	**517 feet**	90 feet	**126 feet**
High-Frequency Cetaceans	Threshold	135 dB SELcum	196 dB Peak	140 dB SELcum	202 dB Peak	155 dB SELcum
	Isopleth Distance	7,700 feet	2,882 feet	**5,140 feet**	**1,564 feet**	1,493 feet
Phocid Pinnipeds	Threshold	165 dB SELcum	212 dB Peak	170 dB SELcum	218 dB Peak	185 dB SELcum
	Isopleth Distance	1,359 feet	565 feet	**900 feet**	**306 feet**	232 feet
Otariid Pinnipeds	Threshold	183 dB SELcum	226 dB Peak	188 dB SELcum	232 dB Peak	203 dB SELcum
	Isopleth Distance	304 feet	136 feet	**185 feet**	**74 feet**	52 feet

Note:
1. For the Temporary Threshold Shift and Permanent Threshold Shift criteria thresholds with dual criteria, the largest criteria distances (i.e., more conservative) are shown in bold.

Threshold Source: NMFS 2016

Isopleth Distance Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017

Table 6. Calculated Distances to Underwater Blasting Threshold Criteria for Level B Behavioral and Temporary Threshold Shift and Level A Permanent Threshold Shift for Implosion of Three 288-foot Span Piers

Species Hearing Group		Behavioral Response	Temporary Threshold Shift [1]		Permanent Threshold Shift [1]	
Mid-Frequency Cetaceans	Threshold	165 dB SELcum	224 dB Peak	170 dB SELcum	230 dB Peak	185 dB SELcum
	Isopleth Distance	920 feet	166 feet	**588 feet**	90 feet	**132 feet**
High-Frequency Cetaceans	Threshold	135 dB SELcum	196 dB Peak	140 dB SELcum	202 dB Peak	155 dB SELcum
	Isopleth Distance	9,403 feet	2,882 feet	**5,900 feet**	1,564 feet	**1,722 feet**
Phocid Pinnipeds	Threshold	165 dB SELcum	212 dB Peak	170 dB SELcum	218 dB Peak	185 dB SELcum
	Isopleth Distance	1,580 feet	565 feet	**1,045 feet**	**306 feet**	258 feet
Otariid Pinnipeds	Threshold	183 dB SELcum	226 dB Peak	188 dB SELcum	232 dB Peak	203 dB SELcum
	Isopleth Distance	339 feet	136 feet	**201 feet**	**74 feet**	52 feet

Note:
1. For the Temporary Threshold Shift and Permanent Threshold Shift criteria thresholds with dual criteria, the largest criteria distances (i.e., more conservative) are shown in bold.

Threshold Source: NMFS 2016

Isopleth Distance Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017

Table 7. Calculated Distances to Underwater Blasting Threshold Criteria for Level B Behavioral and Temporary Threshold Shift and Level A Permanent Threshold Shift for Implosion of Four 288-foot Span Piers

Species Hearing Group		Behavioral	Temporary Threshold Shift [1]		Permanent Threshold Shift [1]	
Mid-Frequency Cetaceans	Threshold	165 dB SELcum	224 dB Peak	170 dB SELcum	230 dB Peak	185 dB SELcum
	Isopleth Distance	920 feet	166 feet	**558 feet**	90 feet	**132 feet**
High-Frequency Cetaceans	Threshold	135 dB SELcum	196 dB Peak	140 dB SELcum	202 dB Peak	155 dB SELcum
	Isopleth Distance	9,935 feet	2,882 feet	**6,590 feet**	1,564 feet	**1,917 feet**
Phocid Pinnipeds	Threshold	165 dB SELcum	212 dB Peak	170 dB SELcum	218 dB Peak	185 dB SELcum
	Isopleth Distance	1,730 feet	565 feet	**1,135 feet**	**306 feet**	264 feet
Otariid Pinnipeds	Threshold	183 dB SELcum	226 dB Peak	188 dB SELcum	232 dB Peak	203 dB SELcum
	Isopleth Distance	349 feet	136 feet	**204 feet**	**74 feet**	52 feet

Note:
1. For the Temporary Threshold Shift and Permanent Threshold Shift criteria thresholds with dual criteria, the largest criteria distances (i.e., more conservative) are shown in bold.
Threshold Source: NMFS 2016
Isopleth Distance Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017

3.4. Incidental Harassment Authorization

The numbers of marine mammals by species that may be taken by each type of take were calculated based on distance to the marine mammal threshold criteria, duration of the activity, and the estimated density of each species in the ZOI. Based on this take analysis presented in the Department's 2017 IHA Application, approximately 38 harbor seals (22 by behavioral response and 16 by TTS) may be taken by Level B harassment during the implosions of Piers E6 to E18 and no take of any other species is anticipated. However, the number of marine mammals in the area at any given time is highly variable. Animal movement depends on time of day, tide levels, weather, and availability and distribution of prey species. Because of this variability the Department and NMFS agreed additional take coverage should be authorized.

The 2017 IHA allows for the incidental take of marine mammals by Level B Harassment—Behavioral Response and TTS during use of controlled charges to implode Piers E6 through E18 (Table 8). Based on calculated sound pressure levels (SPLs) and planned implementation of avoidance and minimization measures, no injury (Level A harassment) or mortality to marine mammals is anticipated from implosion of Piers E6 through E18.

Table 8. Amount of Level B Harassment Take of Marine Mammals Requested for the Implosions of Piers E6 through E18

Species	Level B Harassment Take	
	Behavioral Response	Temporary Threshold Shift
Pacific Harbor Seal	66~~9~~	48
California Sea Lion	18	12
Northern Elephant Seal	6	3
Northern Fur Seal	6	3
Harbor Porpoise	18	9
Bottlenose Dolphin	6	3
Total	**120~~3~~**	**78**

Note:
1. Pier implosions will be delayed if any marine mammals are detected within any of the Level A or mortality threshold criteria exclusion zones.
Source: Compiled by AECOM in 2016

3.5. Pre-Implosion Briefing

Before the implosion season begins (September 1), a briefing will be held between the construction supervisors, construction crew, marine mammal monitoring team, and Department staff. The purpose of the briefing will be to establish the responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of the monitoring purposes, and review operational procedures. In addition, a pre-implosion briefing will be held with the Marine Mammal Center, the local marine mammal rehabilitation center, to discuss logistics of the stranding survey and triage, as discussed further in this chapter. The Blaster-in-Charge and Resident Engineer, in coordination with the SFOBB Environmental Manager or his designee, will have the authority to stop or delay any demolition activity, if deemed necessary.

3.6. Marine Mammal Monitoring

The marine mammal monitoring for the implosions of Piers E6 through E18 will be similar to the monitoring that was implemented for the implosions of Piers E3 to E5.

3.6.1. Establishment of Marine Mammal Exclusion and Monitoring Zones

Before each pier implosion event for removal of Piers E6 through E18, marine mammal exclusion zones (MMEZ) and monitoring zones will be established based on the requirements of the 2017 IHA.

Level A injury exclusion zones and Level B TTS and behavioral response monitoring zones will extend to a predetermined distance from the pier implosion event, based on conservatively estimated distances to acoustic threshold criteria for anticipated pier implosion scenarios as follows:

1. Pier E6 blast event;
2. Blast event of two 504-foot span piers, or blast event of one 504-foot span pier and one 288-foot span pier, or Pier E9 blast event;
3. Blast event of two 288-foot span piers;
4. Blast event of three 288-foot span piers; and
5. Blast event of four 288-foot span piers.

Level A Harassment Injury and Mortality Exclusion Zones: The MMEZs will include the area for both the mortality and Level A harassment thresholds (i.e., PTS, GI track injury, and slight lung injury), using the criteria threshold that extends the furthest. 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 (Tables 3, 4, 5, 6, and 7). Based on the calculated distances and in coordination with NMFS, specific exclusion zones were established for each species group (or combination) for each type of blast event scenario.

The isopleths for PTS to phocid pinnipeds (i.e., harbor seals and elephant seals) cover the entire area for both Level A harassment and mortality for all pinnipeds, including otariid pinnipeds (i.e., sea lions and fur seals), as well as bottlenose dolphin that have smaller zones for Level A harassment. Therefore, the pinniped and dolphin exclusion zone will be established based on the radial distance to the phocid pinniped PTS Level A harassment threshold (Table 9). The harbor porpoise exclusion zone will be established based on the radial distance to the high-frequency cetacean PTS Level A harassment threshold (Table 9). The Level A exclusion zones for pinnipeds and dolphins for each implosion scenario are shown in Figures 5 through 9. The Level A exclusion zones for harbor porpoise for each implosion scenario are shown in Figures 10 through 14.

The MMEZs will be monitored by marine mammal observers (MMOs), and if any marine mammals are observed inside the MMEZs, the implosion will be delayed until the animal leaves the area or at least 15 minutes have passed since the last observation of the animal.

Table 9. Marine Mammal Level A Exclusion Zones for Pier E6 through E18 Implosions

Pier Implosion Scenarios	Species/Group	Level A Injury and Mortality Exclusion Zone
Pier E6	Pinniped and Dolphin	**532 feet** (162 meters)
	Harbor Porpoise	**2,951 feet** (899 meters)
Two 504-foot Span Piers, or One 504-foot Span Pier and One 288-foot Span Pier, or Pier E9	Pinniped and Dolphin	**400 feet** (122 meters)
	Harbor Porpoise	**2,359 feet** (719 meters)
Two 288-foot Span Piers	Pinniped and Dolphin	**367 feet** (112 meters)
	Harbor Porpoise	**1,877 feet** (572 meters)
Three 288-foot Span Piers	Pinniped and Dolphin	**367 feet** (112 meters)
	Harbor Porpoise	**2,066 feet** (630 meters)
Four 288-foot Span Piers	Pinniped and Dolphin	**367 feet** (112 meters)
	Harbor Porpoise	**2,300 feet** (701 meters)

Note:
PTS = Permanent Threshold Shift
Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017

Level B Harassment Behavioral Response and TTS Monitoring Zones: Marine mammal monitoring zones will be established for both Level B behavioral response and Level B TTS. 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 (Tables 3 through 7). Based on the calculated distances and in coordination with NMFS, behavioral and TTS monitoring zones were established for each species group (or combination) for each type of blast event scenario.

The isopleths for Level B harassment to phocid pinnipeds (i.e., harbor seals and elephant seals) for all pier implosion scenarios cover the entire area for Level B harassment to all pinnipeds, including otariid pinnipeds (i.e., sea lions and fur seals), as well as bottlenose dolphin that have smaller zones for Level B harassment. Therefore, the pinniped and dolphin Level B harassment monitoring zones for each pier implosion scenario will be established based on the radial distance to the phocid pinniped thresholds for behavioral response and TTS (Tables 10 and 11). The harbor porpoise Level B harassment monitoring zones will be established based on the radial distance to the high-frequency cetacean thresholds for behavioral response and TTS (Tables 10 and 11). The Level B behavioral response and TTS monitoring zones for pinnipeds and dolphins for each implosion scenario are shown in Figures 5 through 9. The Level B behavioral response and TTS monitoring zones for harbor porpoise for each implosion scenario are shown in Figures 10 through 14.

Table 10. Marine Mammal Level B Behavioral Response Monitoring Zones for Pier E6 through E18 Implosions

Pier Implosion Scenarios	Species/Group	Level B Behavioral Response Monitoring Zones
Pier E6	Pinniped and Dolphin	**2,664 feet** (812 meters)
	Harbor Porpoise	**15,080 feet** (4,596 meters)
Two 504-foot Span Piers, or One 504-foot Span Pier and One 288-foot Span Pier, or Pier E9	Pinniped and Dolphin	**2,148 feet** (655 meters)
	Harbor Porpoise	**12,360 feet** (3,767 meters)
Two 288-foot Span Piers	Pinniped and Dolphin	**1,631 feet** (497 meters)
	Harbor Porpoise	**9,240 feet** (2,816 meters)
Three 288-foot Span Piers	Pinniped and Dolphin	**1,896 feet** (578 meters)
	Harbor Porpoise	**11,284 feet** (3,439 meters)
Four 288-foot Span Piers	Pinniped and Dolphin	**2,076 feet** (633 meters)
	Harbor Porpoise	**11,922 feet** (3,634 meters)
Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a and 2017		

Table 11. Marine Mammal Level B Temporary Threshold Shift Monitoring Zones for Pier E6 through E18 Implosions

Pier Implosion Scenarios	Species/Group	Level B Temporary Threshold Shift Monitoring Zones
Pier E6	Pinniped and Dolphin	**1,781 feet** (543 meters)
	Harbor Porpoise	**10,030 feet** (3,057 meters)
Two 504-foot Span Piers, or One 504-foot Span Pier and One 288-foot Span Piers~~, or Pier E9~~	Pinniped and Dolphin	**1,423 feet** (434 meters)
	Harbor Porpoise	**8,160 feet** (2,487 meters)
Two 288-foot Span Piers	Pinniped and Dolphin	**1,080 feet** (329 meters)
	Harbor Porpoise	**6,168 feet** (1,880 meters)
Three 288-foot Span Piers	Pinniped and Dolphin	**1,254 feet** (382 meters)
	Harbor Porpoise	**7,080 feet** (2,158 meters)
Four 288-foot Span Piers	Pinniped and Dolphin	**1,362 feet** (415 meters)
	Harbor Porpoise	**7,908 feet** (2,410 meters)
Sources: Calculated by Illingsworth & Rodkin, based on results presented in Department 2015a, 2016b, and 2017		

Marine Mammal Observers: A minimum of 10 MMOs will be required during the implosions of Piers E6 through E18, so that the MMEZs and Level B harassment zones can be monitored. Up to 15 MMOs may be required for implosions events involving multiple piers. One MMO will be designated as the Lead MMO and will receive updates from the other MMOs about the presence or absence of marine mammals within the MMEZ. This Lead MMO will notify the Department's SFOBB Environmental Manager of a cleared MMEZ before the start of the implosion. MMOs will be positioned near the edge of each of the pinniped and dolphin exclusion and monitoring zones, and within the extensive harbor porpoise monitoring zone, using boats, barges, bridge piers, and roadway, as well as sites on YBI and Treasure Island. Exact locations to be determined in the field based on implosion event type and physical conditions.

Monitoring Protocol: Implosions of Piers E6 through E18 will be conducted only during daylight hours and with enough time for pre- and post-implosion monitoring, and with good weather conditions (i.e., clear skies and no high winds). This work will be completed so that the MMOs will be able to detect marine mammals within the MMEZs and beyond. The Lead MMO will be in contact with the other MMOs. If any marine mammals enter an MMEZ within 30 minutes of blasting, the Lead MMO will notify the Department's SFOBB Environmental Manager or his designee that the implosion may need to be delayed. The Lead MMO will keep the SFOBB Environmental Manager or his designee informed about the disposition of the animal. If the animal remains in the MMEZ, blasting will be delayed until it has left the MMEZ. If the animal dives and is not seen again, blasting will be delayed at least 15 minutes. After the implosion has occurred, the MMOs will continue to monitor the area for at least 60 minutes.

Although any injury or mortality from the implosions of Piers E6 through E18 is very unlikely, boat or shore surveys will be conducted for 3 days following the event, to determine whether any injured or stranded marine mammals are in the area. If an injured or dead animal is discovered during these surveys or by other means, the NMFS-designated stranding team will be contacted to pick up the animal. Veterinarians will treat the animal or will conduct a necropsy to attempt to determine whether it stranded because of the pier implosions (see Section 3.7, "Stranding Plan").

Data Collection: Each MMO will record 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 will be recorded, if possible:

1. Species
2. Number of animals (include with or without pup/calf)
3. Age class (i.e., pup/calf, juvenile, adult)
4. Identifying marks or color (e.g., scars, red pelage, damaged dorsal fin)
5. Position relative to pier implosion (distance and direction)
6. Movement (direction and relative speed)
7. 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 also will be noted.]
8. Duration of sighting or times of multiple sightings of the same individual

Communication: All MMOs will be equipped with a radio and a mobile phone as a backup. One channel will be dedicated to the MMOs. One person will be designated as the Lead MMO and will be in constant contact with the SFOBB Environmental Manager or his designee. The Lead MMO will coordinate marine mammal sightings with the other MMOs. The Lead MMO will contact the other MMOs when a sighting is made within the MMEZ or near the MMEZ, so that the MMOs in overlapping areas of responsibility can continue to track the animal and the Lead MMO can be kept aware of the animal's status.

3.7. Stranding Plan

The following stranding plan for the implosions of Piers E6 through E18 has been prepared in cooperation with the local NMFS-designated marine mammal stranding, rescue, and rehabilitation center. Although avoidance and minimization measures likely will prevent any injuries, preparations have been made in the unlikely event that marine mammals are injured. The plan includes the following:

1. The stranding crew will prepare treatment areas at an NMFS-designated facility for cetaceans or pinnipeds that may be injured from the implosions. Preparation will include equipment to treat lung injuries, auditory testing equipment, dry and wet caged areas to hold animals, and operating rooms if surgical procedures are necessary.

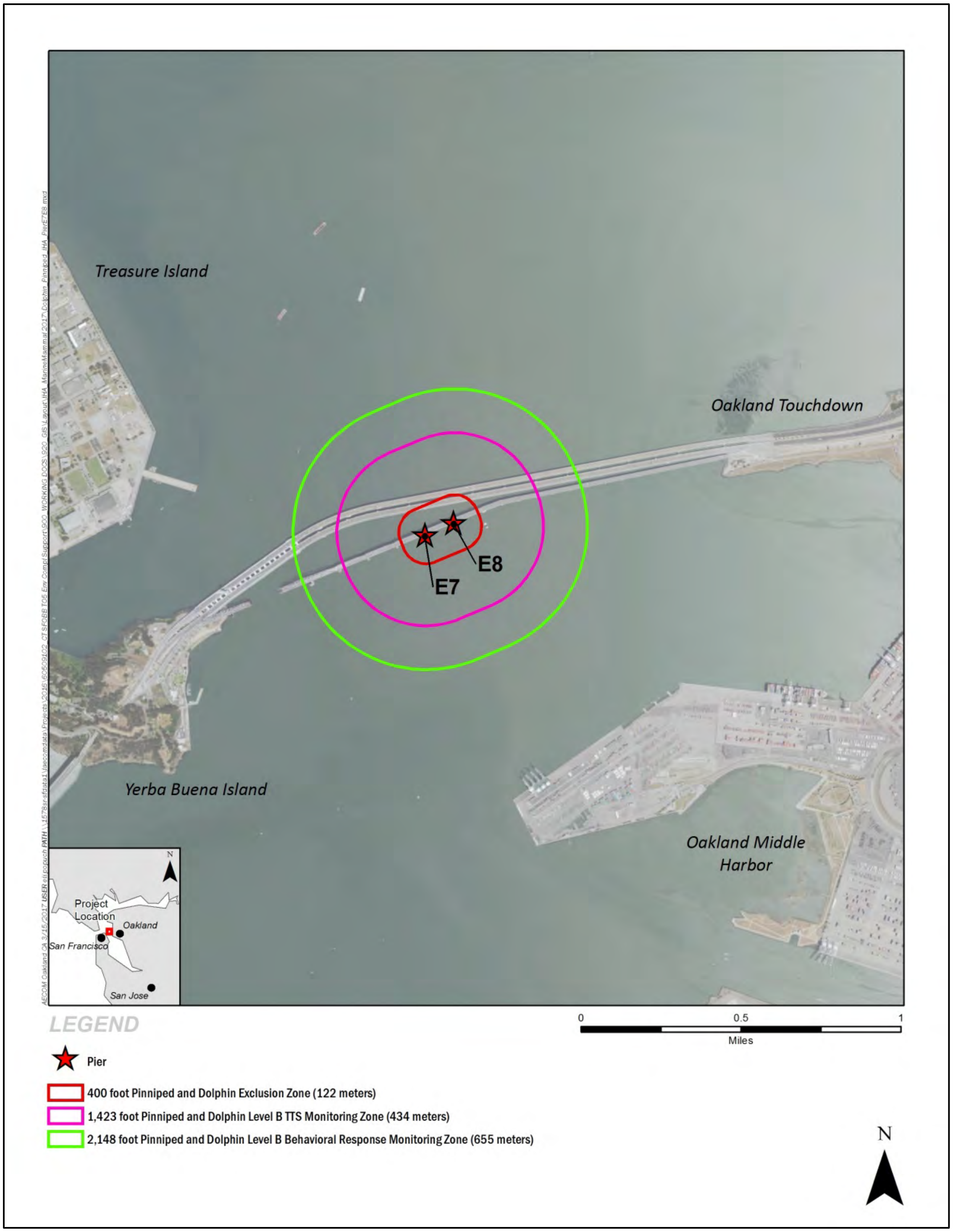
2. A stranding crew and a veterinarian will be on call near the Piers E6 through E18 area at the time of the implosions, to quickly recover any injured marine mammals, provide emergency veterinary care, stabilize the animal's condition, and transport individuals to an NMFS-designated facility. If an injured or dead animal is found, NMFS (both the regional office and headquarters) will be notified immediately, even if the animal appears to be sick or injured from causes other than the implosions.

3. Post-implosion surveys will be conducted immediately after the event and over the following 3 days to determine whether any injured or dead marine mammals are in the area.

4. Any veterinarian procedures, euthanasia, rehabilitation decisions, and time of release or disposition of the animal will be at the discretion of the NMFS-designated facility staff and the veterinarians treating the animals. Any necropsies to determine whether the injuries or death of an animal was the result of an implosion or other anthropogenic or natural causes will be conducted at an NMFS-designated facility by the stranding crew and veterinarians. The results will be communicated to both the Department and NMFS as soon as possible, followed by a written report within a month.

Source: ESRI 2015 (imagery); compiled by AECOM in 2017

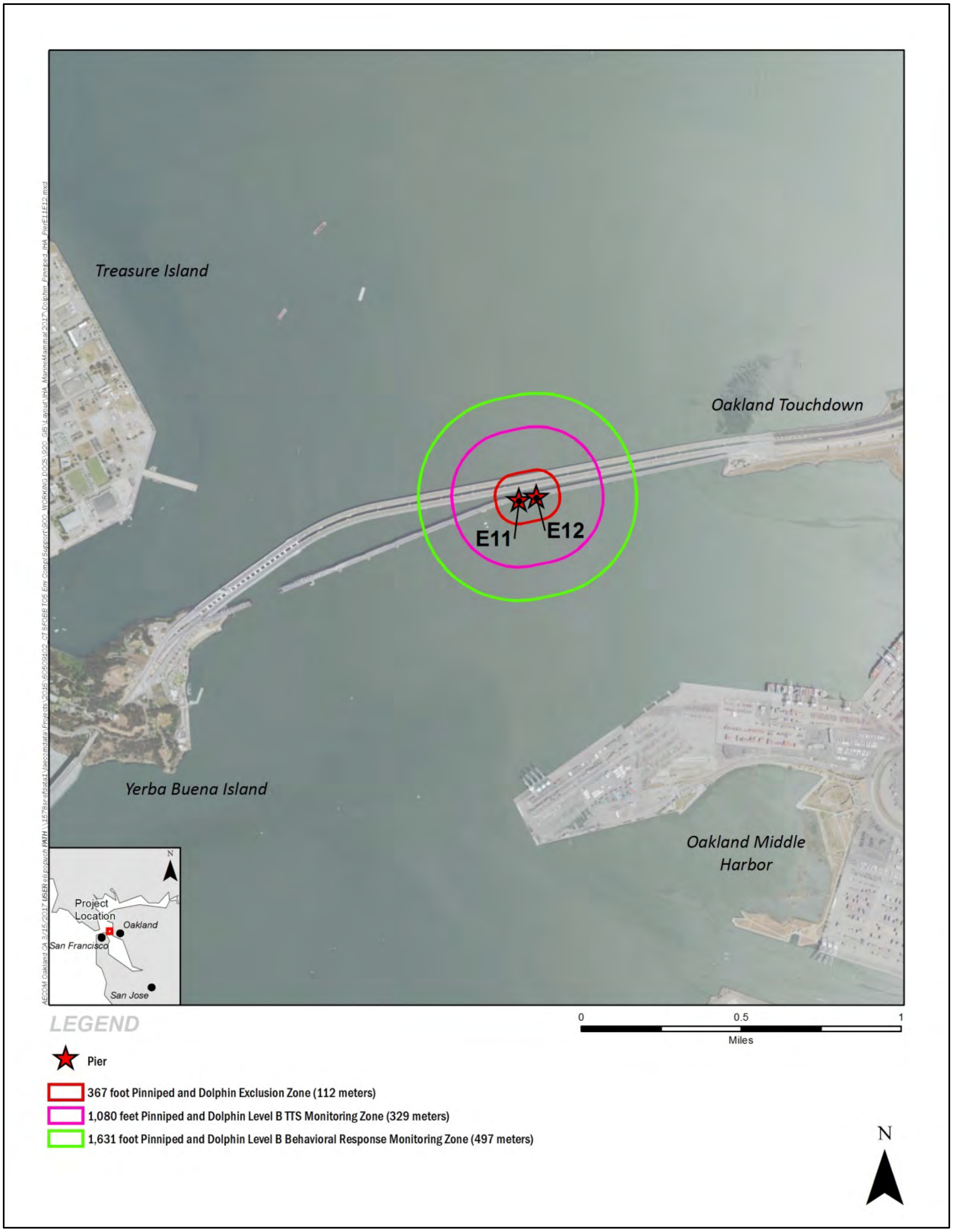
Figure 5. Pinniped and Dolphin Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Pier E6



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown. These isopleth also will be applied for implosion events made up of one 504-foot span pier and one 288-foot span pier, or the implosion of Pier E9 individually.

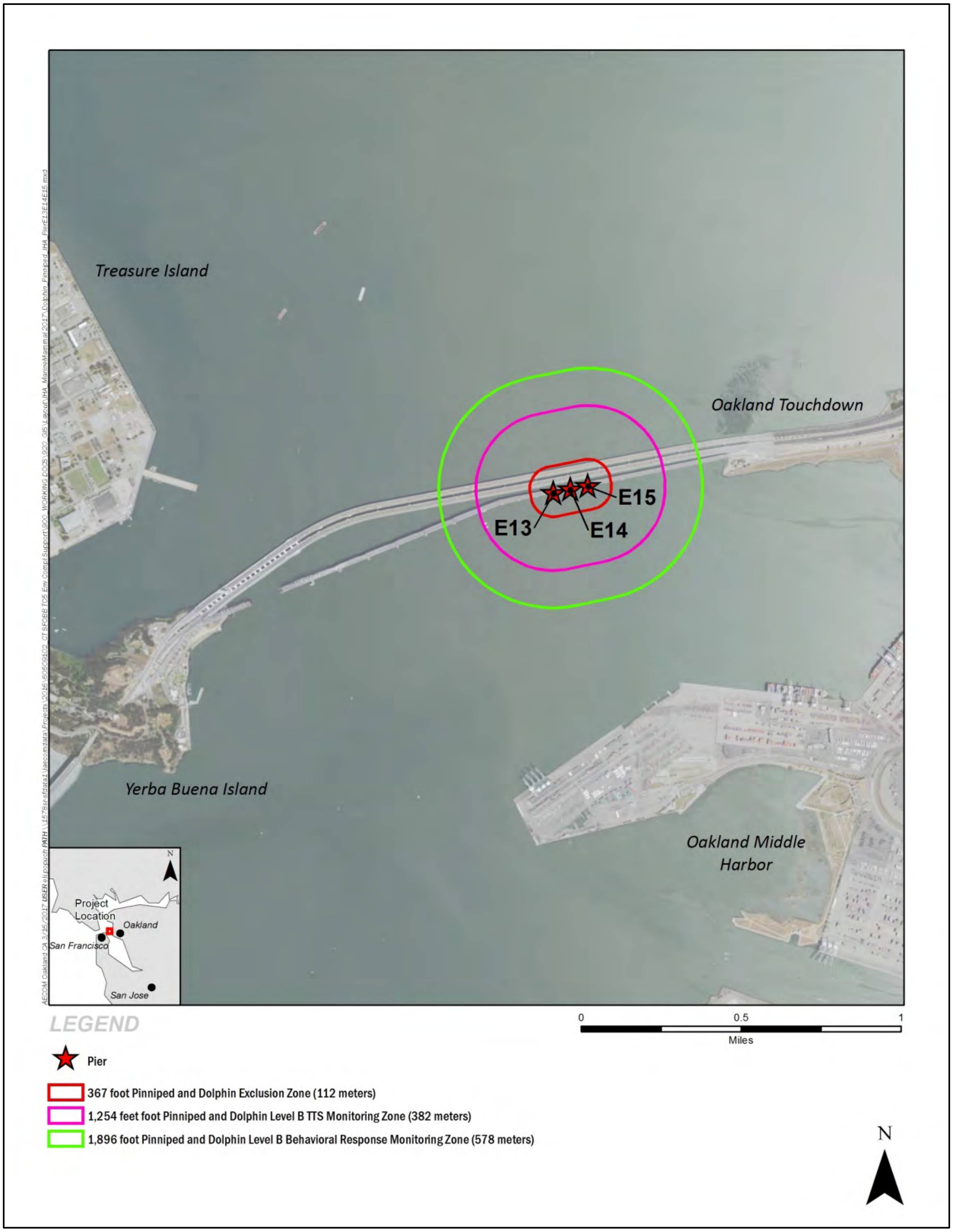
Figure 6. Pinniped and Dolphin Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Two 504-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown.

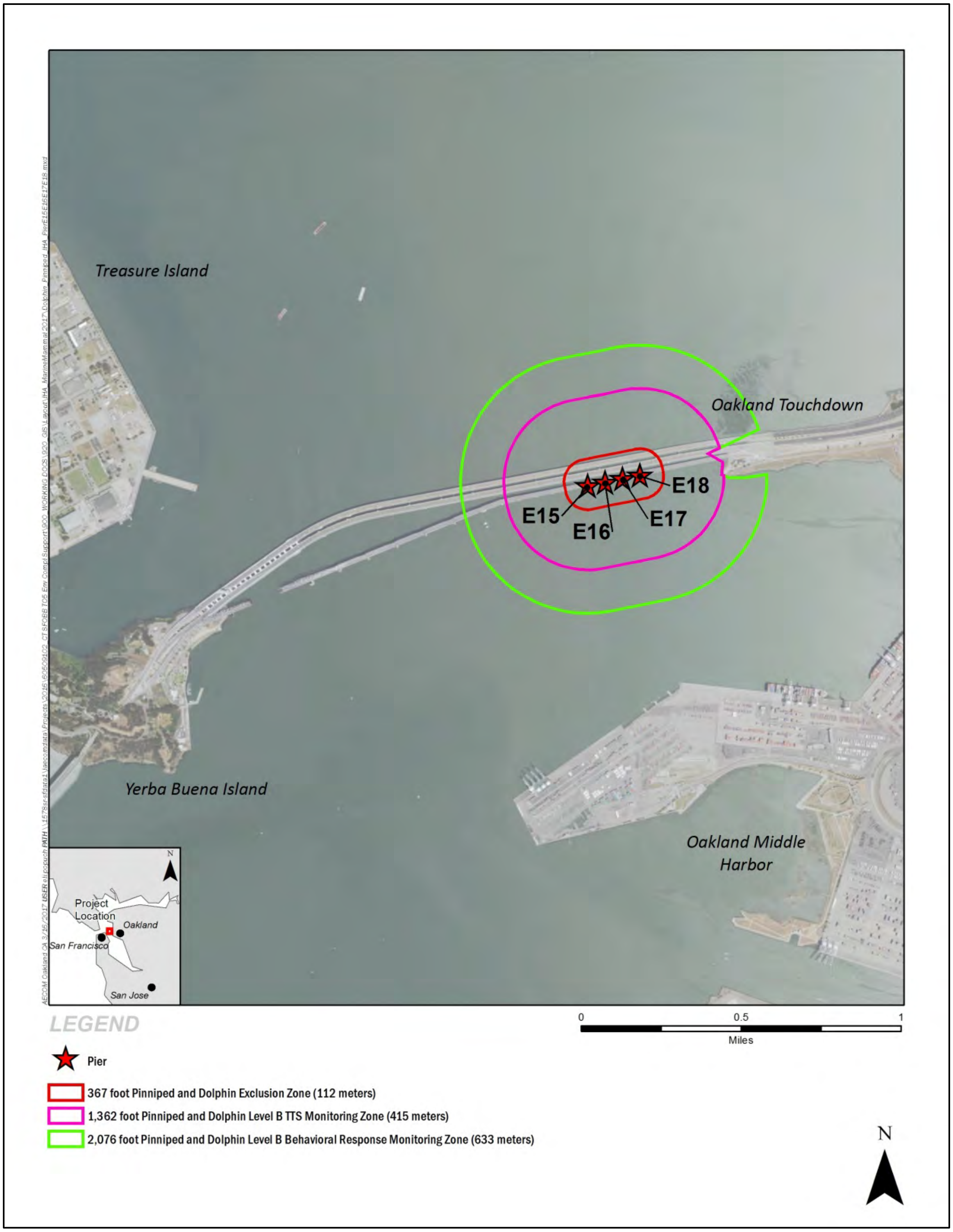
Figure 7. Pinniped and Dolphin Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Two 288-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown.

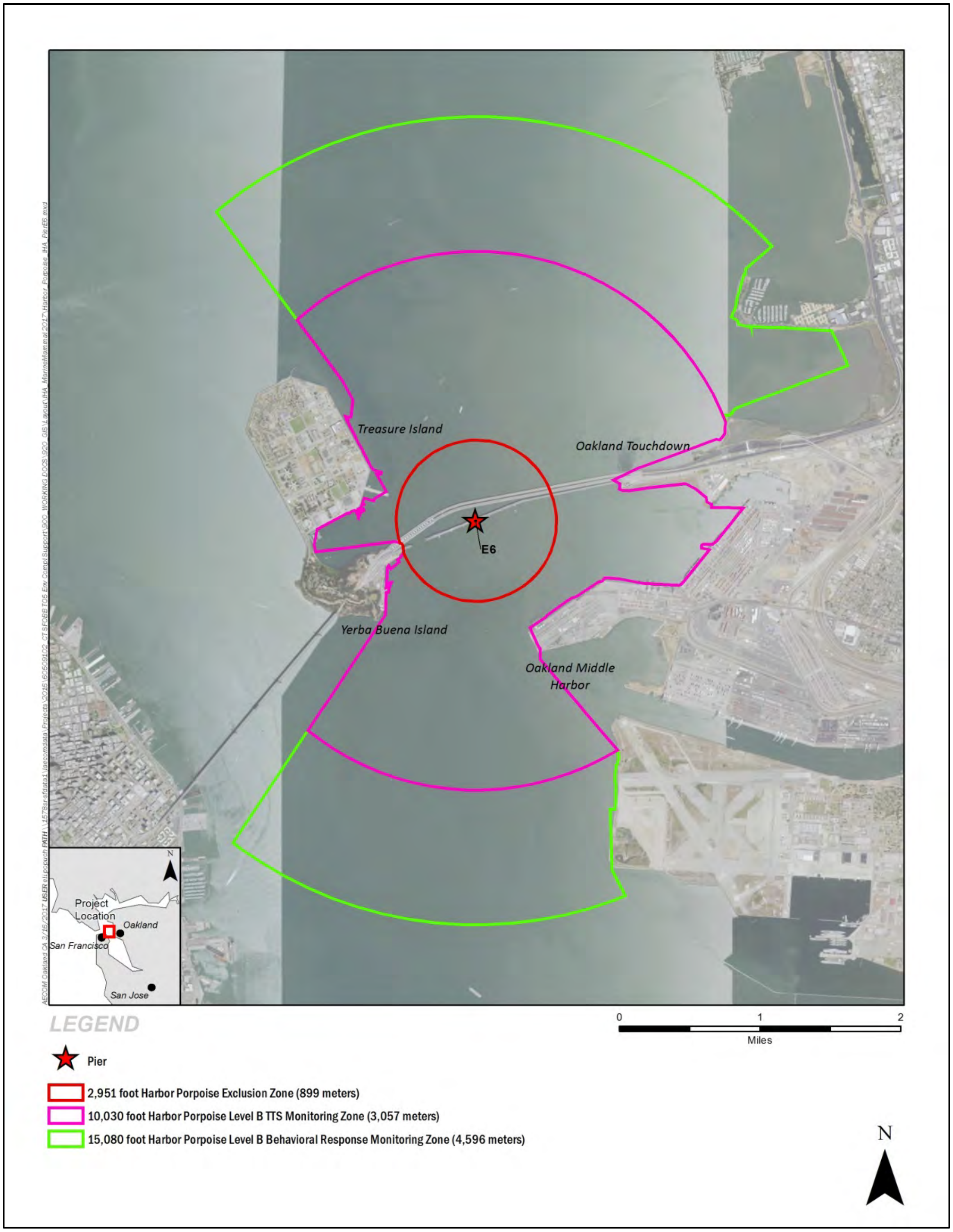
Figure 8. Pinniped and Dolphin Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Three 288-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

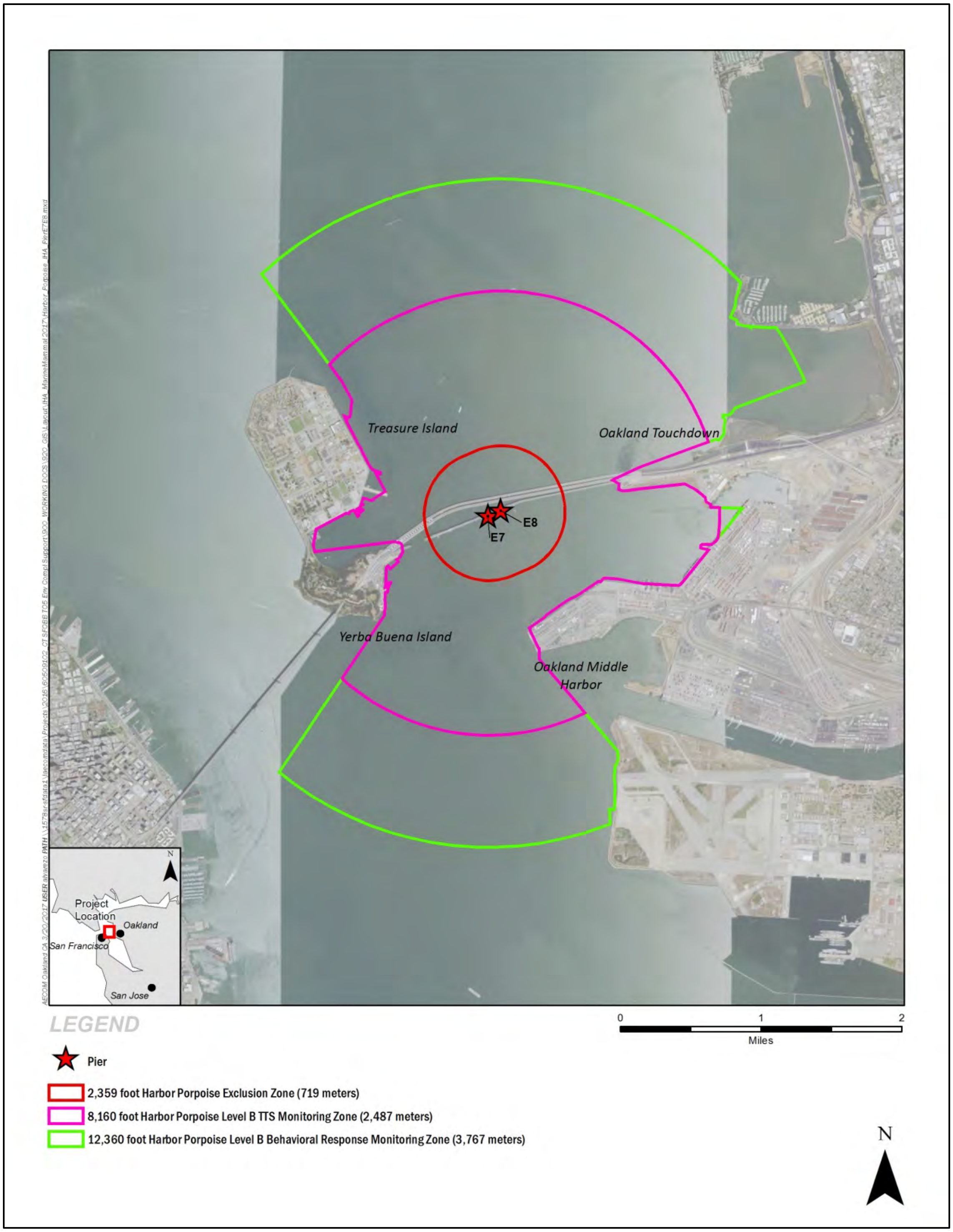
Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown.

Figure 9. Pinniped and Dolphin Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Four 288-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

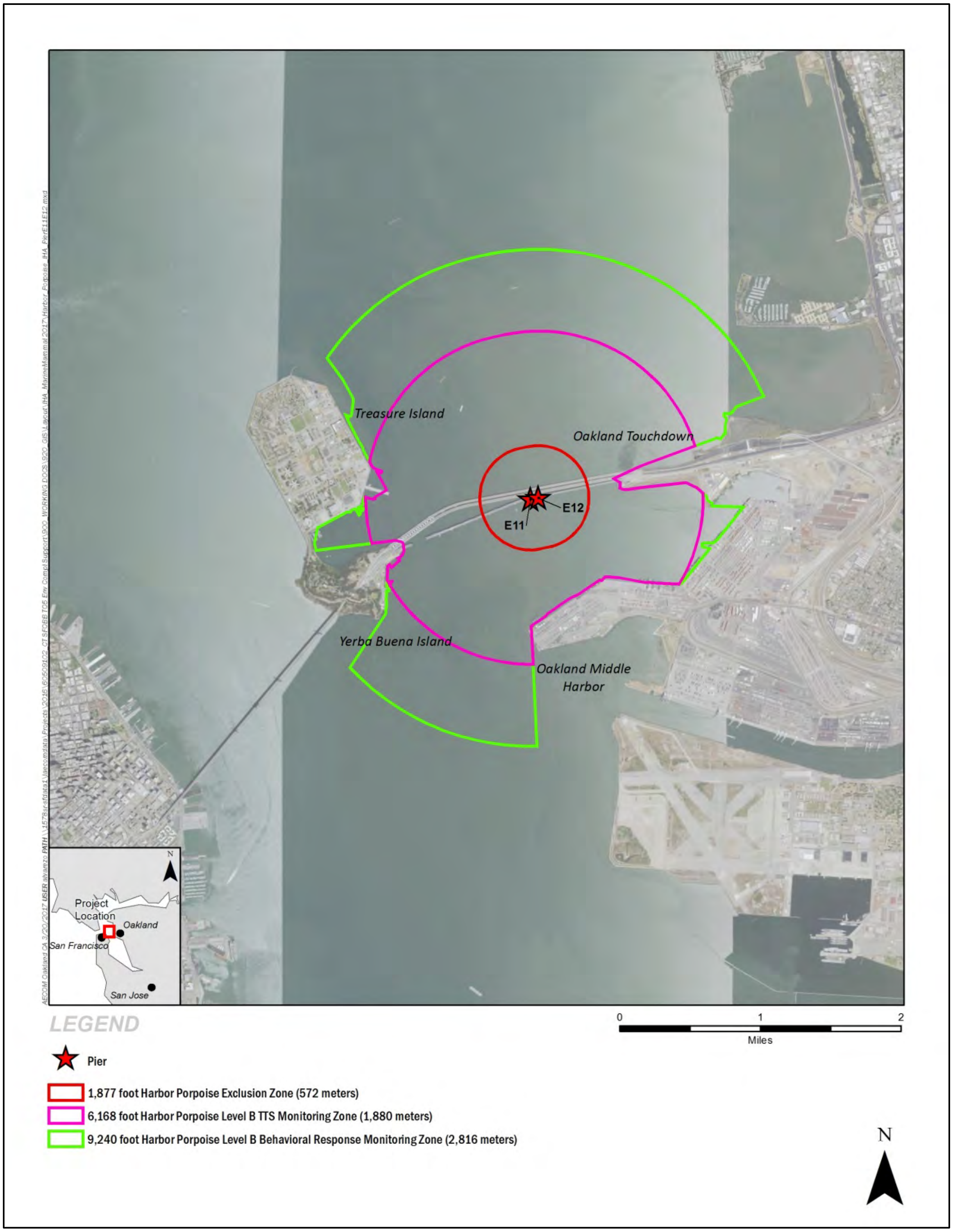
Figure 10. Harbor Porpoise Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Pier E6



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown. These isopleth also would be applied for implosion events made up of one 504-foot span pier and one 288-foot span pier, or the implosion of Pier E9 individually.

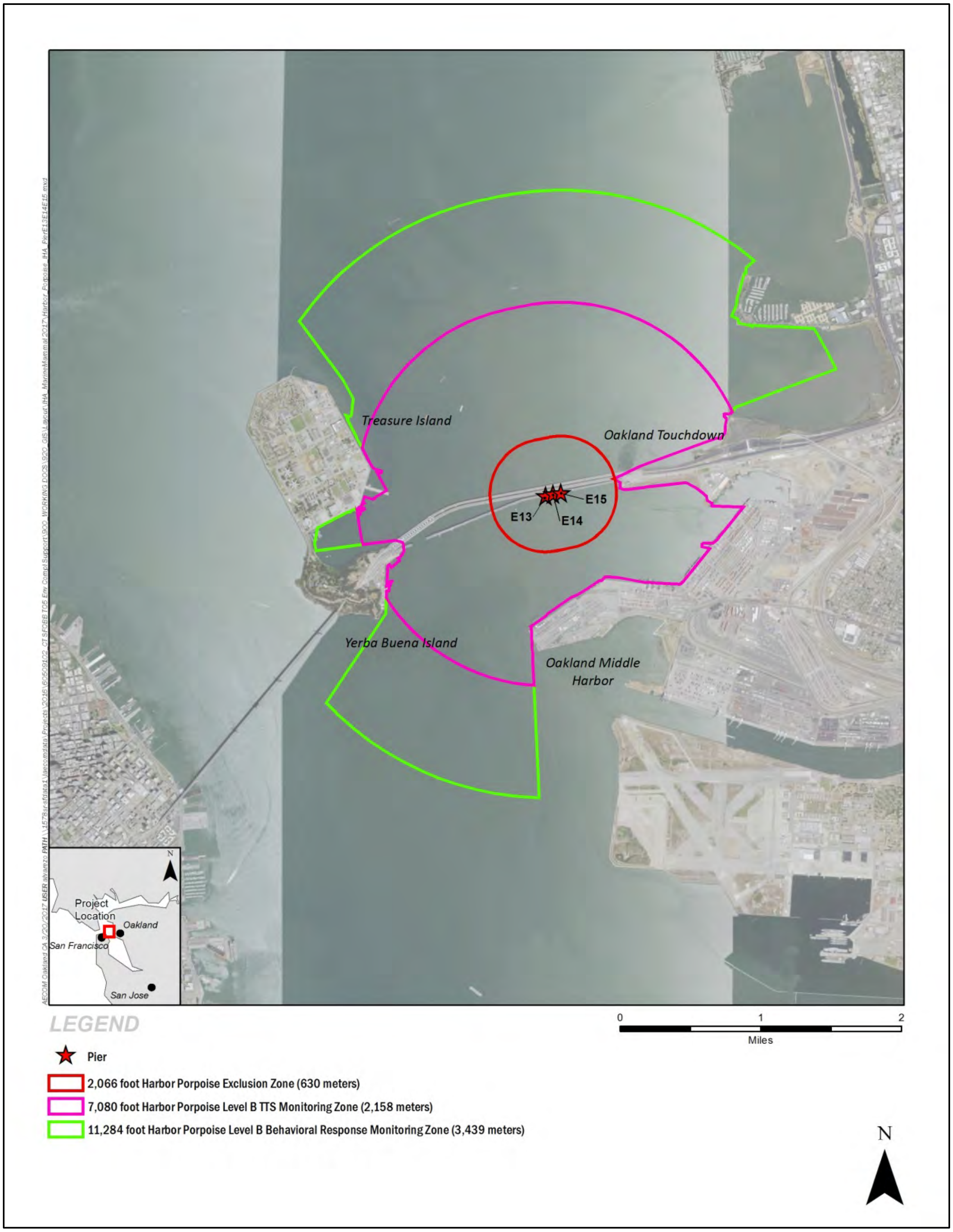
Figure 11. Harbor Porpoise Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Two 504-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown.

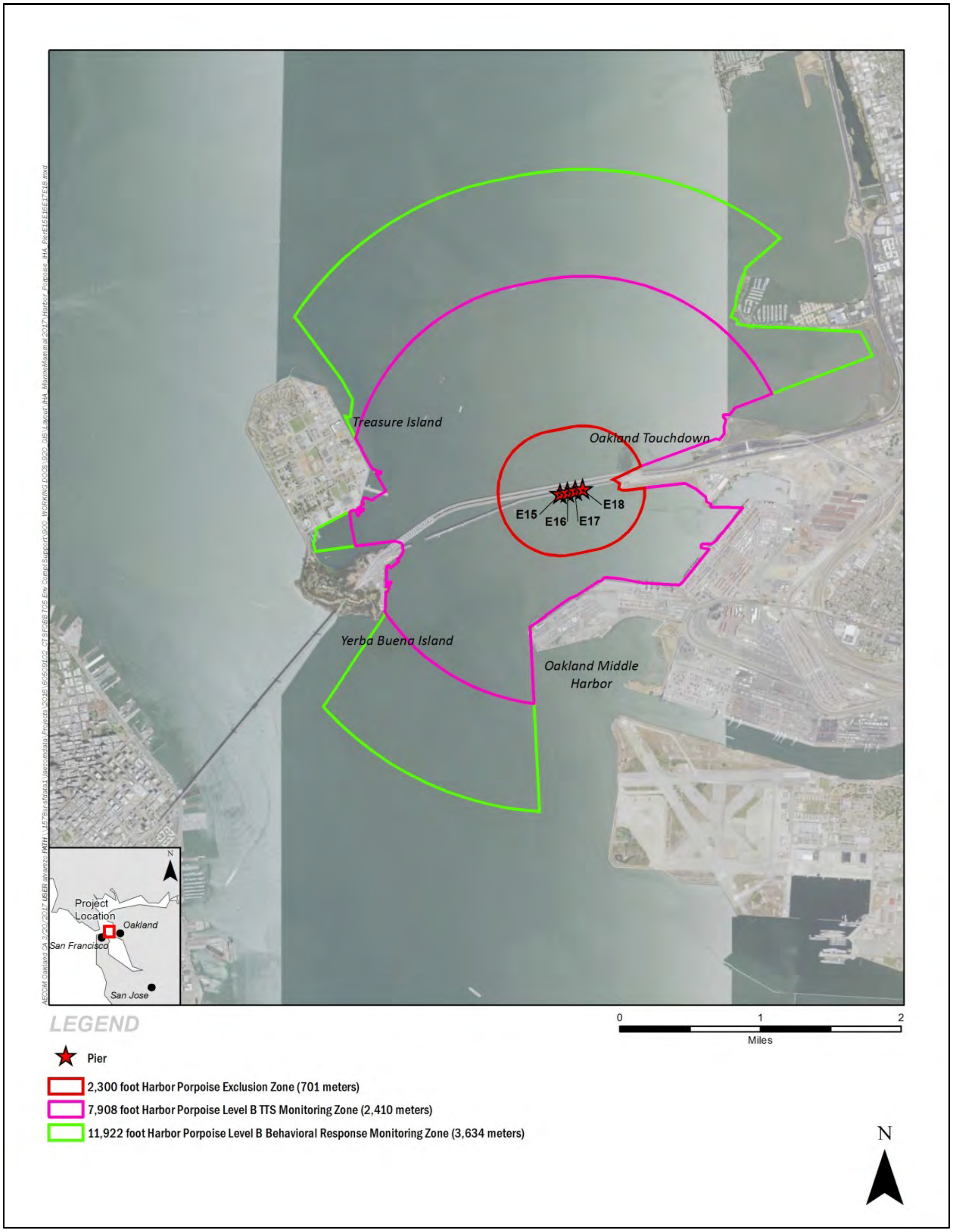
Figure 12. Harbor Porpoise Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Two 288-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown.

Figure 13. Harbor Porpoise Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Three 288-foot Span Piers



Source: ESRI 2015 (imagery); compiled by AECOM in 2017

Note: The pier implosion event shown is hypothetical. Which specific piers will be imploded together is unknown.

Figure 14. Harbor Porpoise Level A Injury Exclusion Zone and Level B Harassment Monitoring Zone for Implosion of Four 288-foot Span Piers

Chapter 4. Avian Monitoring Program

Potential impacts on birds resulting from implementation of the SFOBB Project are specifically addressed in the SFOBB Project Final Environmental Impact Statement and regulatory agency approvals, obtained from the U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Wildlife (CDFW), and the San Francisco Bay Conservation and Development Commission (BCDC). On October 29, 2001, the Department received Biological Opinion 1-1-02-F-0002 from USFWS on the potential effects of the SFOBB Project on the California least tern (*Sterna antillarum browni*) and California brown pelican (*Pelecanus occidentalis californicus*). In 2009, the brown pelican was removed from federal listing status. On November 19, 2001, the Department received CDFW Incidental Take Permit (ITP) No. 2081-2001-021-03, which identified bird species listed as fully protected under the California Fish and Game Code (CFGC) on which the SFOBB Project could have an adverse effect; these species include the California least tern, California brown pelican, and American peregrine falcon (*Falco peregrinus*). USFWS also issued the Department an extension to its Special Purpose–Relocation permit (Permit No. MB22730B-1) on February 10, 2016; this permit allows relocation of a specified number of occupied nest contents (i.e., eggs, nestlings) for certain species that historically have nested in the project area.

Pursuant to the CDFW ITP, the Department prepared the final (revised) Bird Monitoring and Management Plan (BMMP) in 2003, which outlined bird monitoring and management associated with construction of the SFOBB east span as well as avoidance measures for impacts on fully protected species (Department 2003). In the 2003 BMMP, the Department identified the double-crested cormorant (*Phalacrocorax auritus*), western gull (*Larus occidentalis*), and other birds covered under the Migratory Bird Treaty Act (MBTA) and CFGC that may nest in the project area for monitoring, in addition to the protected species identified in the USFWS BO. The primary objective of the monitoring efforts outlined in the 2003 BMMP is to avoid or otherwise document any take of these species resulting from construction activities. Since 2002, bird monitoring has been performed weekly by qualified avian biologists who survey in and around the SFOBB Project area. In addition, the Department has conducted annual peregrine falcon monitoring since 2003.

In 2013, the Department prepared the Bird Management Plan for Bridge Dismantling (BMP) (Department 2013c). The BMP details the management strategy during removal of the original east span, including deterrence of nesting birds and procedures to follow in the event that an occupied nest is found in the work area. The Department has been conducting nesting bird monitoring during bridge dismantling activities since 2013.

In 2015, the Department obtained authorizations for the Pier E3 Demonstration Project, which involved mechanical dismantling, implosion, and clean-up of the Pier E3 marine foundation. An Avian Monitoring Plan (AMP) was developed as part of the *SFOBB Project Pier E3 Demonstration Project Biological Monitoring Programs* (Department 2015c) to provide the necessary direction so that impacts on protected avian species from the mechanical dismantling and controlled implosion of Pier E3 were avoided. In 2016, the Department obtained authorizations to implode Piers E4 and E5. The monitoring protocol for the mechanical dismantling and the clean-up activities associated with removal of Piers E3, E4, and E5 were based on the protocols outlined in the BMMP and BMP. As elevated sound levels resulting from the use of explosives underwater can result in auditory injury to birds, a unique avian monitoring protocol was developed for the implosion of Piers E3, E4, and E5, involving the use of deterrence measures, establishment of a 500-foot Avian Watch Zone for the implosion of Pier E3 and a 300-foot Avian Watch Zone for Piers E4 and E5, and a delay protocol if a listed diving bird entered the Avian Watch Zone immediately before pier implosion. Because of sound's impedance at the air-water interface, it was concluded that impacts on birds would be limited to any individuals submerged in this 500- or 300-foot zone during the implosion.

This AMP has been revised to address the various elements of avian monitoring to be completed for the implosion of Piers E6 through E18.

4.1. Avian Species of Concern

4.1.1. Peregrine Falcon

Prior to 1999, peregrine falcon was identified as a federally and State-listed species. USFWS de-listed peregrine falcon from the FESA in 1999, and CDFW de-listed it from the California Endangered Species Act (CESA) in 2008. Peregrine falcon is classified as "fully protected" by CDFW, is identified federally as a "Bird of Conservation Concern," and is protected under the MBTA.

Peregrine falcon is a year-round resident in the project area. Its nesting season is from February through July. Peregrine falcon was known to nest on the east span of the Bay Bridge before SFOBB Project construction. Observations of an established, historic peregrine falcon territory east of YBI have been made since the mid-1980s.

Since the Department initiated peregrine falcon monitoring in 2003, peregrine falcons have been observed nesting on the SFOBB cantilever structure at various locations from Piers E2 to E4, within the 504-foot truss spans on Pier E8, and on Crane X403 in the Port of Oakland. During the nesting season, peregrine falcons have been observed perching at multiple locations or flying throughout the project area; however, their activity generally is centered on the nest site. During the non-nesting season, peregrine falcons often have been seen perched atop bridge towers, on sign posts, below the lower deck, or on the horizontal cross-beams at the top of the tower legs. However, ongoing bridge removal activities and the installation of nesting deterrents will continue to influence the peregrine's use of structures in the SFOBB Project area for roosting and nesting.

A pair of peregrine falcons made a nesting attempt on Crane X403 in the Port of Oakland during the 2016 nesting seasons. This site is outside the SFOBB Project limits.

4.1.2. California Brown Pelican

California brown pelican was listed formerly as an endangered species under the CESA and the FESA because of population declines associated with pesticide residues in the environment. Brown pelican was de-listed from the CESA and the FESA in 2009; however, it still is protected under the MBTA, its colonies are protected under the CFGC, and CDFW includes brown pelican on its list of "fully protected" species.

Individual brown pelicans have been observed in the project area throughout the year. However, because the Bay Area is not considered to be within the breeding range of the species, no breeding records for brown pelican have ever been documented in the project area or in the Bay. Nesting season for brown pelican is from January through July; individuals observed in the project area during the nesting season are sub-adults or adult non-breeders.

In the SFOBB Project area, brown pelicans usually are observed alone or in small groups of less than five individuals. Brown pelicans use bridge piers for perching, often in close proximity to construction activities. Brown pelicans also may be observed sitting on the water, actively feeding, or flying through the project area.

4.1.3. California Least Tern

California least tern is federally and State-listed as endangered under the FESA and CESA, is protected under the MBTA, and is fully protected by the CFGC. A large colony of least terns nests annually at the former Naval Air Station in Alameda, approximately 3 miles southeast of the project area. Least tern occurs in the Bay Area during the nesting season (April through August) and is absent from the Bay Area during the remainder of the year, during which time it resides within its winter range along the Pacific coast of Central and South America.

During bird monitoring conducted from 2002 to 2016, least terns were observed in the vicinity of the SFOBB Project area only from April through July, foraging primarily in the Port of Oakland Outer Harbor. Least tern observations have occurred consistently near the shore, moving toward the various marinas and harbors along the waterfront of the East Bay. Although SFOBB avian monitors have observed least terns in the vicinity of the marine foundations to be removed (Piers E6 through E18), all of these observations were made within the April–July window.

4.1.4. Double-Crested Cormorant

Double-crested cormorant is protected under the MBTA and CFGC. The 2008 CDFW California Bird Species of Special Concern report includes double-crested cormorant nesting colonies in the "Taxa to Watch" list (Shuford and Gardali 2008).

Double-crested cormorant was first documented nesting on the original SFOBB east span in the early 1980s. This species nests colonially on the steel girders below the lower deck. The nesting season for cormorants is from March through August. During the non-nesting season, double-crested cormorants historically used the structure of the original SFOBB east span for roosting; winter bridge surveys have recorded roosting cormorants numbering in the thousands. In addition, double-crested cormorants have been observed perched, foraging, or in transit (singly or in groups) in the project area. Ongoing cormorant nesting deterrent installation and bridge removal activities will continue to reduce nesting and roosting habitat available to double-crested cormorants on the original east span.

4.1.5. Western Gull

Western gull has no status under the FESA or CESA. Western gull is protected as a migratory bird under the MBTA and the CFGC.

Western gull is present in the SFOBB Project area year-round. The nesting season for western gull is from March through August. Individuals have been observed to be extremely persistent in attempts to nest on the bridge or other suitable surfaces. Nests have been constructed on ledges or other wide surfaces, including the marine foundations, pilings, tower legs, and other locations where the species is protected from terrestrial predators. In some cases, eggs have been laid without the presence of any nest or nesting materials. Occasional pairings between western gull and glaucous-winged gull (*Larus glaucescens*) have been noted during the SFOBB Project. For management and monitoring purposes, these species are treated equally. As with other bird species that nest on the bridge, ongoing nesting deterrent installation and bridge removal activities will continue to reduce available nesting habitat on the original east span.

4.1.6. Other Protected Nesting Birds

Other migratory birds may nest or have been documented nesting in the SFOBB Project area. While nesting, these species are protected under the MBTA and CFGC. Common species observed nesting in the SFOBB Project area include pigeon guillemot (*Cepphus columba*), house finch (*Carpodacus mexicanus*), and black phoebe (*Sayornis nigricans*).

4.2. Avian Monitoring during Controlled Blasting for Piers E6 through E18

The bird monitoring protocol for controlled blasting has been designed to ensure that protected species will not be affected by harmful sound/pressure waves generated by pier implosion. Because of sound's impedance at the air-water interface, impacts on birds will be limited to any individuals submerged during the implosion. Protected diving bird species include the California least tern and the brown pelican, but the least tern, in addition to other sensitive species, is absent from the Bay Area in the fall, when the pier implosions are permitted.

The following sections describe the various elements of avian monitoring to be completed before, during, and after all implosions associated with the removal of Piers E6 through E18.

4.2.1. Establishment of the Avian Watch Zone

In 2012, the Washington Department of Transportation established a guidance threshold of 202 dB cumulative Sound Exposure Level (cSEL) for auditory injury and 208 dB cSEL for non-auditory injury thresholds during in-water pile driving for marbled murrelets (WSDOT 2014). This threshold is not a regulatory requirement, but a conservative guideline that the Department has elected to adopt. The Department proceeded with the use of the auditory injury threshold (i.e., 202 dB cSEL) to avoid impacts on protected diving birds during the Pier E3, E4 and E5 implosions, to maintain consistency with past projects where measures were taken to protect avian species. For the implosion of Pier E3, the Department calculated a 500-foot (152-meter) distance to the 202 dB cSEL threshold, based on advanced modeling. Based on the Pier E3 Demonstration Project's hydroacoustic monitoring results, the 202 dB cSEL threshold was measured at approximately 300 feet (91 meters). These results indicate that the Department's calculated distance for potential auditory injury to birds was conservative and slightly higher than the measured cSEL levels. Based on these results, the Department established a 300-foot watch zone around Piers E4 and E5. The measured cSEL levels observed during Piers E4 and E5 were 201 feet and 137 feet, respectively. The Department will establish a 300-foot avian watch zone for the implosion of Pier E6 and then establish a 200-foot watch zone for Piers E7 through E18, to protect diving birds during each controlled blasting event (Figure 15).

Auditory and visual deterrents will be available and may be used as necessary to encourage target avian species to relocate from the 300-foot watch zone before the test blasts and implosions associated with the removal of Piers E6 through E18. The Department used two sound cannons and a long-range laser (as a visual deterrent) during the Pier E3 Demonstration Project, to discourage individuals from occupying the avian watch zone before the test blasts and

Source: Compiled by AECOM in 2016

Figure 15. Approximate Avian Monitoring Locations and Watch Zones

pier implosion. The propane-powered sound cannons emit a short, loud shot and can cover areas up to 5 acres. The lasers produce a green light, visible up to 1.2 kilometers (0.75 mile). Tests conducted by avian monitors during the Pier E3 Demonstration Project found the laser to effectively flush birds under low light conditions only. Bird cannons, fired remotely immediately before the test blasts and implosion of Pier E3, were observed to successfully flush birds.

The bird cannons that were fired remotely immediately before the test blast and implosion of Piers E4 and E5 also were observed to successfully flush birds, including flushing one gull sitting directly atop Pier E4 before the implosion. Based on these successful demonstrations, the Department plans to continue using these deterrents to flush birds from the avian watch zone before the test blasts and implosions associated with removal of Piers E6 through E18. Lasers will be used only under low light conditions, and direct exposure to the laser will be avoided.

4.2.2. Avian Monitoring

A minimum of two monitors will be present to monitor the avian watch zone for bird activity before the implosions of Piers E6 through E18. One monitor will be designated as the Lead Avian Monitor and will communicate directly with the Department Environmental Compliance Manager or designee. The two avian monitors will be positioned on the bicycle and pedestrian pathway of the new east span. For bird predation monitoring that will follow the implosion (see Chapter 8, “Bird Predation Monitoring”), if the current is moving north, a minimum of one additional avian monitor will be positioned on either the footing of a marine foundation of the new east span or on the water in a boat along the MTSZ, before and during the implosion. The additional avian monitor will be needed only if the current is moving north because the two avian monitors located on the bridge will lose visual sight of after-implosion debris as it travels north with the current, under the new east span.

The avian monitors will observe and record all bird activity within and surrounding the avian watch zone prior to the implosion. At a minimum, the following data will be recorded for each bird observed in the time leading up to the implosion:

- Time
- Species
- Approximate distance from pier
- Cardinal direction relative to pier
- Behavior/status (i.e., flying through, foraging from the air, on water, diving, foraging below surface)

If a protected (e.g., FESA, CESA, or CFGC-fully protected) bird(s) is (are) sighted, the avian monitors will monitor its activity. If the bird(s) is (are) in the air and traveling from the avian watch zone, no further action will be necessary. If a bird is sighted diving into or foraging in the water column within the watch zone, the monitor will communicate this information to the Lead Avian Monitor, who will be in direct communication with the Department's Environmental Manager or his designee, Resident Engineer, and Blaster-in-Charge. Pier implosion(s) will be delayed until the protected species is no longer submerged in the water column within the watch zone. Departure of an individual bird from the watch zone will be documented and will be communicated to the Department's Environmental Manager.

If a dead or injured bird is sighted after the demolition blast events, the Lead Avian Monitor will notify the Department's Environmental Manager, who will contact USFWS and CDFW within 24 hours. The Department will make attempts to collect dead or injured birds using a boat-based biologist. The Department will make preparatory receiving arrangements with a local wildlife care center before any of the implosions of Piers E6 through E18, and rescued or salvaged individuals will be transferred to the arranged wildlife care facility for rehabilitation. USFWS and CDFW will have the authority to perform a necropsy on any salvaged bird to determine whether an implosion was the cause of the injury or death. Individuals that are mortally injured by an implosion may be donated to the University of California, Berkeley Museum of Vertebrate Zoology. Such situations are expected to be dealt with on a case-by-case basis.

4.2.3. Monitoring Plan for One to Four Pier Implosions

Table 12 shows the protocol that has been established for the implosions of Piers E6 through E18 in fall 2017.

Table 12. Monitoring Plan for All Implosion Events

Avian Watch Zone (202 dB cSEL auditory threshold)	Laser usage (In low light)	Sound Cannons	Avian Monitors
300- or 200-foot watch zone from pier	One laser to be used during low light conditions	Two cannons to be placed on contractor barge or footing of the new east span, both facing the pier(s)	A minimum of two avian monitors will be stationed on the bike path of the new span. If the current is moving north, one additional monitor will be positioned on the footing of the marine foundation of the new east span or will be positioned in a boat along the Marine Traffic Safety Zone (MTSZ).
Source: Compiled by AECOM in 2016			

4.3. Minimization Measures for Implosion Events

The Department will implement specific measures, as required by CDFW Incidental Take Permit No. 2081-2001-021-03, USFWS Biological Opinion No. 1-1-02-F-0002, and BCDC Permit No. 2001.008.32 (formerly Permit No. 8-01), to minimize impacts on special-status diving bird species known to occur in the SFOBB project area. Specific avoidance and minimization measures that will be implemented include the following:

- The test blasts, if conducted, and implosions will be scheduled no earlier than September 1 and no later than November 30. During project-related bird monitoring conducted from 2002 to 2016, California least terns were observed only between April and July, during their nesting season, because they are migratory. Therefore, California least terns are not expected to be in the project area during the implosion events. Monitoring data also shows a reduced number of California brown pelican observations during the implosion events time frame.

- The test blasts (if conducted) and implosions will be weather-dependent, to ensure climatic conditions are suitable for observing and identifying avian species. Blasting will be delayed during periods of fog, wind, or heavy rain.
- The test blasts and implosions will be limited to daylight hours for safety reasons, and to allow adequate observation of the SFOBB project area for diving birds.
- A 300-foot (91-meter) Avian Watch Zone will be established around Pier E6 and a 200-foot Avian Watch Zone will be established around Piers E7 through E18, to protect diving birds. In accordance with the monitoring plan, the implosion will be delayed if any special-status birds (i.e., California least tern or California brown pelican) is observed actively diving into the water within 300 or 200 feet of Pier E6 through E18 immediately before an implosion event.
- Avian deterrents (i.e., lasers and sound cannons) will be used to encourage target avian species to relocate from the Avian Watch Zone.
- At least two avian monitors will be stationed on the bicycle and pedestrian pathway of the new east span. If needed because of the current moving north, either one or two monitors will be stationed on the footing of the marine foundation of the new east span or on a boat, to observe bird activity before, during, and after the implosion events. All avian monitors will have had previous experience in observing/spotting diving birds.

- Avian monitoring will begin at least 30 minutes before the scheduled start of each implosion event, to identify the possible presence of diving birds. Monitoring during this period before each implosion will allow avian monitors to evaluate the potential risk to protected species. Avian monitoring will continue for at least 30 minutes after each implosion event.

- The avian monitors will follow the monitoring protocol established in this AMP.

Chapter 5. Fish Assemblage Assessment

As a condition of the CDFW Incidental Take Permit, the Department will conduct sonar-based surveys before each implosion event, to assess the presence of fish assemblages in the water column around the pier. In the event of multiple piers involved in blasting, the action area (approximately 500 feet around each pier (or pier grouping) or as close as is safely feasible) will be surveyed before the blasting event. The goal of the survey will be to identify the presence of any major schools of fish that have massed in the areas immediately surrounding the pier, and that could be affected by the blast.

Approximately 4 hours before the scheduled blast, a boat with biologists will navigate around the pier using a standard “fish finder” type sonar device. Because of the presence of safety and navigational hazards in the area, including explosives, delicate hydroacoustic equipment lines, cables, air hoses, and anchor lines, the boat will not be able to navigate close to the piers. For safety purposes, the boat will target areas approximately 500 feet from the pier; however, this distance may vary in different localities around the pier, based on the presence of hazards. Because of the configuration of the hazards in the area, the survey generally will be divided into four quadrants (i.e., northwest, southwest, northeast, and southeast). During the survey within each quadrant, the biologist will record photographs of the fish finder display screen, GPS coordinates, and the time. Any potential schools of fish that are detected also will be recorded in the same way. The results of this survey will be provided to CDFW electronically within 3 business days of the blast. Observations that are made by the sonar survey will not have any effect on the blasting schedule.

Chapter 6. Pacific Herring Monitoring Program

As a CDFW-managed fishery and Magnuson-Stevens Act managed species, the Department proposes to conduct Pacific herring monitoring if work activities continue past November 30 of a given year. Because all controlled blasting will be completed prior to November 30, the activities potentially occurring on December 1 or later will include post-implosion clean-up, such as removing debris with a clam-shell dredge bucket, and hydrographic surveying. The Department will submit a Pacific Herring Work Waiver request to CDFW for any work completed during this period and will employ only properly trained herring observers to monitor the work.

6.1. Monitoring Plan

Per previous herring work waiver authorizations, CDFW has required the Department to monitor for evidence of recent herring spawns within 1,640 feet (500 meters) of any activity that may affect schools of herring or spawning herring during the herring spawning season. If work associated with the project occurs during the herring spawning season, the Department will conduct herring surveys. These surveys, which will be conducted daily before the start of any work, will include some or all of the following methods:

- Monitoring for the presence of milt in the water;
- Monitoring for the presence of recently fertilized eggs on rocks, piles, along shorelines, barges, boats, piers, and other substrates;
- Monitoring for active surface predation of herring by birds or marine mammals; or
- Surveying for large spawning schools using a fathometer.

Monitoring during in-water work will require prior clearing of the action area and monitors checking for large schools of fish near the 1,640 feet (500 meters) project buffer zone. If a suspected herring spawning event is observed or is suspected to have recently occurred within the monitoring zones, the Department will stop work and will notify CDFW. If a large school of fish is observed within 1,640 feet (500 meters) of the work area with the fathometer, work will not resume until the school of fish clears the work area and/or CDFW confirms the school of fish is not Pacific herring. If work is halted because of the presence of milt, eggs, or observed predation within 1,640 feet (500 meters) of the work area, the work will not resume until it is confirmed that Pacific herring and associated roe are no longer within 1,640 feet (500 meters) of the work area.

Chapter 7. Hydroacoustic/Underwater Pressure Monitoring Program

A monitoring program will be implemented to collect in-water noise and pressure data during controlled blasting of Piers E6 to E18. The purpose of the blast pressure and hydroacoustic noise monitoring are to verify and evaluate distances to specific fish, marine mammal, and diving bird noise impact criteria. The monitoring plan below describes the monitoring for Piers E6 to E18 and is based on data collected during the implosion of Pier E3 to E5.

7.1. Noise Criteria

7.1.1. Marine Mammals

Noise criteria for marine mammals for controlled blasting will follow the interim underwater explosive criteria, established by NMFS most recently in 2016, and will consist of cSEL, single strike peak level (L_{pk}), and acoustic impulse. The cSEL criteria for marine mammals are complex because different designations for the SEL criteria exist for each group/species. These refer to group/species-specific filter shapes that are to be applied to the pressure signal. For Peak and Impulse, no filters are specified. Hydroacoustic monitoring results from the implosions of Piers E3, E4, and E5 were used to estimate sound pressure and exposure levels and distances to marine mammal threshold criteria for the implosions of Piers E6 through E18. Methods used for estimating these potential impacts are discussed in Section 3.3.For Piers E6 to E18, the Department will continue to provide measured results to marine mammal criteria from its hydroacoustic monitoring efforts for each blast event.

7.1.2. Birds

Chapter 4, “Avian Monitoring Program,” presents background on 202 dB cSEL criterion guidance for avian auditory injury from underwater blasting.

Based on the monitoring results from Piers E3, E4 and E5, as summarized in Table 13, the Department plans to establish a conservative monitored exclusion zone for federally or State-listed diving birds during blast events scheduled in 2017, extending out 300 feet or 200 feet, depending on the blast event scenario. Avian monitoring is detailed in Section 4.2, “Avian Monitoring during Controlled Blasting for Piers E6 through E18.”

Table 13. Measured Results to 202 dB cSEL Criterion for Piers E3 through E5

Pier	Measured Distance to 202 dB cSEL Criterion (feet)
E3	300
E4	201
E5	137
Source: Compiled by AECOM in 2016	

7.1.3. Fish

The agreed criteria for potential impacts on fish are those currently established by the Fisheries Hydroacoustic Working Group (FHWG) for underwater impact pile driving along the West Coast. These criteria, for the onset of injury, include a cSEL of 187 dB re 1 μPa^2/second for fishes more than 2 grams and 183 dB re 1 μPa^2/second for fishes less than 2 grams, and an L_{pk} of 206 dB re 1 µPa for all sizes of fishes (Stadler and Woodbury 2009). In addition, a threshold of 150 dB root mean square (RMS) is included per the NMFS BO of August 2016 as the level that elicits a behavioral response, but no injury, in fish. The background on the use of pile driving criteria to monitor impacts on fish species is presented in the following sections.

7.1.3.1. Fish Criteria Background: Peak Pressure Level

At this time, NMFS, CDFW, and USFWS do not have specific peak pressure criteria for potential impacts on fish from underwater blasting. In the absence of such criteria, and after consultation with NMFS and CDFW (no fish species in the project area are regulated by USFWS), it was decided to compare the measured peak pressure level from the controlled blasting of Piers E6 to E18 to the existing criterion used for impact pile driving.

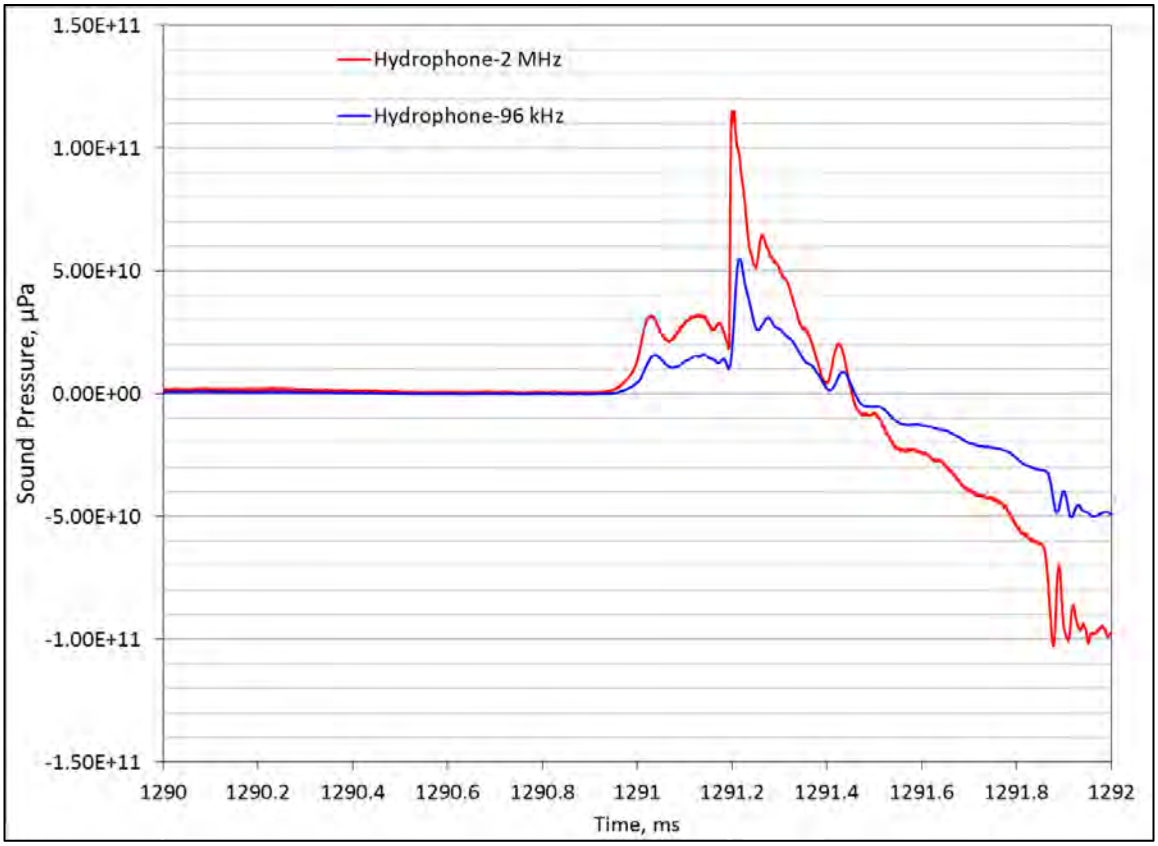
The pressure pulses generated by impact pile driving do not have rise times as fast as those generated by underwater blasts. Although lower in amplitude, pile driving pressure fluctuations are longer in duration, and therefore may have more energy when integrated over time. Furthermore, for fish injury/mortality, the metric with the best correlation of underwater blast pressures to injury is impulse, not peak pressure, based on research by Govoni et al. (2003) and Yelverton et al (1975). In developing the interim criteria for fish, the impacts from pile driving compared to underwater blasts were recognized to be significantly different and the pressure rise time could be a factor. After review of the work done by Yelverton et al. (1975) that involved underwater blasts, Hastings and Popper (2005) recommended cSEL as the metric most appropriate for assessing injury impacts of pile driving sound on fish. This was affirmed further by Hastings (2007) review of other work done, including blasts by Govoni et al. (2003, 2007).

The cSEL criteria for fish were derived from blasting data that were sampled at a higher rate (i.e., approximately 1,000,000 samples per second) and with appropriate pressure transducers (Hastings 2007). However, the peak pressure level criterion was based on the nature of the peaks produced by pile driving that did not have the high frequency components that are seen in pressure fluctuations produced by blasting.

In 2005, Hastings and Popper published a paper assessing the Effects of Sound on Fish. Hastings and Popper concluded the body of data available at the time was inadequate to develop anything more than the most preliminary scientifically supportable criteria for injury to fish from pile driving sounds. Therefore, such a criterion was not proposed in their 2005 report. Instead, information from blasting and pure tone studies was used to develop recommendations for interim guidance. Hasting and Popper noted that such guidance should not be used for any signal other than pile driving. (Hasting and Popper 2005)

In 2006, Popper et al. recommended that interim criteria for injury to fish from pile driving be set at a peak SPL of 208 dB Peak and an SEL level of 187 dB SEL (single strike) (Popper et al. 2006). These recommended interim criteria were based on findings from four studies; blasting and pure tone studies previously considered by Hasting and Popper in their 2005 report and one study by the Department using pile driving stimuli (Popper et al. 2006). In 2007, Hastings, Popper, and Carlson recommended a slightly more stringent peak criteria of 206 dB Peak and cumulative SEL criteria of 189 dB cSEL for fish greater than 2 grams and 183 dB cSEL for fish less than 3 grams (Carlson et al. 2007; Buehler et al. 2007). Ultimately in 2008, the FHWG agreed in principle on an interim criteria for injury to fish from pile driving activities of 206 dB Peak for all fish, a cumulative SEL criteria of 187 dB cSEL for fish greater than 2 grams, and 183 dB cSEL for fish less than 2 grams (FHWG 2008).

In practice, impact pile driving typically is measured with hydrophones and sampled at lower rates (typically less than 100,000 samples per second [S/s]). Figure 16 shows the results from the Pier E3 implosion measuring the same event with the same sensor type (hydrophone) sampled at two different rates, high speed (2,000,000 S/s) compared to a lower speed (96,000 S/s). Sampling at the lower rates that typically are used for measuring peak pressures during pile driving may not capture the actual peak pressure when monitoring during blasting. When monitoring the Piers E3, E4, and E5 implosions, two types of sensors were used: hydrophones and pressure transducers. The peaks that were measured with either a pressure transducer or hydrophone, using the same high sampling rate, were likely to capture the fast peaks generated by blasting (Figure 17).



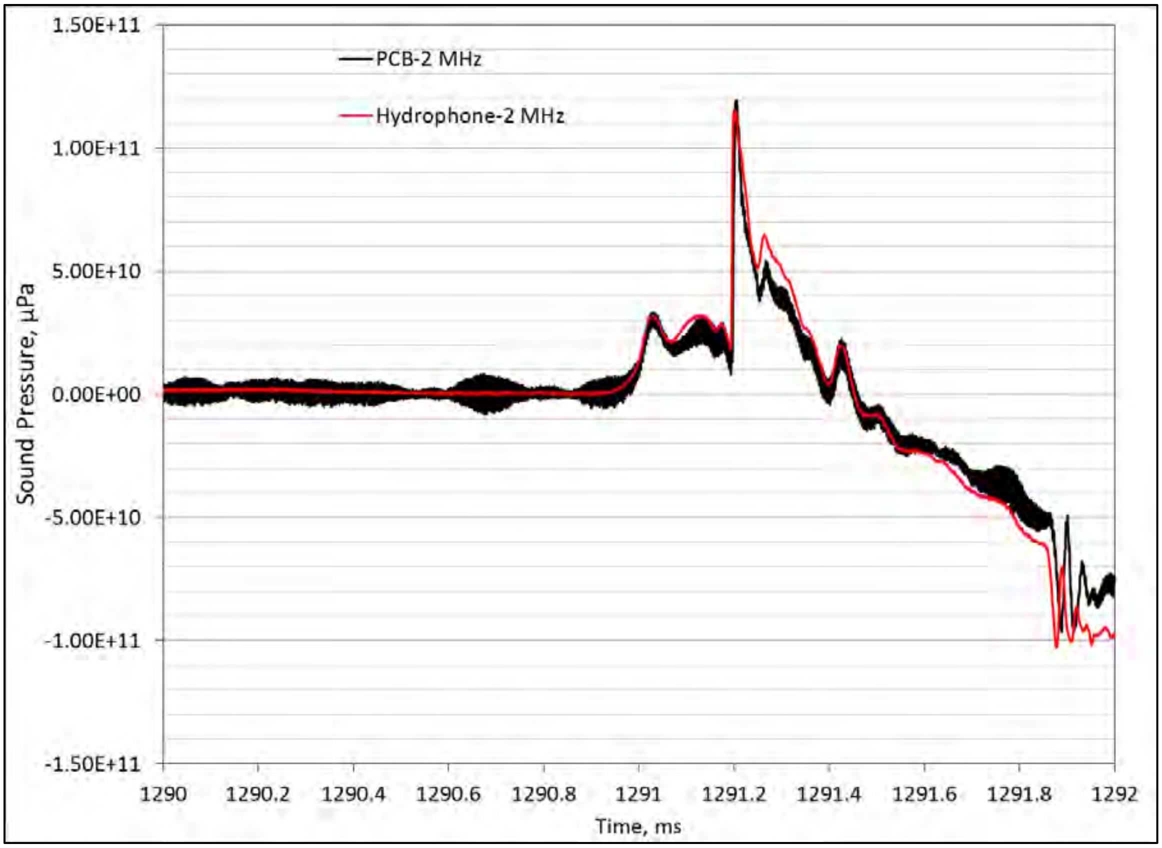
Note: Pressure waveform at 500 feet from the east for a hydrophone sampled at both 2,000,000 and 96,000 samples/second.
Source: Department 2016a

Figure 16. Pressure Waveform at 500 feet from the East of Pier E3 (1)

On the other hand, use of higher sampling rates during blast monitoring could have captured peaks that had a much faster rise time and may have been missed by using the lower sampling rates typically used to monitor impact pile driving. It is not the intent of this monitoring plan to comment on the appropriateness of peak pressure criteria, but rather to point out the differences that sampling rates could make in applying peak criteria to monitoring results especially at distances closer to the implosion. However, if fish peak pressure is going to be applied as a criterion for underwater blasts, development of criterion specific to blasts needs to be considered.

7.1.3.2. FISH CRITERIA BACKGROUND: CUMULATIVE SOUND EXPOSURE LEVEL

As noted above, the cSEL criteria for fish were derived from underwater blast data. Furthermore, the cSEL produced with the hydrophone sampled at 96,000 S/s was nearly identical to that sampled at 2,000,000 S/s with the pressure transducer. Therefore, the choice between using a pressure transducer or hydrophone to capture cSEL data is not critical.



Note: Pressure waveform at 500 feet from the east for a pressure transducer and hydrophone, both sampled at 2,000,000 samples/second.

Source: Department 2016a

Figure 17. Pressure Waveform at 500 feet from the East of Pier E3 (2)

7.1. Monitoring Methods

Unlike previous implosion events for the project, Piers E6 through E18 will be imploded in blast events that include one, two, three, or four piers blasted during a single event. The Department is anticipating six or seven blast events in 2017. During multiple-pier blast events, piers will be imploded sequentially with adequate time between pier implosions to avoid exposure of biological resources to the pressure waves produced by more than one blast at the same time. Based on the successful monitoring and robust data set collected during the Piers E3, E4, and E5 implosions, the Department is proposing a more efficient monitoring plan for Piers E6 through E18. The proposed monitoring plan will use the project's collected data from those previous events to support the measured results, as needed. The Department asserts that monitoring within the BAS is no longer necessary, as the effectiveness of this system has been established, as documented in the reported results for Piers E3, E4, and E5.

During all blast events to implode Piers E6 through E18, the Department will deploy a sensor array that includes pressure transducers and/or hydrophones within 800 feet of the pier with the greatest explosive weight, using high-speed data acquisition systems (sampling at up to 1,000,000 samples per second). The data acquisition systems will be triggered by the start of the blast. During the Pier E6 implosion and the first double pier and triple (or quadruple) pier blast events, monitoring beyond 800 feet will be conducted using multiple, independent monitoring units, equipped with hydrophone sensors placed at distances of 1,500 to 6,000 feet. These autonomous units will be triggered by monitoring technicians to record in the field. The results for blast events monitored within 800 feet will be calculated using the data collected by the three sensors within 800 feet for each event. Under these parameters, the Department anticipates that at least three events will be monitored in the far field beyond 800 feet (e.g., the implosion of Pier E6, the Pier E7 plus Pier E8 blast event, and the first three-pier [or four-pier] event).

As discussed above in the Sections 7.3.1 and 7.3.2, the Department has considered appropriate sampling rate and instrumentation for monitoring in-water blast events. The following summarizes the Department's selection process for monitoring equipment before addressing the more technical specifications of the monitoring array. The Department will use pressure transducers in the near field (less than 800 feet from the pier) and hydrophones may be used starting at 500 feet and will be used at location farther than 800 feet. Peak pressure can successfully and accurately be captured using either sensor type (pressure transducer or hydrophone), however the success of capturing the blast event with a given sensor is dependent on the pressure created by the event, the distance from the event, and sampling rate used.

Pressure transducers have a higher threshold before the signal received overloads the sensor, in other words, they can withstand and interpret a greater pressure load without overloading or damaging the sensor and compromising the data. Therefore, based on the results of previous monitoring events, pressure transducers are the appropriate choice at the near-field locations (from the blast location to 500 or 800 feet). Hydrophones have a lower pressure threshold, less inherent noise, and are more sensitive. That means that these sensors have a greater potential to overload when exposed to higher pressures, but a greater ability to receive lower amplitude waves with minimal inherent noise that would need to be filtered out in post processing. Therefore hydrophones are appropriate at distances of 500 feet or greater, where pressures are expected to be lower.

Out to 1,500 feet, a very high sampling rate is used with either sensor. This high sampling rate (1,000,000 samples per second to distances of 800 feet; and 500,000 samples per second beyond 800 feet) is adequate to capture the incredibly high frequency blast pressure waves that are generated by the blasts. These high frequency waves are associated with the peak pressures observed during blasting. Based on the results of the previous blast events, the fall off rate for these high frequency peak pressure waves are rapid enough that extremely high sampling rates are not necessary at the monitoring locations beyond 1,500 feet. For locations past 1,500 feet (i.e., at 3,000 and 6,000 feet) a sampling rate of 96,000 samples per second is used.

For events that do not collect data beyond the near field, the Department will use data collected in the near field and calculate the distance to species criteria (for Peak and cSEL) with a fall off rate curve established by previous blast events.

7.2. Equipment Description and Calibration

Outside the BAS, pressure transducers capable of measuring up to 1,000 pounds per square inch (psi) that generate a lower noise floor (i.e. noise interference from the system itself combined with general background noise) may be used within 800 feet of a single pier. No method of field calibration exists for the pressure transducers. However, within 6 months of the scheduled controlled implosion, the pressure transducers will be laboratory calibrated by a service traceable to the National Institute of Standards and Technology (NIST).

At monitoring locations within 800 feet of blast events to remove Piers E6 through E18, a hydrophone may be used in conjunction with, or in place of, pressure transducers with data recorded using high-speed sampling rates.

When far-field monitoring is conducted at the 1,500-foot monitoring location, a hydrophone will be connected to high-speed data acquisition system sampling, at a rate of up to 0.5 megahertz (MHz) (500,000 samples per second). Based on the monitoring results of Piers E3, E4, and E5, this sample rate is expected to be high enough to capture peak pressures at 1,500 feet from the controlled blast. In addition, these data will be used to further refine continuity when comparing results among systems using different sample rates and sensors.

For monitoring at distances greater than 1,500 feet, autonomous units equipped with hydrophones and solid state recorders will be used. Based on the results of the Pier E3 Demonstration Project and confirmed by measured results from Pier E4 and E5, the sensitivity of the pressure transducers was determined to be too low to capture the amplitude of the low psi signals at farther distances from the implosion, and that the noise floor of the pressure transducers will be too high to remove by filtering. For this reason, hydrophones have been selected as the appropriate sensor at these farther locations, to capture the implosion signal. Autonomous units will record data using a hydrophone and a solid state recorder sampling at 96 kHz (96,000 samples per second) or more. At the time of deployment, each hydrophone system will be field calibrated using a pistonphone calibrator, generating a 250 Hz tone at a known level for the type of hydrophone and calibration coupler. Within 6 months of the scheduled demolition blasting, the hydrophone (similar to the pressure transducer) will be laboratory calibrated by a service traceable to the NIST.

Table14 shows specifications for the monitoring equipment, similar equipment with appropriate frequency response ranges may be substituted in the near field as appropriate for smaller blast events.

Table 14. Anticipated Monitoring Equipment Specifications

Location	Sensor	Maximum Pressure	Transducer Frequency Range	Signal Conditioner Frequency Range	Data Acquisition/ Storage Rate
Outside BAS within 800 feet*	Pressure Transducer	1,000 psi	2.5 Hz to 1000 kHz	1 Hz to 1000 kHz	≥1000 kHz
Outside BAS within 800 feet	Hydrophone	100 psi	1 Hz to 140 kHz	1 Hz to 1,000 kHz	≥1000 kHz
Outside BAS at 1,500 feet	Hydrophone	100 psi	1 Hz to 140 kHz	1 Hz to 1,000 kHz	≥500 kHz
Outside BAS at greater than 1,500 feet	Hydrophone	100 psi	1 Hz to 140 kHz	1 Hz to 100 kHz	≥96 kHz

Notes:
*Similar equipment with appropriate frequency response ranges may be substituted as appropriate for smaller blast events.
BAS = Blast Attenuation System
Hz = Hertz
kHz = kilohertz
psi = pound per square inch
Source: Compiled by AECOM in 2017

7.3. Monitoring Plan

7.3.1. Monitoring Locations

The Department plans to monitor at three locations within 800 feet during all blast events. In addition, monitoring will be conducted from 1,500 feet and beyond during the Pier E6 implosion, the first two-pier blast event, and the first three-pier (or four-pier) blast event. All remaining blast events are anticipated to be well characterized and within authorized blast impact parameters. Monitoring within 800 feet will be sufficient to verify blast pressure and noise impacts for these remaining and subsequent blast events.

The Department is proposing to monitor only at near-field locations for subsequent blast events. The reduced monitoring points included in the 2017 monitoring plan relative to previous monitoring are supported by the robust data that was collected during the Pier E3 Demonstration Project in 2015 and the Piers E4 and E5 implosion events in 2016. This comprehensive data set will allow the Department to better interpret and analyze new data collected, using fewer data points.

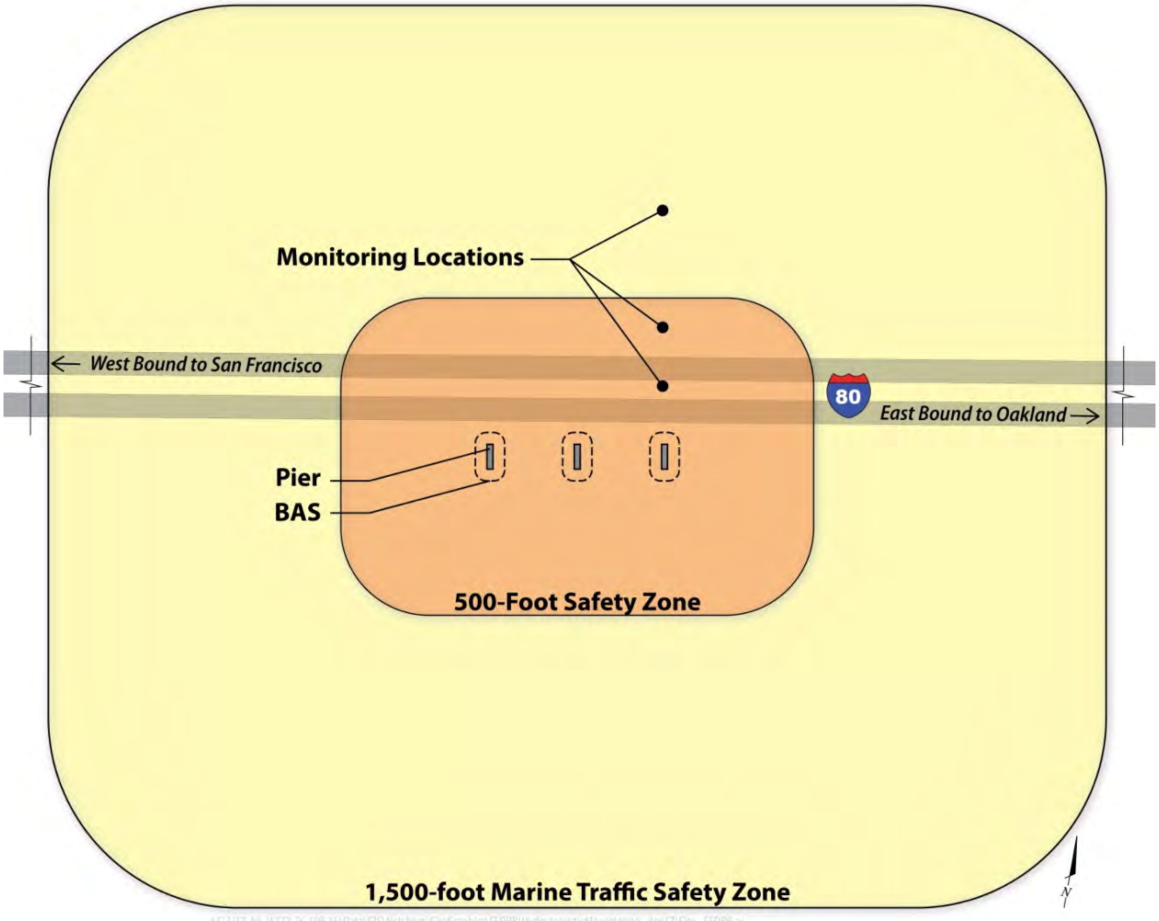
7.3.1.1. MONITORING ARRAYS

Perpendicular to the ~~north or~~ south face of the pier with the greatest total charge weight to be imploded during a blast event, a single measurement line will extend outward up to 800 ~~or 6,000~~ feet from that pier. All sensors will be deployed below the water surface to approximately mid-water column depth at the monitoring location. At monitoring locations that are outside the BAS and within 800 feet, three stations containing standard pressure transducers or hydrophones will be deployed. All sensors within 800 feet on an array will be connected to a high-speed data acquisition system. The array within 800 feet will be used during all blast events. Figure 18 shows a schematic of one potential blast event scenario with monitoring locations within 800 feet. Actual deployments will vary in the number of piers being imploded, the direction of the array (north or south), and which pier the array stems from, depending on the event scenario and field conditions.

During events that include monitoring in the far field, an additional array at and beyond 1,500 feet will be deployed to the north of the pier to verify impacts at greater distances. At the 1,500-foot station, a hydrophone with a high-speed data acquisition system will be used. This unit will be deployed from a boat and manually initiated before the blast by a technician on site. At the approximately 3,000-foot and 6,000-foot stations, autonomous units with hydrophones and solid state recorders will be used. Figure 19 shows a conceptual overview of one potential blast event scenario with monitoring locations within 6,000 feet. Actual deployments will vary in the number of piers being imploded, the direction of the near field array (north or south), and which pier the array stems from, depending on the event scenario and field conditions.

7.1. Signal Processing and Analysis

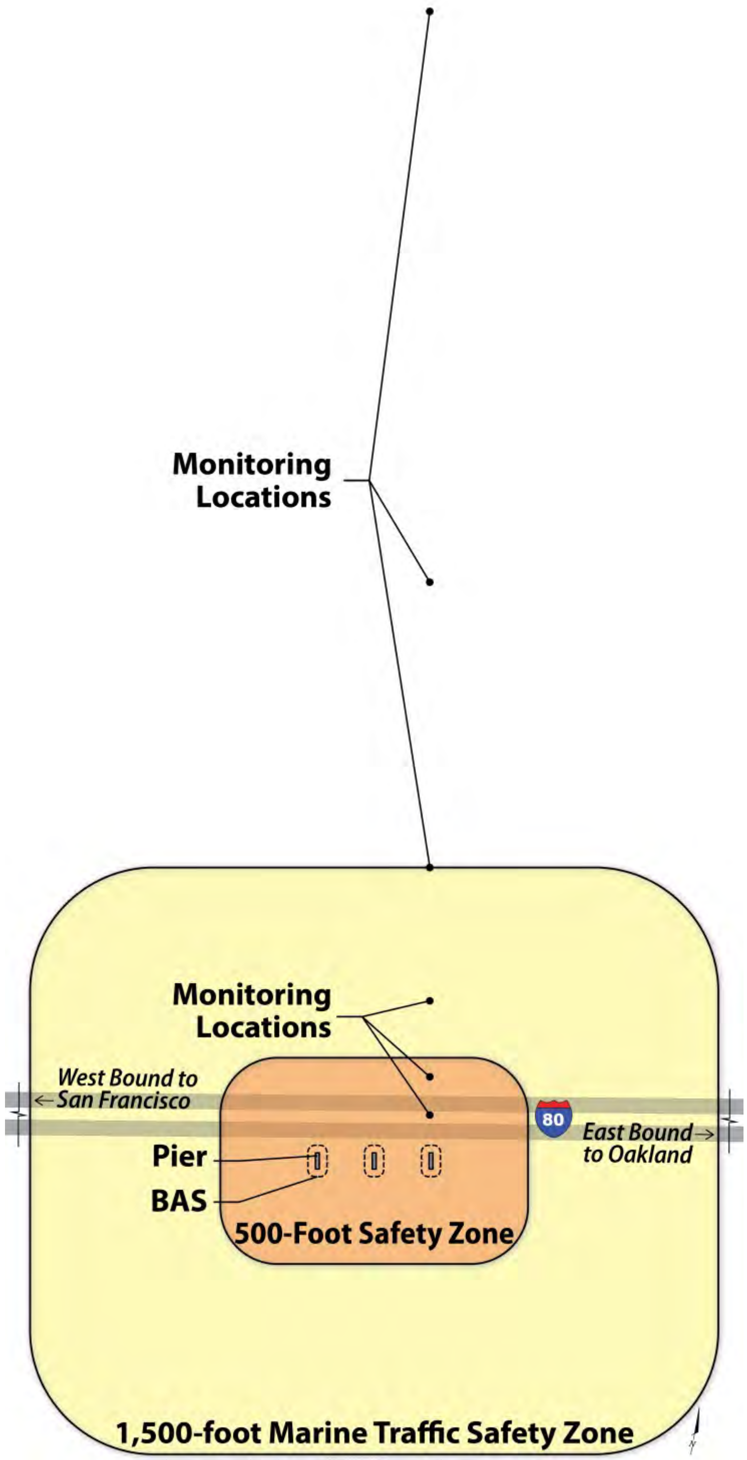
To compare with appropriate marine mammal and fish sound criteria, the controlled blast pressure signals will be analyzed to obtain peak pressure level, impulse, cSEL, and RMS levels. Data obtained will be analyzed first to determine peak pressures, assess data quality, and evaluate the performance of the BAS. The pressure transducers used to monitor within 800 feet are designed to capture the true peaks in signals with rapid rise times and have an inherent



Note: Actual locations to be determined in the field.

Figure 18. Conceptual Drawing Showing a Possible Near-Field Blast Pressure Monitoring Array

amount of high-frequency electronic noise. Because of this, the pressure time histories will record a high level of noise from the instrument. To eliminate this noise, each pressure transducer signal will be filtered using a low pass filter to reduce the high frequency content not caused by the blasting event. Based on the signal, acoustic cutoff frequencies used for the analysis will range from 8,000 to 50,000 Hz. Based on the data collected during the Piers E3, E4, and E5 implosion data, the hydrophone signals captured using high speed data acquisition systems will not contain the high frequency noise found with the pressure transducers and will not require filtering (Figure 17).



Note: Actual locations to be determined in the field.

Figure 19. Conceptual Overview Showing a Possible Near-Field and Far-Field Blast Pressure Monitoring Array

To compare with appropriate marine mammal and fish sound criteria, the implosion's pressure signals will need to be reduced and analyzed to obtain peak pressure level, impulse, cSEL, and RMS levels. To reduce the data from the measurement locations, the recordings will be scanned to isolate the implosion. The pressure versus time signals from the monitoring locations then will be processed using the same algorithm to calculate the required metrics. Peak pressure level is defined as:

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

where L_{pk} is the peak level in dB and P_{ref} is the reference pressure of 1 µPa. The acoustic impulse that is the time integral of the under positive peak pressure is given as:

$$Im = \int_{t_1}^{t_2} P(t)\ dt \qquad (2)$$

where $P(t)$ is the instantaneous pressure, t_1 is the time of the first zero cross of the positive pressure corresponding to L_{pk} and t_2 is second zero crossing of positive pressure. Cumulative SEL is given by:

$$cSEL \quad = 10\ Log_{10}\left(\int_0^T \frac{P^2(t)\ dt}{P_{ref}^2}\right) \qquad (3)$$

where T is the duration of entire implosion, $P^2(t)$ is the instantaneous pressure squared and T_{ref} is the reference time of 1 second. The RMS level is given by:

$$L_{RMS} = 10\ Log_{10}\left(\sqrt{\frac{1}{T_2-T_1}\int_{T_1}^{T_2}\frac{P^2(t)\ dt}{P_{ref}^2}}\right) \qquad (4)$$

where T_1 is the time at the beginning of the event and T_2 is the time at the end. The peak pressure level is determined by identifying the maximum pressure in the signal and calculating the level as defined in Eqn. 1. The other quantities defined in Eqns. 2 through 4 will be calculated using the numerical equivalent of these equations. For each of the quantities determined with Eqns. 1 through 4, a fall-off rate of the metric with distance will be determined using the near- and far-field data. These rates will be used to estimate the distance to which the respective criteria are exceeded.

Chapter 8. Bird Predation Monitoring Program

Bird predation monitoring will be conducted immediately after each pier implosion, to help assess the level to which fish are affected by the project. Bird predation is defined as birds attempting to prey or feed on other organisms. Monitoring of predation activity consists of counting bird strikes on the water surface. A bird strike on the water surface is not counted specifically as actively feeding or consumption; it is only informative of general bird activity and behavior.

8.1. Bird Strike Counts

Immediately after each implosion, avian monitors located on the bike path of the new SFOBB and potentially located on the marine foundation or in a boat along the MTSZ (as described in Chapter 4, "Avian Monitoring Program") will transition to monitoring for signs of bird strikes on the water's surface around the former pier. Lessons learned during the removal of Pier E3 suggested that debris present on the surface immediately following a pier implosion can be made up of a mixture of wood debris (from the blast mat), organic material (from the Bay bottom or outside the pier, barnacles or other invertebrates attached to the pier walls), mud, foam or bubbles (likely proliferated by the BAS), as well as fish, and that these materials can attract birds to the area. Specifically, the bird predation monitors will be focused on determining the extent to which birds are preying on dead or moribund fish (strikes) on the surface of the water. The monitors will use binoculars to observe and identify the species and size of any affected fish.

If birds are observed feeding on the surface of the water, 1-minute counts of bird strikes will be initiated. These counts will be repeated throughout the duration of the monitoring period. When feeding events are not observed, 1-minute counts will be conducted to provide recorded confirmation that feeding events did not occur. Diving and surface-scavenging birds that appear to scavenge fish from the surface will be recorded as a strike count. In addition, general bird activity and behavior will be noted and recorded, identified by species, during project activities and throughout the day.

8.2. Fish Collection

To further understand the relative quantity, species, and nature of injury or mortality to fish, biologists on-board boats will attempt to collect any dead or moribund fish from the water surface for further examination. This collection may be performed in two ways. First, if feasible, fish may be collected from the debris management boats operated by the contractor, which will be used to collect floating debris from the surface that is generated by the blast. Fish that are collected from the surface will be stored in a bucket for further identification and assessment on shore by a biologist. Second, biologists on-board dedicated boats will navigate around the pier(s) (when it is deemed safe to do so after the implosion) and will collect fish using long-handled nets. This will be conducted from a minimum of two boats per blast event, with one positioned south of the pier(s) and the other positioned north of the pier(s). All collected dead or injured fish will be recorded and photographed. A cursory physical examination will be performed on the fish, and any visible signs of barotrauma will be recorded. Any green sturgeon, ~~or~~ salmonids, or EFH species fish collected following the implosion will be preserved and transferred to NMFS, and any longfin smelt will be preserved and transferred to CDFW within 30 days of collection. Non-listed and non-EFH species will be discarded after they are recorded and photographed.

Chapter 9. Water Quality Monitoring Program

Water quality monitoring will be conducted during the controlled implosions and subsequent clean-up activities. This chapter includes a brief description of the monitoring strategy for both operations. The contractor prepared a Storm Water Pollution Prevention Plan (SWPPP) for the implosions of Piers E4 through E18, which was submitted to the Regional Water Quality Control Board (RWQCB) for review and was accepted on June 27, 2016. The SWPPP describes best management practices that will be employed during the course of the construction work, related to removing the remaining pier foundations. The SWPPP has been amended, as needed, to provide best management practices during the implosion of all piers.

Operations associated with controlled implosions will include both over-water and in-water activities. All activities with the potential to affect the Bay water will require monitoring, in accordance with Waste Discharge Requirements (WDRs) for the SFOBB Project, issued by the RWQCB on January 2002 (Board Order No. R2-2002-0011). A Sampling and Analysis Plan (SAP; Department 2017b) for construction activities not specifically related to the controlled implosion was prepared in accordance with Appendix B of the WDR, which includes a Self-Monitoring Program (SMP) related to in-water construction activities. A separate SAP has been developed for the 2017 implosion season (Department 2017c). The implosion SAP is based on the requirements in the WDR and the SMP, and has been tailored to address specific constituents of concern related to explosives and the specific schedule required for the implosions.

9.1. Waste Discharge Requirements Monitoring Background

Under the WDRs for the SFOBB Project, the Department is required to prevent increases of turbidity and chemicals of concern in amounts greater than those specified by the RWQCB. The Department will conduct monitoring and reporting activities as described in the WDR SAP, in accordance with the SMP. The purpose of the SMP is to document compliance with effluent requirements and prohibitions established for the SFOBB Project, and to facilitate self-policing by the Department for the prevention and abatement of pollution arising from dredging, fill and other activities that may affect water quality in the Bay. The SMP identifies water quality objectives (WQO) that must be met by the project to stay in compliance with the RWQCB permits. Table 15 shows the SFOBB WQO included in the SMP and based on the requirements set forth in the RWQCB Basin Plan for the Bay (RWQCB 2015). The SMP outlines turbidity control measures intended to protect eelgrass beds and other biological resources during in-water work, when work occurs within

Table 15. SFOBB Project Water Quality Objectives

Turbidity
Turbidity of the waters of the State, as measured in nephelometric turbidity units, will not increase above background levels by more than the following, to the extent practicable. Receiving Waters Background Incremental Increase Greater than or equal to 50 units, 10 percent of background, maximum
Floatables
Floating, suspended, or deposited macroscopic particulate matter or foam in waters of the State at any place more than 100 feet from the project boundary or point of discharge of return flow.
Petroleum Hydrocarbons
Visible floating, suspended, or deposited oil or other products of petroleum origin in waters of the State at any place.
Dissolved Oxygen
5.0 milligram per liter minimum. When natural factors cause lesser concentrations, then this discharge will not cause further reductions in the concentration of dissolved oxygen.
Dissolved Sulfide
0.1 mg/l maximum
pH
A variation of natural ambient pH by more than 0.5 pH units and within 6.5 and 8.5
Toxic or Deleterious Substances
None will be present in concentrations or quantities that may cause deleterious effects on aquatic biota, wildlife, or waterfowl, or that render any of these unfit for human consumption, either at levels created in the receiving waters or because of biological concentrations.
Note: Table text from Order No. R2-2002-0011 Source: RWQCB 2002

3,280 feet (1,000 meters) of an eelgrass bed or sand flat, also known as environmentally sensitive areas (ESAs). As discussed above, only water quality monitoring during the controlled implosions and post-implosion clean-up are discussed.

9.2. Implosion Monitoring Plan

Based on the results from the controlled implosions of Pier E3, E4, and E5, impacts on water quality are anticipated to be temporary and minimal for the remaining piers. To document impacts resulting from the controlled implosion, a separate SAP for the implosions of Piers E6 through E18 has been developed, based on the SMP in the SFOBB Project's WDR, Order No. R2-2002-0011 (Department 2017c).

Water quality monitoring will include a combination of the following four approaches, before and during the controlled implosions of Piers E6 through E18; ESA monitoring will be determined on a case-by-case basis, depending on location of the pier to be imploded in relation to the location of the closest ESA and the results observed from previous implosions:

- **Environmentally Sensitive Area (ESA) Monitoring (Piers E6 through E18)**: To confirm that the water quality in the vicinity of the eelgrass beds is not affected, continuous monitoring buoys will measure turbidity, pH, temperature, and conductivity in the water column near the ESA. Additional information regarding the buoys is presented below.

- **Water Quality Monitoring (Piers E6, E7, and E8):** Static water column profiling techniques consistent with the non-implosion SAP (Department 2017c) will be used. These procedures will be supplemented with the use of two fixed buoys positioned within 100 feet of the imploded pier (or as closely as can be safely achieved); one buoy north and one buoy south of the pier (i.e., based on the timing of the blasting, the plume could travel in either direction depending on tidal currents). These actions were deemed appropriate due to the similarity of conditions (in particular, pier size and water depth) of the 2017 implosions to previous implosions. The fixed buoys will provide continuous monitoring with multi-parameter sondes and data loggers for measuring turbidity, pH, dissolved oxygen, temperature, and conductivity at mid-depth.

- **Dynamic/Static Plume Mapping (Piers E9 through E18)**: Dynamic and static water column profiling techniques will track the dispersion of the plumes generated by the pier implosions over a 4-hour window, following the implosion. Dynamic plume profiling will consist of towing a continuously monitoring array, to define the three-dimensional shape of the plume, while static profiling will include raising and lowering a monitoring device from a stationary vessel. Drogues, which travel with tidal currents, will be used to help track the movement of the plume and guide the profiling effort.

  For each multiple-pier implosion event, the dynamic plume mapping would occur along the expected plume path from the eastern-most pier; this will enable tracking of the plume and define any possible interaction path with nearby ESAs. For each multiple-pier implosion event, static profiling would occur along the expected plume path from the western-most pier; this will define the plume from this western-most pier which is expected to generally parallel the travel path of the eastern-most pier plume. Monitoring the progress of the western-most and eastern-most plume paths creates an enveloped area of all plumes generated by a multiple pier blasting event.

- **Sediment Quality Assessment:** Sediment analysis will be conducted before and after the implosions, to measure potential benthic effects and attenuation rates. A random stratified sampling design will be implemented to test the spatial variability of sediment chemistry (i.e., trace metals and pH). Toxicity measurements at the sediment-water interface will be taken only where post-implosion trace metal chemistry sample readings are statistically significant as defined in the implosion SAP (Department 2017c).

Each approach is described further in the subsequent sections.

9.2.1. Dynamic Plume Mapping with Drogues

9.2.1.1. Drogues

Drogues will be deployed to track the water current, and therefore the plume resulting from the implosion. The drogues are floating monitoring devices, capturing geo-spatial data in real-time. Drogues will be suspended from a surface float at a target depth determined by the length of a suspension line and will hang vertically in the water column perpendicular to the direction of the current flow. Attached buoys with GPS sensors and radio transmitters will send drogue position coordinates to the plume mapping vessel. Drogues will be deployed in pairs after the implosion, to move with the current and track the plume in real-time.

9.2.1.2. Dynamic and Static Plume Mapping

Before the implosion preparation activities begin on the morning of the event, a background sample will be taken at approximately 900 feet (274 meters) from the pier(s) that is/are scheduled for implosion, to establish baseline conditions. The water quality team will be positioned in marine vessels in the staging areas north or south of the implosion event site, depending on the anticipated direction of the current.

When safety restrictions are lifted after the controlled implosion event, the sediment plume will be monitored by a marine vessel and guided by the current-tracking drogues, as described above. In accordance with the draft SAP and guided by the drogues, the water quality of the plume will be monitored by taking measurements within or as close as possible to the plume. Specifically, a sonde will measure depth-averaged conductivity-temperature-depth, turbidity, pH, and dissolved oxygen, using a towed monitoring array to capture a dynamic three-dimensional analysis of the plume as well as a static analysis using a sonde from the vessel. Standard observations also will be performed, as defined in the WDR's SAP (Brown and Caldwell, and AMEC Foster Wheeler 2016). Vessel-based monitoring will cease when the monitoring data are consistent with the baseline data.

9.2.2. ESA Monitoring

Water quality monitoring buoys will be deployed near environmentally sensitive areas that contain eelgrass beds, as required by the WDRs. The ESAs near the project area include those at the Oakland Touchdown and west of the Emeryville Marina. ESA monitoring at YBI and Treasure Island are not planned because no observable changes in water quality parameters were observed during the implosions of Pier E3, E4, and E5; Piers E6 through E18 are located further from YBI and TI than Piers E3 through E5; and the eelgrass beds at the Emeryville Marina and the Oakland Touchdown are located closer to the piers where controlled implosions are planned.

Water quality sensors will be suspended from each monitoring buoy below the water surface. Each monitoring sensor will measure turbidity, pH, temperature, and conductivity. Water quality logging instrumentation will be a YSI 6920 V2-2 Environmental Monitoring System or equivalent. On each day of an implosion event, buoys will continue logging water quality data until sunset after each event to monitor any other potential effects.

9.2.3. Sediment Quality Assessment

Based on results from the implosions of Piers E3, E4, and E5, impacts to benthic habitat and sediment toxicity following each implosion event are expected to be minimal. It is expected that sporadic occurrences of elevated metals (i.e., lead) in sediment samples will continue to be found in pre- and post-implosion sediment sampling in the area around Pier E6 through Pier E18. Pre-implosion sampling will provide additional characterization of the background frequency for observing elevated, heterogeneous lead concentrations in sediments. As indicated by prior monitoring, no increase in toxicity is associated with elevated lead concentrations in sediments, thus toxicity testing will not be performed on pre-implosion sediment samples.

Post-implosion sediment samples will assess whether metal concentrations in the work area are comparable to the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) which establishes ambient conditions in the Bay. For any of the post-implosion sediment samples where metals concentrations exceed the 95 percent confidence interval of the mean RMP concentration for Central San Francisco Bay, follow-up sampling will be conducted at the location of interest to confirm the metals concentration and perform toxicity testing. Toxicity results for any post-implosion confirmation sediment samples will be compared to RMP ambient conditions. Toxicity testing will be evaluated at the surface-water interface core toxicity by assessing the response of mussel larvae. The sediment sampling will take place within 1 month of the implosions and within 1 month after clean-up activities have taken place.

Pre- and post-implosion sediment sampling locations will be selected by dividing the samples between locations in relatively deep water (Pier E6 to Pier E10) from locations in relatively shallow water (Pier E11 to Pier E18). Six sample locations were randomly selected from these two areas – deep and shallow – for a total number of twelve sample locations. At these random locations, sediment samples will be analyzed for sediment chemistry (i.e., trace metals and pH) and sediment-water-interface toxicity will be measured only for those samples that meet appropriate criteria (as previously defined).

9.2.4. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) samples, including duplicates and field and equipment blanks, will be collected so as to make up 10 percent or more of the total samples collected. A State-certified laboratory will perform standard QA/QC procedures to determine the accuracy of the water sample data. In addition, the buoy monitoring data will be calibrated to NIST standards before deployment. Following recovery, data will be compiled and transformed into depth-averaged water quality, for monitoring stations where multiple logging devices are deployed.

9.2.5. Post Implosion Clean-up Monitoring

Monitoring will be conducted during the post-implosion clean-up activities in accordance with the WDR monitoring, as described in Section 9.1, "Waste Discharge Requirements Monitoring Background." Background samples will be taken daily during in-water post-implosion clean-up activities, to establish baseline conditions. Samples taken within the vicinity of the project site, in accordance with the SMP, will be compared to the baseline conditions and the WQOs, as described in Table 15.

Chapter 10. Test Charge Monitoring

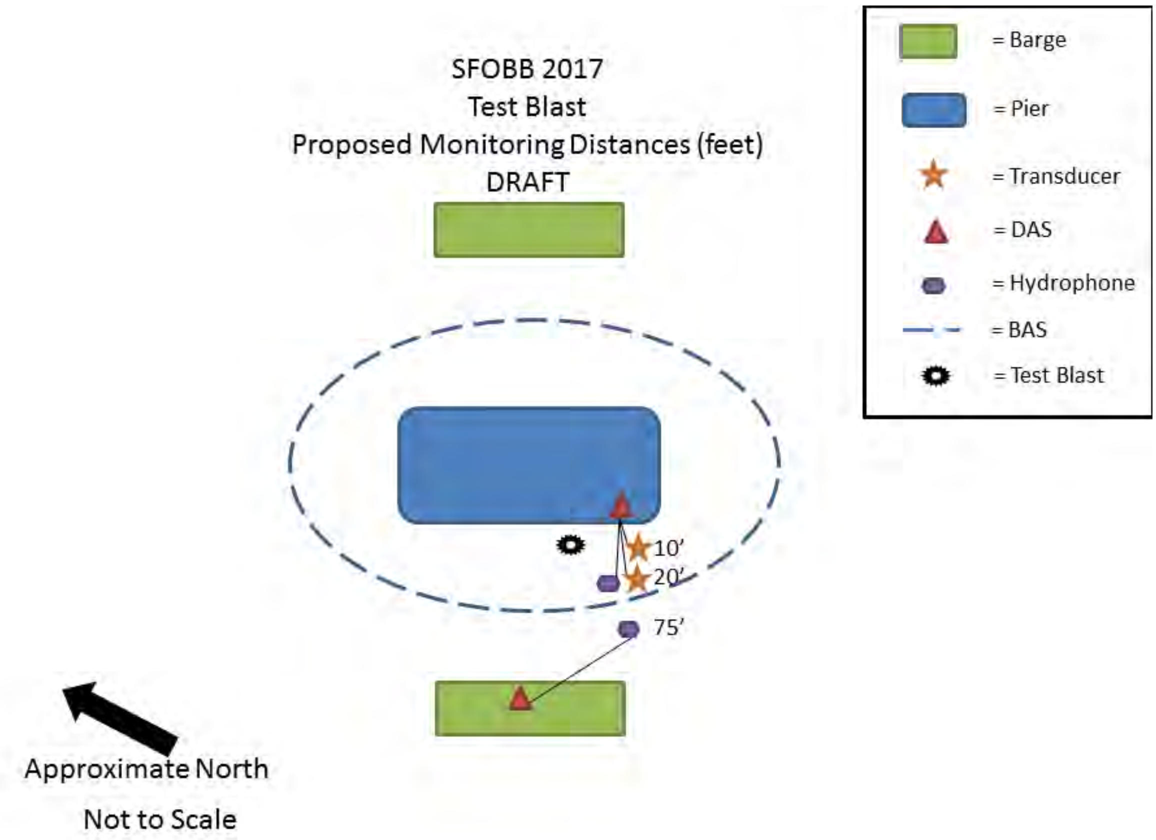
Release of small test charges at the beginning of the implosion season may be conducted, if necessary, to verify and confirm that all equipment is functional, and to set the triggering parameters for the implosion events. In 2015 at Pier E3 and in 2016 at Pier E5, test charges were measured inside and outside the BAS, at distances of 30 feet and 100 feet, respectively. Based on the experience gained from the previous test blasts, the Department expects that it may elect to discharge up to two test charges at separate times within a single day of testing.

10.1. Scheduling and Testing

Test blasts will be conducted within the completely installed and operating BAS so that the hydroacoustic monitoring equipment will be properly triggered and functional before the start of the pier implosion events. Multiple test blasts may be required on the same day, to verify proper instrument operation and calibrate the equipment for the implosion events. These same instruments and others of the same type will use high-speed recording devices to capture hydroacoustic data at both near-field and far-field monitoring locations during the implosions.

Tests will use individual charges, with a charge weight of approximately 18 grains (0.0025 pound) or less. During tests, a charge will be placed along one of the longer faces of the pier and inside the BAS while it is operating. Because of the minimal size of the test blast charge and the high thresholds of the pressure transducers, they will need to be deployed inside the BAS. This monitoring is not intended to verify the already established efficiency of the BAS but to test the trigger response of the pressure transducers. Results from test blasts that occurred before the implosions of Piers E3 and E5 indicate that these test blasts will have negligible impacts on fish and no impacts on marine mammals (see Appendix A: Measured Test Blast Levels).

Acoustic measurements during the test blast will be made with the same instrumentation to be used for the near- and far-field monitoring of the actual implosion events. The location of the equipment is shown in Figure 20. Measurements inside the BAS will be made with high speed data acquisition systems, using pressure transducers and hydrophones. At a distance within 10 feet, the system will use a pressure transducer. At the 20-foot monitoring location, the system will use a pressure transducer and a hydrophone. At the 75-foot monitoring location, only a hydrophone will be used.



Source: Compiled by AECOM in 2016

Figure 20. Test Charge Location and Hydroacoustic Monitoring Locations

Before activating the BAS, ambient noise levels will be measured. While the BAS is operating and before the test, background noise measurements also will be made. After the test, the results will be evaluated to determine whether any final adjustments are needed in the measurement systems before the implosions. Pressure signals will be analyzed for peak pressure and SEL values before the scheduled time of the implosions.

10.2. Biological Effects of the Test Charge

Release of each test charge will occur in the water between the pier structure and the bubbles produced by the BAS. The test charge will produce an underwater pressure wave that will be evaluated against the fish, avian, and marine mammal acoustic thresholds, presented in Chapter 7, "Hydroacoustic/Underwater Pressure Monitoring Program."

10.2.1. Fish

Based on the results of test blasts conducted on Piers E3, E4 and E5 for a single-test charge within a BAS compared to the noise criteria established by the FHWG and implemented by CDFW and NMFS for the SFOBB Project, impacts are expected to be below the 206 dB Peak, 187 dB cSEL and 183 dB cSEL within 30 feet of the test charge. Based on these same criteria and test blast results, there would be no impact outside of the BAS from the test charges to fish. Based on the results of the test blasts conducted in 2015 and 2016, test blast and the seasonal avoidance window implemented for all blasting activities, impacts on federally listed salmonids or green sturgeon from the test charge are not expected, and impacts on the State-listed longfin smelt are not expected. Similarly, impacts on the other managed fish species from the test charge are anticipated to be negligible and short-term.

10.2.2. Marine Mammals

Hydroacoustic measurements collected during the 2015 test blast at Pier E3 were used to estimate distances to former marine mammal acoustic thresholds for TTS that were in place in 2015. In 2016, NMFS established new marine mammal acoustic thresholds for underwater explosives, based on NMFS (2016) and Finneran and Jenkins (2012) studies. Hydroacoustic measurements collected during the 2016 test blast at Pier E5 were compared against the new 2016 marine mammal acoustic thresholds for underwater explosives. Table 16 shows measured SPLs from the Pier E5 test blasts, compared to phocid pinniped (i.e., harbor seal and elephant seal) and high-frequency cetacean threshold criteria (i.e., harbor porpoise), at a distance of 100 feet (30 meters) from the blast (just outside the BAS). SPLs from the Pier E5 test blasts did not reach or exceed thresholds for harassment of marine mammals, beyond the bubble flux of the BAS. Because of the force of the bubble flux and absence of buoyancy in the bubble field, it will not be possible for a marine mammal to swim through the bubble flux and be exposed to near field SPLs. Therefore, no impacts on marine mammals are anticipated from the test charge.

As a conservative measure, one MMO will be on-site during all test blasts, to monitor the movement and response of marine mammals in the area.

10.2.3. Birds

Chapter 4, “Avian Monitoring Program,” presents the background of the 202 dB cSEL regulatory criteria for avian auditory injury from underwater sound. Hydroacoustic monitoring results from the Piers E3 and E5 test blasts were used to calculate the distance to the 202 dB cSEL threshold. These results show that the 202 dB cSEL criteria may have occurred within less than 5 feet from the point of discharge which is within the turbulence of the BAS. The

Table 16. Measured Pier E5 Test Blast Sound Levels Compared to Phocid Pinniped and High-Frequency Cetacean Threshold Criteria

Species Group	Threshold	Pier E5 Measured Test Blast Levels at 100 feet (30 meters)
Phocid Pinniped (harbor seals and elephant seals)	**Behavioral Response**	
	165 dB cSEL (P_{WI})	134.4 to 138.3 dB cSEL (P_{WI})
	Temporary Threshold Shift	
	170 dB cSEL (P_{WI})	134.4 to 138.3 dB cSEL (P_{WI})
	212 dB peak SPL	150.6 to 157.1 dB peak SPL
	Permanent Threshold Shift	
	185 dB cSEL (P_{WI})	134.4 to 138.3 dB cSEL (P_{WI})
	218 dB peak SPL	150.6 to 157.1 dB peak SPL
High-Frequency (HF) Cetaceans (harbor porpoise)	**Behavioral Response**	
	135 dB cSEL (HF_{II})	118.5 to 124.4 dB cSEL (HF_{II})
	Temporary Threshold Shift	
	140 dB cSEL (HF_{II})	118.5 to 124.4 dB cSEL (HF_{II})
	196 dB peak SPL	150.6 to 157.1 dB peak SPL
	Permanent Threshold Shift	
	155 dB cSEL (HF_{II})	118.5 to 124.4 dB cSEL (HF_{II})
	202 dB peak SPL	150.6 to 157.1 dB peak SPL

Note:
The thresholds for phocid pinnipeds and HF cetaceans are lower than the thresholds for other pinnipeds and cetaceans. Therefore, take of any marine mammal species during test blast activities is not anticipated.
Threshold Source: NMFS 2016
Measured Test Blast Levels: Appendix A

Department's calculated distance for potential auditory injury to birds was conservative and was slightly higher than the measured cSEL levels. Based on these results, the Department will monitor bird activity as part of the regular construction monitoring but will not establish any exclusion zones beyond the influence of the turbulence from the BAS.

Each test blast will occur in a fraction of a second, and the Department does not anticipate any impacts on diving birds during test blasts. Based on the results of past implosions, the Department will use the monitoring protocol outlined in the Department's BMMP and BMP for the test blasts, associated with removal of Piers E3 and E5 (Section 4.3). The Department will monitor for birds immediately before, during, and following each test blast. Deterrents may be used to encourage birds to leave the test blast area. Avian deterrents are described in Chapter 4, "Avian Monitoring Program." Data from past test blasts will refine the avian monitoring protocol for the test blasts associated with removal of Piers E6 through E18, as necessary.

Chapter 11. Hydrographic Surveys and Infill Monitoring

The Department will perform a hydrographic survey at each pier location, using a small vessel with side-scan sonar equipment before removal, immediately after removal, and following site clean-up. These surveys will be performed to determine existing conditions before removal, to verify that pier removal was achieved, and what, if any, additional debris management will be required. Hydrographic surveys at the end of each year after blasting is complete will aid in providing final verification that each pier has been removed to the removal limits and in confirming that regulatory requirements have been met. For Piers E4 through E18, after consultation with regulatory agencies, the Department defined the mudline elevations and removal limits, and it has committed to removing the foundations to these agreed on limits. The mudline was defined as the lowest elevation of the natural mudline adjacent to and outside any scoured pit surrounding an object in the Bay. Removal limits were defined as, at a minimum, 3 feet below the mudline. Approximate mudline and removal limit elevations for Piers E4 through E18 are shown in Table 17.

Table 17. Approximate Mudline and Removal Elevations of Original East Span Marine Foundations

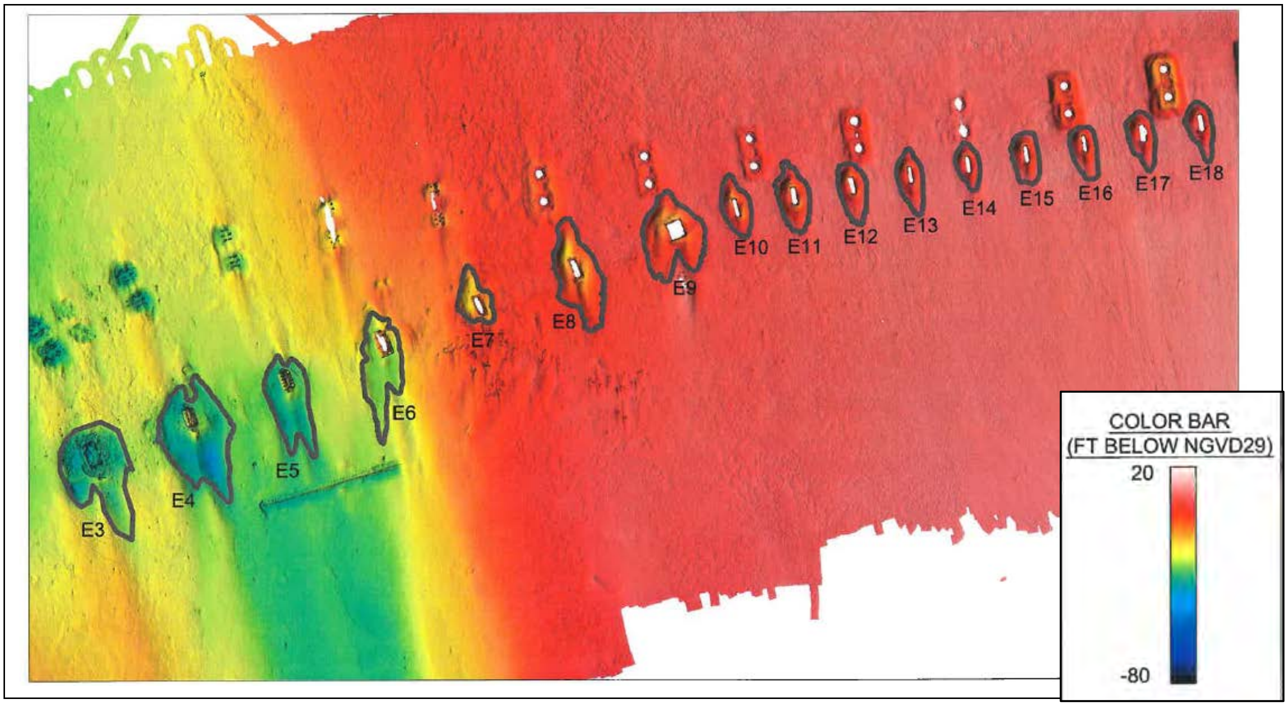
Pier Number	Mudline Elevation (feet)	Required Removal Elevation (1.5 feet below mudline) (feet)	Planned Removal Limits (3 feet below mudline) (feet)
E4	-45.0	-46.5	-48.0
E5	-47.5	-49.0	-50.5
E6	-40.0	-41.5	-43.0
E7	-28.0	-29.5	-31.0
E8	-19.0	-20.5	-22.0
E9	-17.5	-19.0	-20.5
E10	-18.0	-19.5	-21.0
E11	-14.0	-15.5	-17.0
E12	-14.0	-15.5	-17.0
E13	-14.0	-15.5	-17.0
E14	-15.0	-16.5	-18.0
E15	-12.5	-14.0	-15.5
E16	-12.5	-14.0	-15.5
E17	-12.5	-14.0	-15.5
E18	-12.5	-14.0	-15.5

Note:
All elevations use National Geodetic Vertical Datum 1929.
Source: Caltrans 2016; compiled by AECOM in 2016

Each pier foundation is in a scoured hole that is measurably deeper than the natural surrounding Bay floor. Since their original construction, a local scour has developed around each pier. As currents in the Bay flow past each pier, the water is forced to speed up as it is pushed into the pier. This localized increase in current speed around each pier allows the water to pick up the sediment around the pier and effectively digs a hole around the solid structure. After pier removal, sediment will redeposit at all former pier locations, and the scoured areas will return naturally to the surrounding mudline elevation. Similar effects of sediment infill from river mechanics are seen in the Bay's shipping channels that fill regularly with sediment, carried by watershed and tidal flows.

Based on the accepted mudline elevations, the Department determined appropriate sediment infill monitoring for scoured areas around each pier location (Appendix B: Sedimentation Analysis Boundary Establishment). These same areas will be used in all monitoring analyses, to determine sediment infill after pier removal. At the end of each year, the Department will conduct annual hydrographic surveys of each former pier location, to determine the rate of sediment infill in the remaining scoured pits. Sonar scans obtained from hydrographic surveys can be compared to the original post-cleanup sonar scans, to track and judge the Bay floor recovery. The sediment infill rate will be determined by quantifying the volume of accretion and erosion occurring in the remaining scoured pit after each pier removal. All annual surveys will quantify infill within a set scour pit boundary, based on mudline elevations for Piers E4 through E18 (Figure 21/Appendix B). The Department has monitored or will monitor per the following schedule:

- Surveyed the former Pier E3 location in December 2015;
- Surveyed the former Piers E3, E4, and E5 locations before the end of 2016;
- Will survey the former Piers E3, E4, E5, E6, E7, E8, E9, E10, E11 E12, E13, E14, E15, E16, E17, and E18 locations by the end of 2017; and
- Will conduct an additional survey of Piers E3, E4, E5, E6, E7, E8, E9, E10, E11 E12, E13, E14, E15, E16, E17, and E18 locations by the end of 2018.
- Additional surveys may be conducted after agency review of 2018 results as required by project regulators if it is determined that additional data is needed to demonstrate adequate back fill. A stand-alone memo summarizing the survey results from the 2018 will be submitted for agency review.



Source: Kiewit Manson 2017

Figure 21. Scour Pit Boundaries for Infill Monitoring (based on Approximate Mudline Elevations)

- Hydrographic survey imagery and a narrative of the results from 2017 will be included in the Annual Report, to be submitted by February 15, following year. As part of the hydrographic survey reporting, the Department will include information on the debris management operations at each pier.

Scour pit sediment infill monitoring results for monitored former pier locations also will be included in the Annual Report. The Department will include an estimate of accretion based on results from the hydrographic surveys in the Annual Report by February 15 of the subsequent year. The results summary will analyze and describe the change in area and estimated volume of sediment accretion, or infill, at each monitored location. After these surveys are completed, the Department will analyze the data and discuss the findings with its partnering agencies, including the BCDC, the RWQCB, and USACE, to determine whether further monitoring will be necessary and to assure that these locations are being naturally restored to surrounding mudline elevations. The success criteria for this monitoring operation will be determined on whether a positive infill trend is exhibited at the former pier locations within the scope of the proposed monitoring. The Department's goal will be to verify that these areas will infill to surrounding mudline elevations over time.

Chapter 12. Reporting

The Department will provide preliminary results to the respective regulatory agencies as required by project permits. The following is a brief summary of the reporting timelines for each of the resource monitoring efforts for the implosion events. A comprehensive Annual Report, summarizing the results from the implosions of Piers E6 through E18, will be prepared by February 15, 2018 and will be submitted to all of the Department's partnering agencies, including the BCDC, CDFW, NMFS, the RWQCB, USACE, and USFWS. The Annual Report will include a summary of results from marine mammal monitoring, avian monitoring, hydroacoustics monitoring, fish assemblage and mortality monitoring (including bird predation monitoring), water quality monitoring, and hydrographic surveys. The Annual Report will include lessons learned and recommendations for improvements for future implosions. Specific reporting timelines, as stipulated in individual permits, will be met with separate reports from the Annual Report, if necessary, to meet permit requirements.

12.1. Marine Mammal Reporting

The NMFS Chief of the Permits and Conservation Division, Office of Protected Resources will be notified of the scheduled implosion dates, in advance of implosion activities. NMFS will be notified of any delays or changes in the implosion schedule.

In accordance with the IHA, a monitoring report will be submitted to NMFS 90 days after construction activities or expiration of the 2017 IHA. The report will detail the monitoring protocol, summarize the data recorded during monitoring, and estimate of the number of marine mammals that may have been behaviorally harassed by the implosion activities, and will determine whether any marine mammals were exposed to TTS, PTS, or suffered physical injuries. The report will include results from the test charge blast(s), if conducted, the Pier E6 through E18 implosions, and the stranding surveys. A summary of the marine mammal monitoring effort for the 2017 implosion season will also be included in the comprehensive Annual Report, as described above.

12.2. Avian Reporting

The Annual Report will summarize avian monitoring data collected prior to and during pier implosion events, including avian watch zone monitoring results and monitoring during clean-up activities. Information regarding any dead or injured birds observed and/or collected in the project area during all construction operations will be provided.

Additionally, the SFOBB Project maintains compliance with the terms and conditions found in its USFWS BO and CDFW ITP which include providing weekly bird monitoring reports to these agencies. Results from the bird monitoring conducted before and immediately following each implosion event will be summarized and included in the ongoing weekly bird monitoring reports, prepared for the SFOBB Project. The results from each implosion event will be included in the following week's report and will be submitted to CDFW and USFWS. The weekly reports will include the monitor logs, the names of the avian monitors, their positions during the pier removal activity monitored, the number and location of birds/nests sighted, and actions taken when the birds/nests were observed.

12.3. Pacific Herring Reporting

If debris removal work occurs during the herring spawning season (December 1 through February 28), daily monitoring reports will be prepared by the Department and will be submitted to appropriate staff at CDFW on a weekly basis. Daily Pacific herring monitoring reports will use the CDFW monitoring form template and will include the following:

- The number and types of project activities;
- A description of any large masses of fish congregating in the area around the work area, including location information; and
- A description of the species captured and identified (if required).

12.4. Hydroacoustics Reporting

The Department will be providing a final report for all blast events in 2017 as well as summaries of preliminary results after each blast event. All of the digital field records (raw files) from the pressure transducers and hydrophones will be reviewed and compiled by monitoring technicians in the field within 3 business day after each controlled blast. The actual, as deployed, positions of the monitoring stations, water depth, sensor depth, and distance/orientation to the pier(s) will be documented. After all field measurements are collected, peak pressure level, impulse, cSEL, and RMS SPL will be reported for each monitoring location. From the collected data, the estimated distance to the respective fish and marine mammal criteria will be calculated to ensure that incidental take limits are not exceeded for each blast event. Equipment calibration and test charge verification procedures will be provided in the Annual Report.

Following each blast event, a summary of preliminary monitoring results will be provided to BCDC, NMFS, and CDFW as soon as they are available. A draft report containing a full analysis of the hydroacoustics results from Piers E6 through E18 will be submitted to NMFS and CDFW for review within 60 days of the last implosion, and a summary of the final results will be included in the Annual Report.

12.5. Fish Assemblage and Mortality Reporting

Within 3 business days of each implosion, preliminary results of the fish assemblage survey (or sonar survey) and the bird predation and fish collection monitoring will be submitted to the BCDC, CDFW, and NMFS. The preliminary results will describe any large assemblages of fish observed before the blast, and any dead or injured fish observed and/or collected after the blast. Within 3 business days, a memorandum summarizing the results of the bird predation monitoring will be submitted to BCDC, CDFW, and NMFS. A summary of the fish assemblage and mortality results will be included in the Annual Report.

12.6. Water Quality Reporting

After the controlled implosion of the piers, the Department will submit a comprehensive water quality report to the RWQCB and USACE. The draft summary report and a final report will contain the following, at a minimum:

- A compliance evaluation summary, including descriptions of exceedances of receiving water limitations or water quality objectives, the duration of the exceedances, and corresponding observations and data;
- Monitoring methods, equipment, data, photography and videos, including DVDs with all water quality logging data;
- Contingency reporting, as described in the SMP;
- An estimate of the total amount of sediment that was suspended and subsequently deposited;
- A summary of standard observations, as defined in the WDR issued to the SFOBB Project;
- Discussion regarding the effectiveness of the monitoring methods;
- Assessment of the impacts on special aquatic sites; and
- Data to be used for calibration and refinement of the three-dimensional hydrodynamic and sediment transport model for subsequent demolition activities.

Because of the number of implosions scheduled for 2017, a draft summary report for the 2017 implosion season will be prepared by April 2018, and a final report will be prepared by June 2018 or as directed by the RWQCB. Because of the long lead time for certain laboratory analyses, a summary of the preliminary results will be included in the Annual Report.

12.7. Test Charge Reporting

If the Department elects to conduct a test charge, it will submit the test charge monitoring results for avian monitoring as part of the ongoing weekly bird monitoring reports, described above. Hydroacoustic results from the test charge will be included in the draft and final implosion hydroacoustics reports, as described in Section 12.4. All monitoring results from the test charge, including marine mammal results, will be included in the Annual Report.

12.8. Hydrographic Survey Reporting

12.8.1. Sedimentation Monitoring

The Department will include results from the hydrographic surveys in the Annual Report. The results summary will analyze and describe the change in area and estimated volume of sediment accretion at each monitored location. After these surveys are completed, the Department will analyze the data and will discuss the findings with its partnering agencies, including the BCDC, the RWQCB, and USACE, to determine whether further monitoring will be necessary and to assure that these locations are being naturally restored to surrounding mudline elevations. The success criteria for this monitoring operation will be determined by whether a positive infill trend is exhibited at the former pier locations within the scope of the proposed monitoring. The Department’s goal will be to determine a reasonable projection for when these areas will infill to surrounding mudline elevations.

12.8.2. Debris Management

As part of the hydrographic survey reporting, the Department will include information on the debris management operations at each pier. This information will include the estimated area of the debris that was managed and the estimated volume of material that was removed and disposed.

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Appendix A. Measured Test Blast Levels

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Preliminary Summary of Test Blast Results

Test blasts were conducted during a low slack tide on November 5, 2015 alongside Pier E3 in order to assess the measurement techniques to be used for hydroacoustic monitoring of the Pier E3 Demolition Implosion scheduled for November 14, 2015. The source was an 18 grain blasting cap positioned approximately 20 feet from Pier E3 at a depth of 20 feet below the surface. Illingworth & Rodkin, Inc. (I&R) monitoring locations were 20 feet and 75 feet away from the Pier and the blast, as illustrated in the sketch shown in Figure 1. The depths of both sensors were 20 feet below the water surface. The data acquisition systems were placed on the Pier and on the barge supporting the compressors used for the eastern half of the blast attenuation system (BAS). A third location was also monitored from the barge at the southwest corner, at a distance slightly more than 100 feet from the blast, at a depth of 20 feet. Two blasts were produced and monitored; one while the BAS was supplied with air at 30 psi and one approximately 20 minutes later while the BAS was supplied with air at 100 psi.

The peak sound pressure levels measured for the first blast are shown in Figure 2 superimposed on a photograph of the measurement set up as viewed from the barge. The results for both blasts are shown in Table 1. The modeled results for peak pressure and cumulative SEL are shown in Table 2. The reported values include the peak pressure level, the SEL, and the RMS level, as monitored at both the 20-foot and 75-foot distances. The levels at Location 3 (100 feet) were too low to be measured relative to the background noise due to the ambient and instrumentation noise. Ambient levels were measured to be approximately 140 dB at 20 feet, 119 dB at 75 feet, and 139 dB at 100 feet.

The levels at Location 1 (20 feet) were lower than expected; however, it appears that these measurements were actually made within the BAS bubble stream. The signals at this location were only slightly higher than the background ambient noise, and reported levels may be actually inflated by this background noise. The pressure signals at Location 2 (75 feet from Location 1) propagated more fully through the BAS and are significantly lower in level. The difference between Blast 1 and Blast 2 was different at Locations 1 and 2. Close to the blast at Location 1, the higher air pressure supplied during Blast 2 resulted in lower levels for all three metrics, as compared to Blast 1. At Location 2, the different metrics for Blast 2 ranged from slightly lower to slightly higher than Blast 1. The actual pressure versus time histories for Locations 1 and 2 were quite different on account of the differences in the metrics. Given that there are only two measurement locations, one being within the BAS and the other outside the BAS, a fall-off rate for these cannot be determined. When compared to the noise criteria established by the National Marine Fisheries Service, however, the levels at 75 feet are below the 206 dB peak pressure criteria for injury to all fish, below the 187 and 183 dB SEL criteria for injury to fish greater than and less than 2 grams, respectively, and below the 150 dB RMS criteria for behavioral response to fish.

Table 1: Test Blast Noise Levels

Pier E3 Data (20ft from Blast)			
Metric	Blast 1	Blast 2	Reference
Peak	207.1	201.9	dB re 1µPa
SEL	180.9	178.2	dB re 1µPa2-sec
RMS	192.6	189.2	dB re 1µPa

Barge Data (75ft from Blast)			
Metric	Blast 1	Blast 2	Reference
Peak	153.9	157.1	dB re 1µPa
SEL	136.4	135.9	dB re 1µPa2-sec
RMS	142.7	149.1	dB re 1µPa

Table 2: Predicted Peak Pressures by Distance

Criteria	
Distance	**PEAK Level**
20 feet from blast	235 dB
88 feet from blast	206 dB
100 feet from blast	205 dB

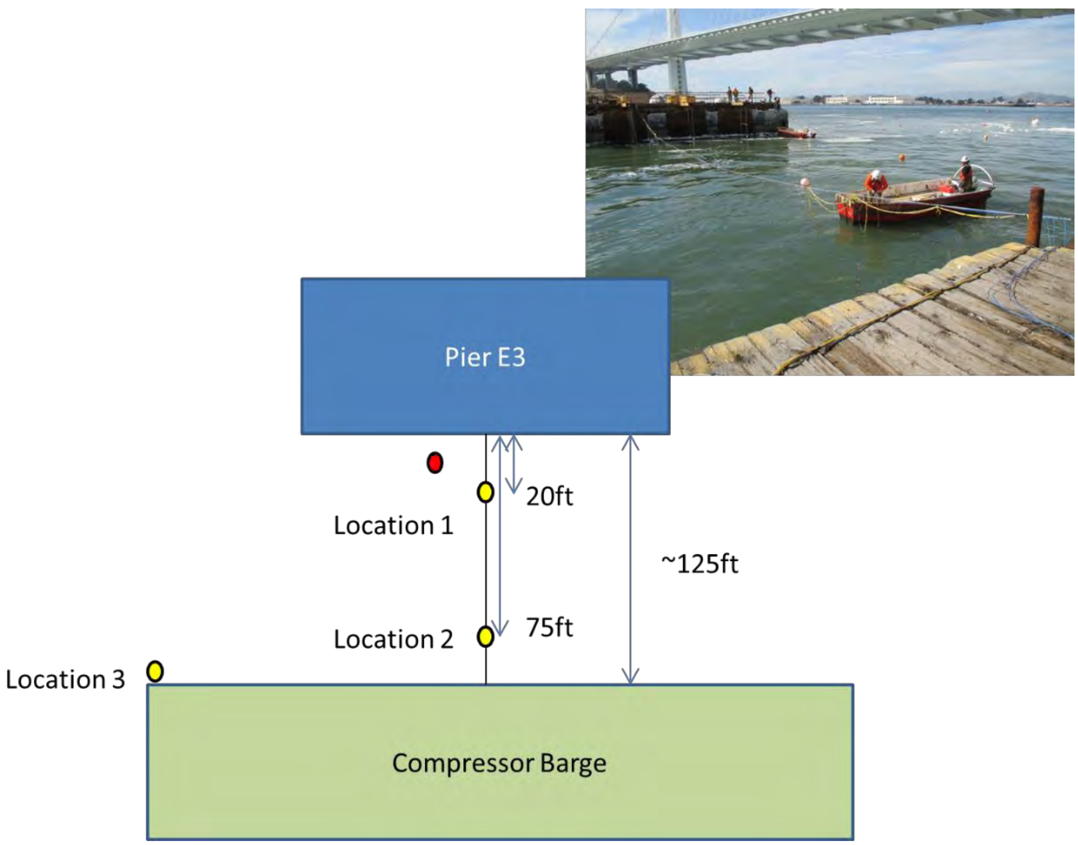

Figure 1: Test blast measurement geometry sketch

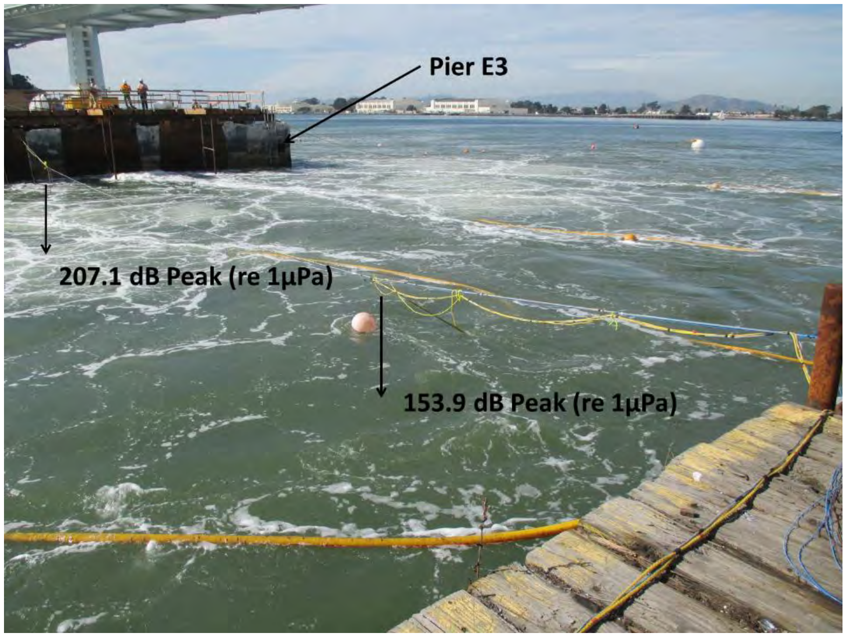

Figure 2: Photograph test blast measurement set up with peak pressure levels

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San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Piers E5 and E4 Removal

Preliminary Summary of Test Blast Results

Test blasts were conducted during a low slack tide on Friday, October 7, 2016, alongside Pier E5 in order to assess the measurement techniques to be used for hydroacoustic monitoring of the Piers E5 and E4 demolition implosion scheduled for October 15, 2016 and October 29, 2016, respectively. The source was an 18 grain blasting cap positioned approximately 30 feet from Pier E5 at a depth of 20 feet below the surface. Illingworth & Rodkin, Inc. (I&R) monitoring locations were 30 feet and 100 feet away from the blast, as illustrated in the sketch shown in Figure 1. The depths of both sensors were 20 feet below the water surface. Autonomous recording systems were used to record the blasts, as well as ambient conditions. Location 1 was supported by a cable connecting the Pier to the barge, and Location 2 was connected to the barge used to support the compressors for the blast attenuation system (BAS). Once the data was collected, it was later processed using a high-speed data acquisition system. Two blasts were produced and monitored: one at approximately 11:09 a.m. and the second at 11:47 a.m.

Background levels were measured at Location 2 (100 feet) with and without the BAS in operation. Without the BAS, the background levels were 116.6 decibels (dB), and background levels with the BAS in operation were 128.8 dB. The results for both blasts are summarized in Table 1. The peak sound pressure levels measured for the first blast are shown in Figure 2 superimposed on a photograph of the measurement set up as viewed from the barge.

For reference, the results measured at 20 feet and 75 feet from the Pier E3 test blasts, conducted on November 5, 2015, for peak pressure, root mean squared (RMS) and cumulative sound exposure level (cSEL) are shown in Table 2.

For the Pier E5 test blasts, the levels measured during the first blast were lower than the second blast. In comparing results from the Pier E5 test blast with those from the Pier E3 test blast, the initial levels at Pier E3 (Table 2) were higher at the close-in locations, while the levels fell-off much faster for each metric than seen at Pier E5 (Table 1). Given that there were only two measurement locations for each test blast, one being within the BAS and the other outside the BAS, a fall-off rate cannot be determined.

Pier E5 test blast results compared to the noise criteria established by the National Marine Fisheries Service at both locations are below the 206 dB peak pressure criteria for injury to all fish and below the 187 dB cSEL and 183 dB cSEL criteria for injury to fish greater than and less than 2 grams, respectively. While the results at the 30-foot location exceed the 150 dB RMS level for onset of possible behavioral response to fish, the levels measured at 100 feet are below the threshold.

Table 1: Test Blast Noise Levels at Pier E5

Blast	Distance from Blast, feet	Peak, dB re 1μPa	SEL, dB re 1 μPa^2-sec	RMS, dB re 1μPa
Blast #1 (At 11:09 a.m.)	30 feet	187.3	164.0	169.2
	100 feet	150.6	133.8	139.1
Blast #2 (At 11:47 a.m.)	30 feet	199.8	178.1	183.4
	100 feet	157.1	139.7	145.0

Table 2: Test Blast Noise Levels at Pier E3

Blast	Distance from Blast, feet	Peak, dB re 1μPa	SEL, dB re 1 μPa^2-sec	RMS, dB re 1μPa
Blast #1	20 feet	207.1	180.9	192.6
	75 feet	153.9	136.4	142.7
Blast #2	20 feet	201.9	178.2	189.2
	75 feet	157.1	135.9	149.1

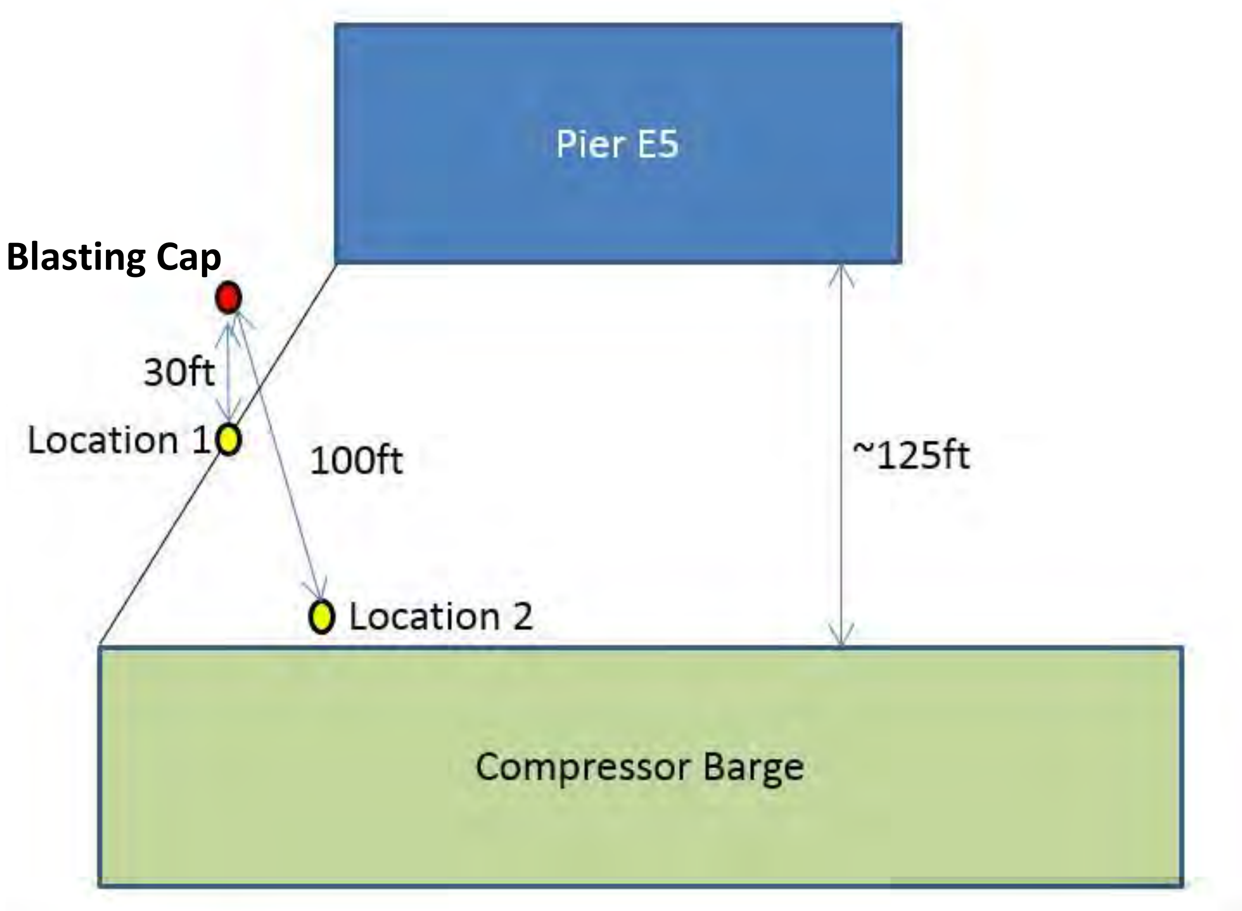


Figure 1: Pier E5 Test blast measurement geometry sketch

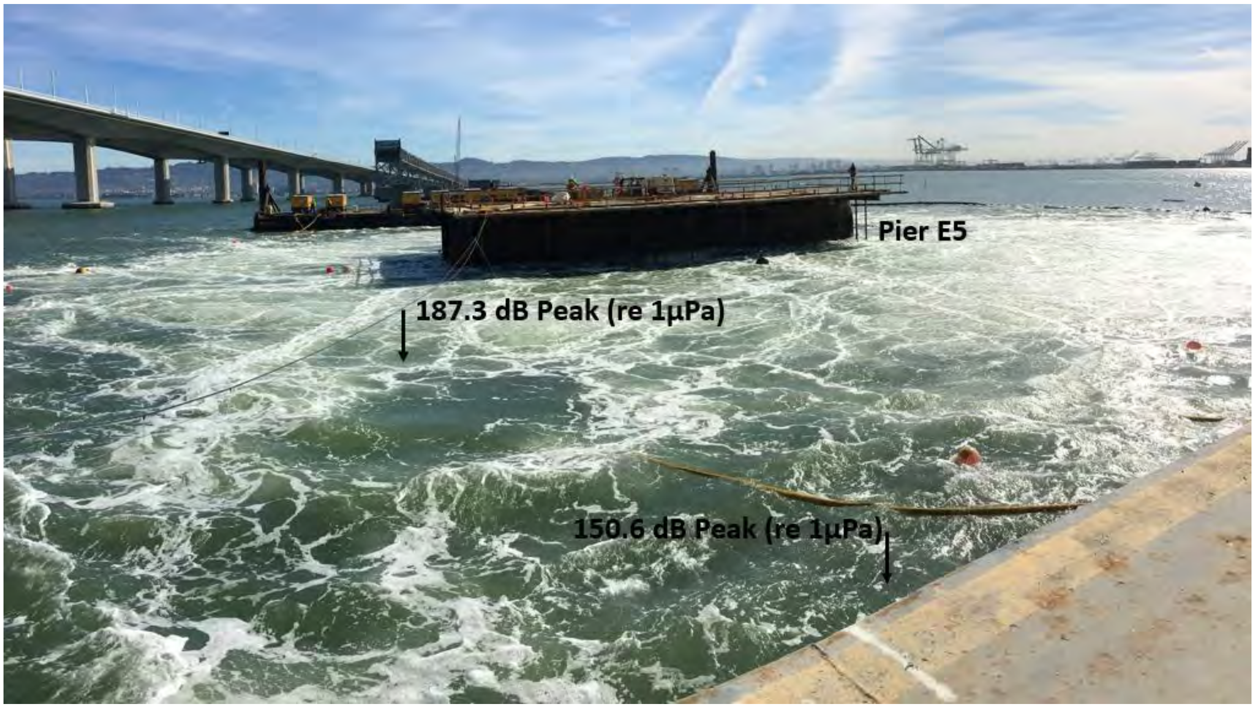


Figure 2: Photograph of test blast measurement set up at Pier E5 with peak pressure levels

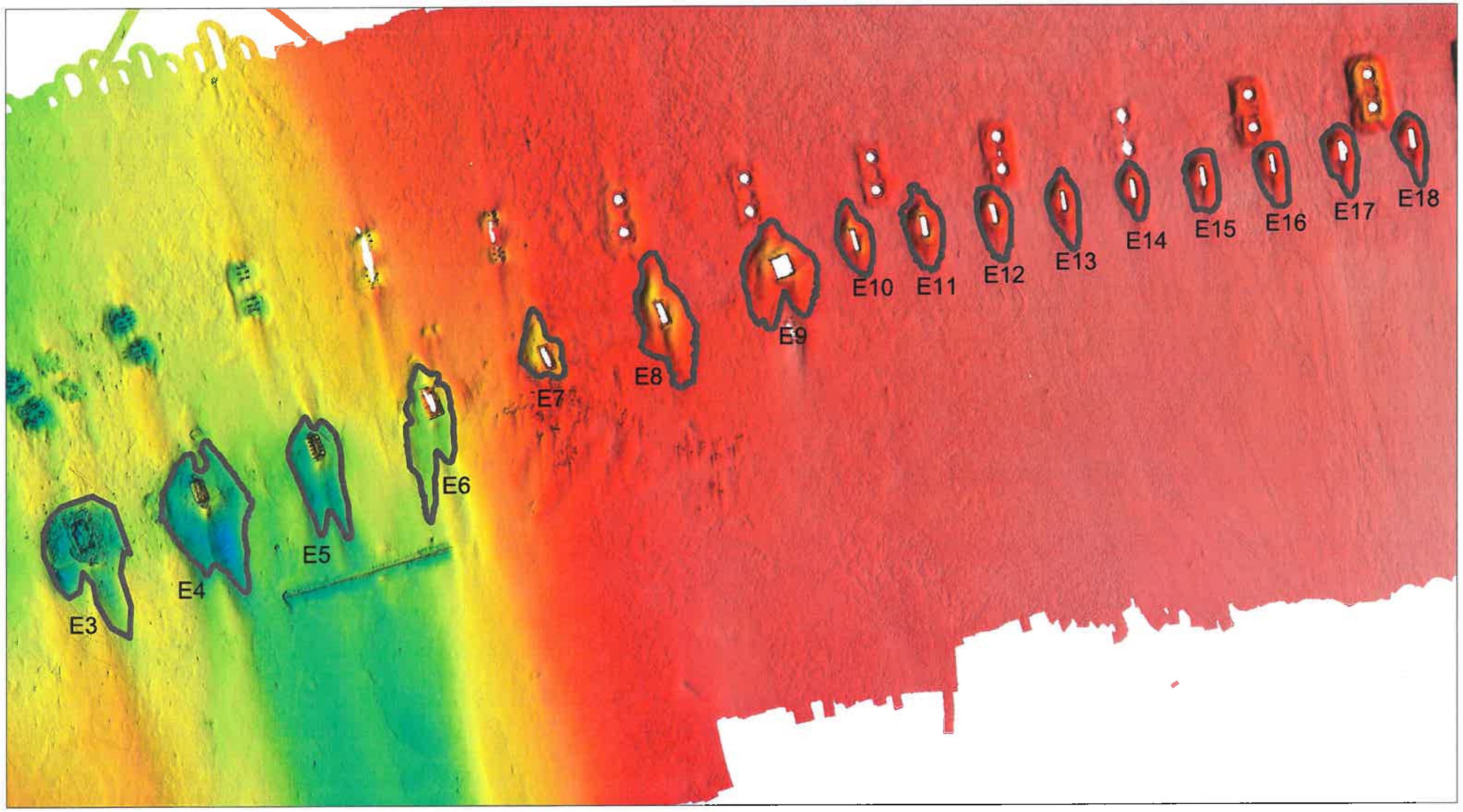
Appendix B. Sedimentation Analysis Boundary Establishment

SAN FRANCISCO BAY BRIDGE

ACCRETION ANALYSIS BOUNDARIES

KIEWIT MANSON A JOINT VENTURE

Overview



not to scale

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Oakland CA 94607

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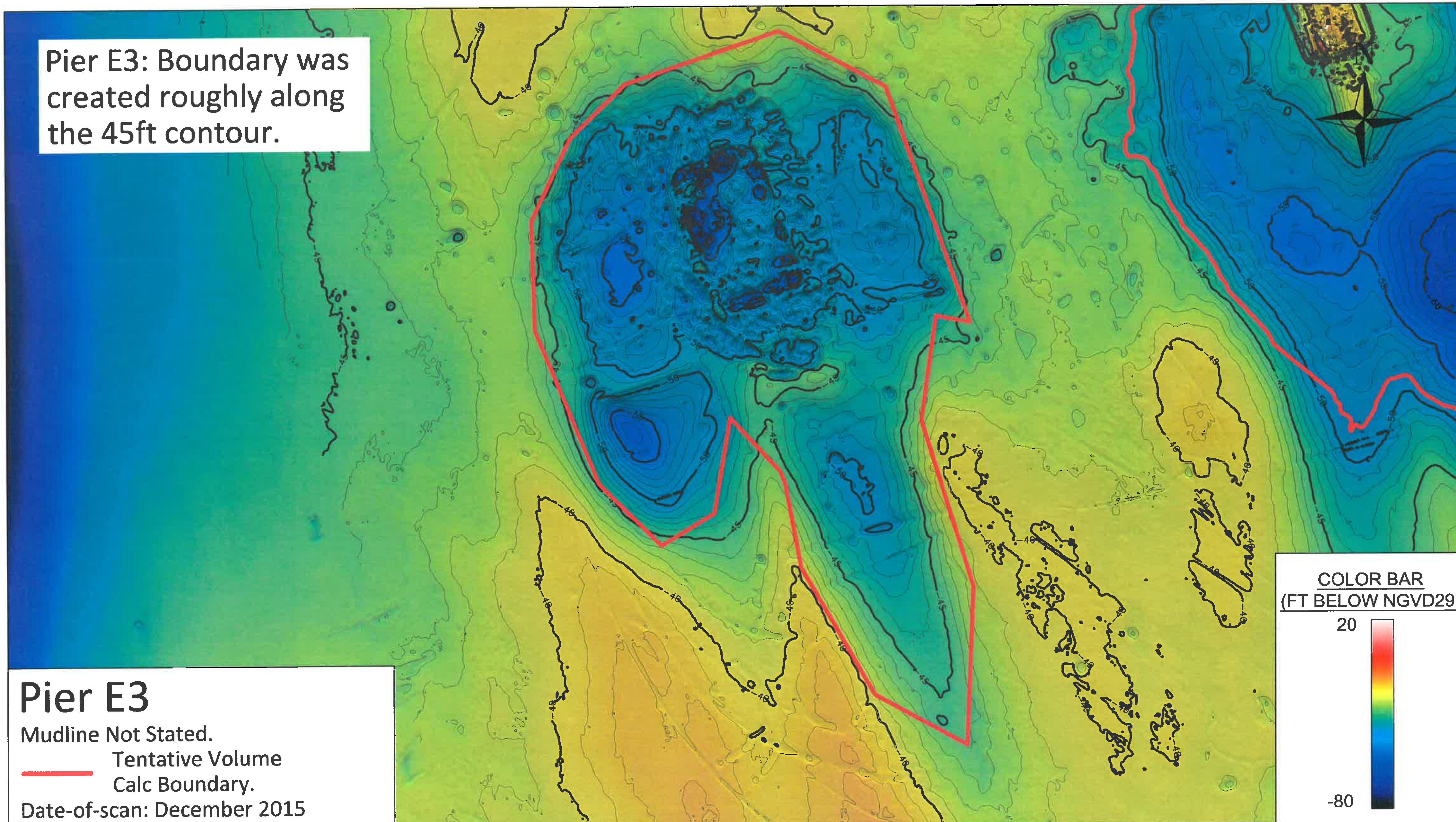
SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES
PLOT OVERVIEW

Reference Number:
S1



37.5 0 18.75 37.5 75

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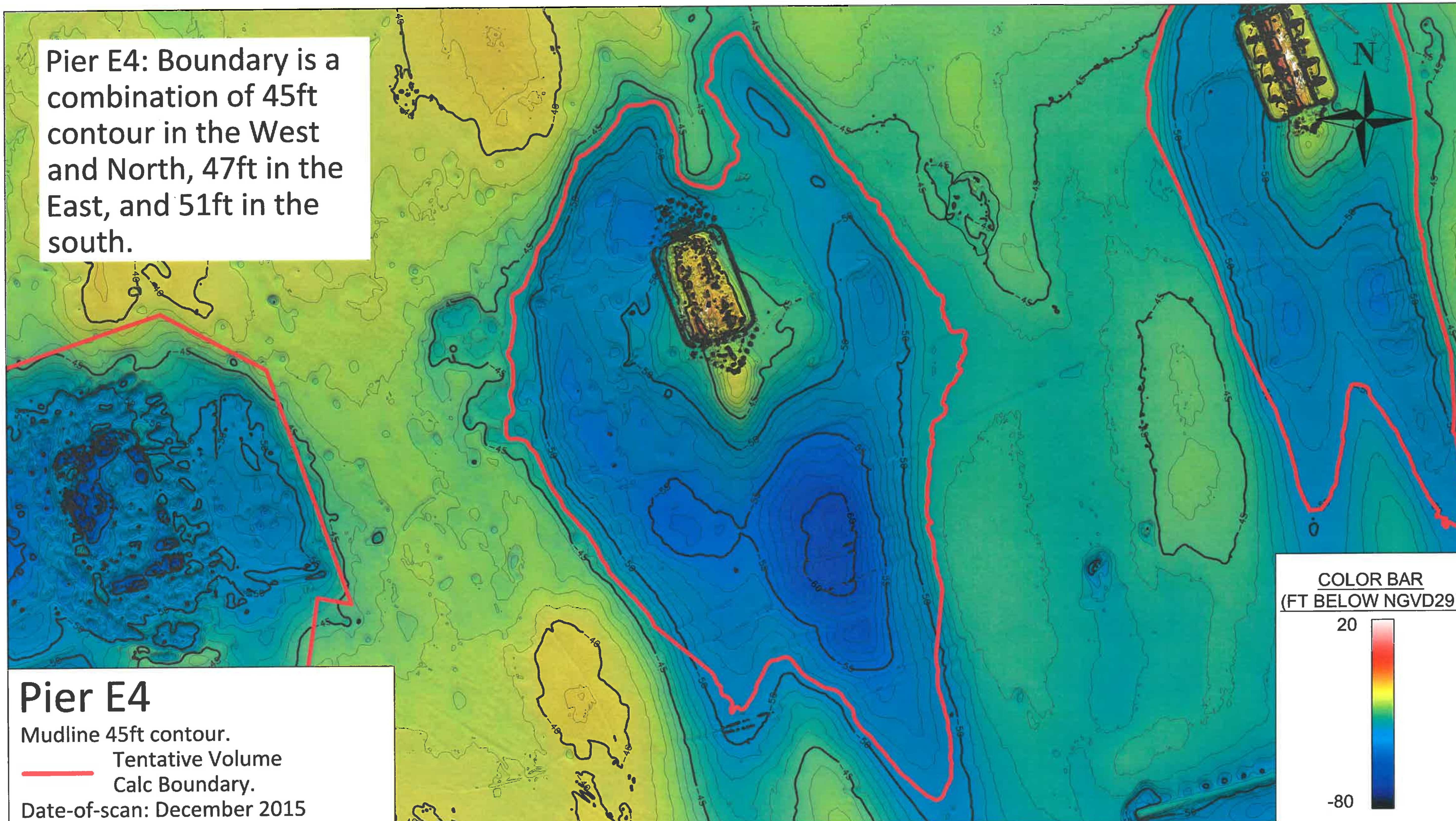
SAN FRANCISCO BAY BRIDGE
ACCRETION ANALYSIS BOUNDARIES
E3 BOUNDARY

Reference Number:
S2



Pier E4: Boundary is a combination of 45ft contour in the West and North, 47ft in the East, and 51ft in the south.

Pier E4

Mudline 45ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

37.5 0 18.75 37.5 75

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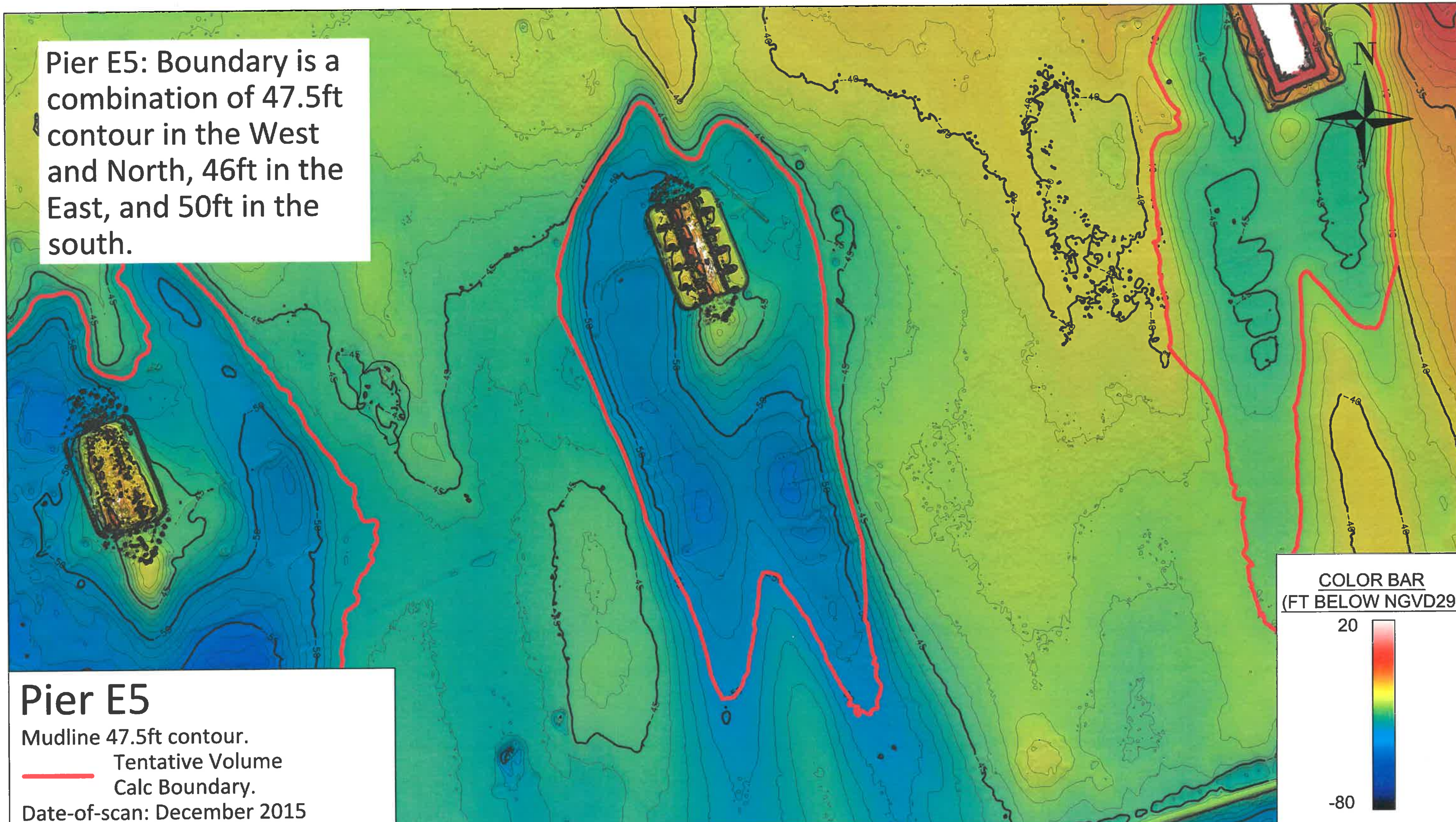
E4 BOUNDARY

Reference Number:

S3

Pier E5: Boundary is a combination of 47.5ft contour in the West and North, 46ft in the East, and 50ft in the south.



Pier E5

Mudline 47.5ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

37.5 0 18.75 37.5 75

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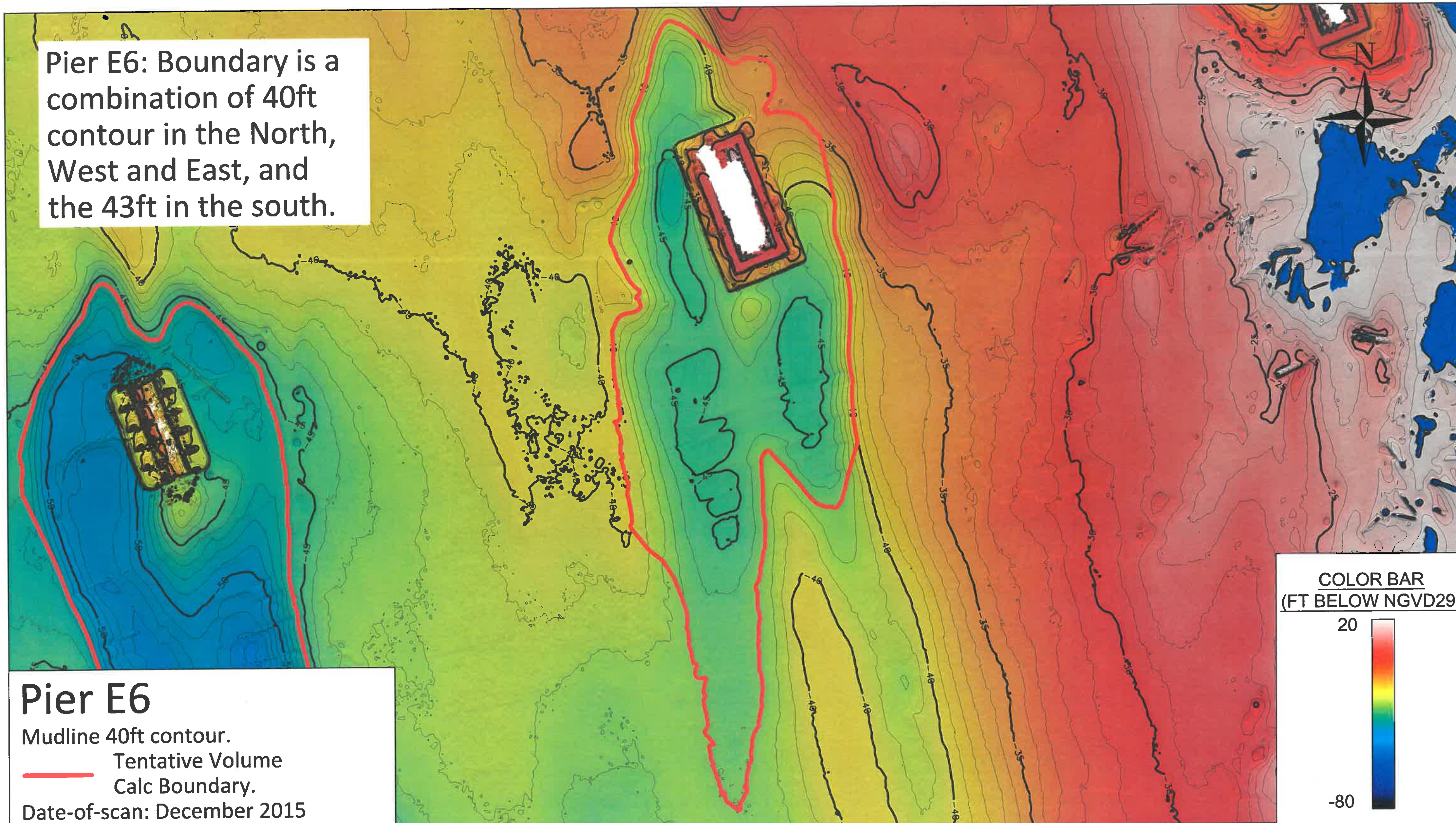
E5 BOUNDARY

Reference Number:

S4



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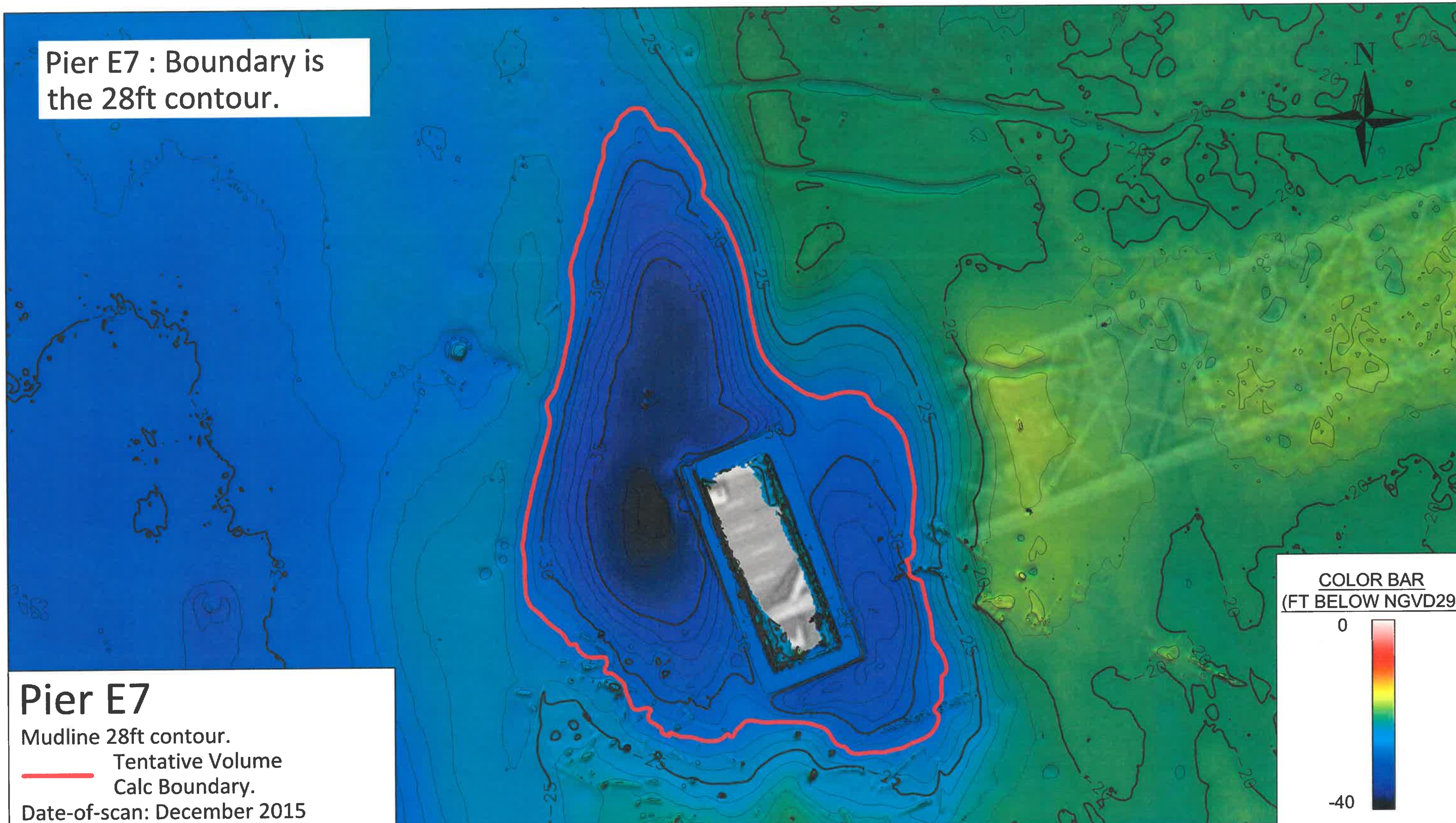
BOUNDARIES
E6 BOUNDARY

Reference Number:
S5



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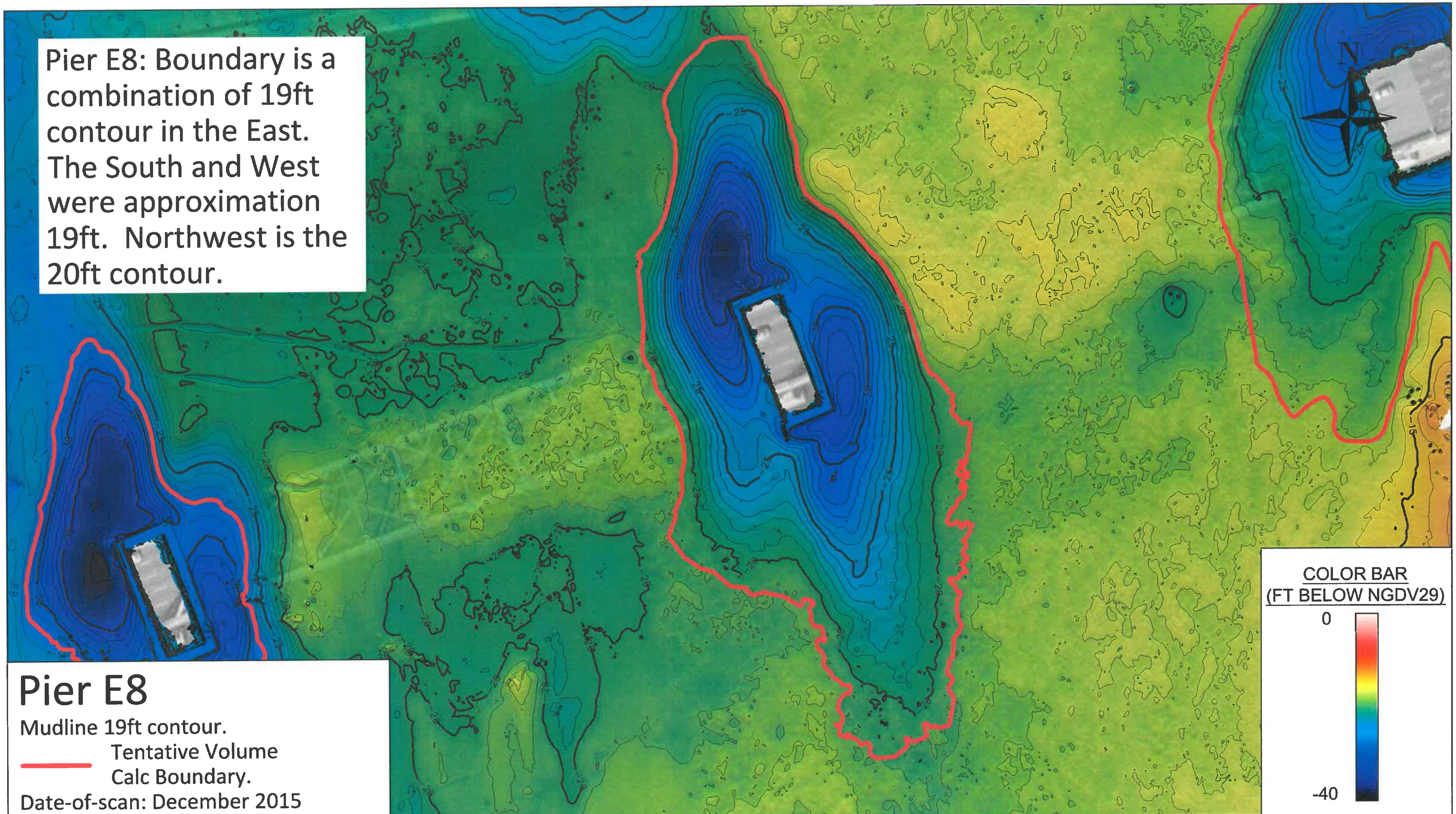
BOUNDARIES
E7 BOUNDARY

Reference Number:
S6



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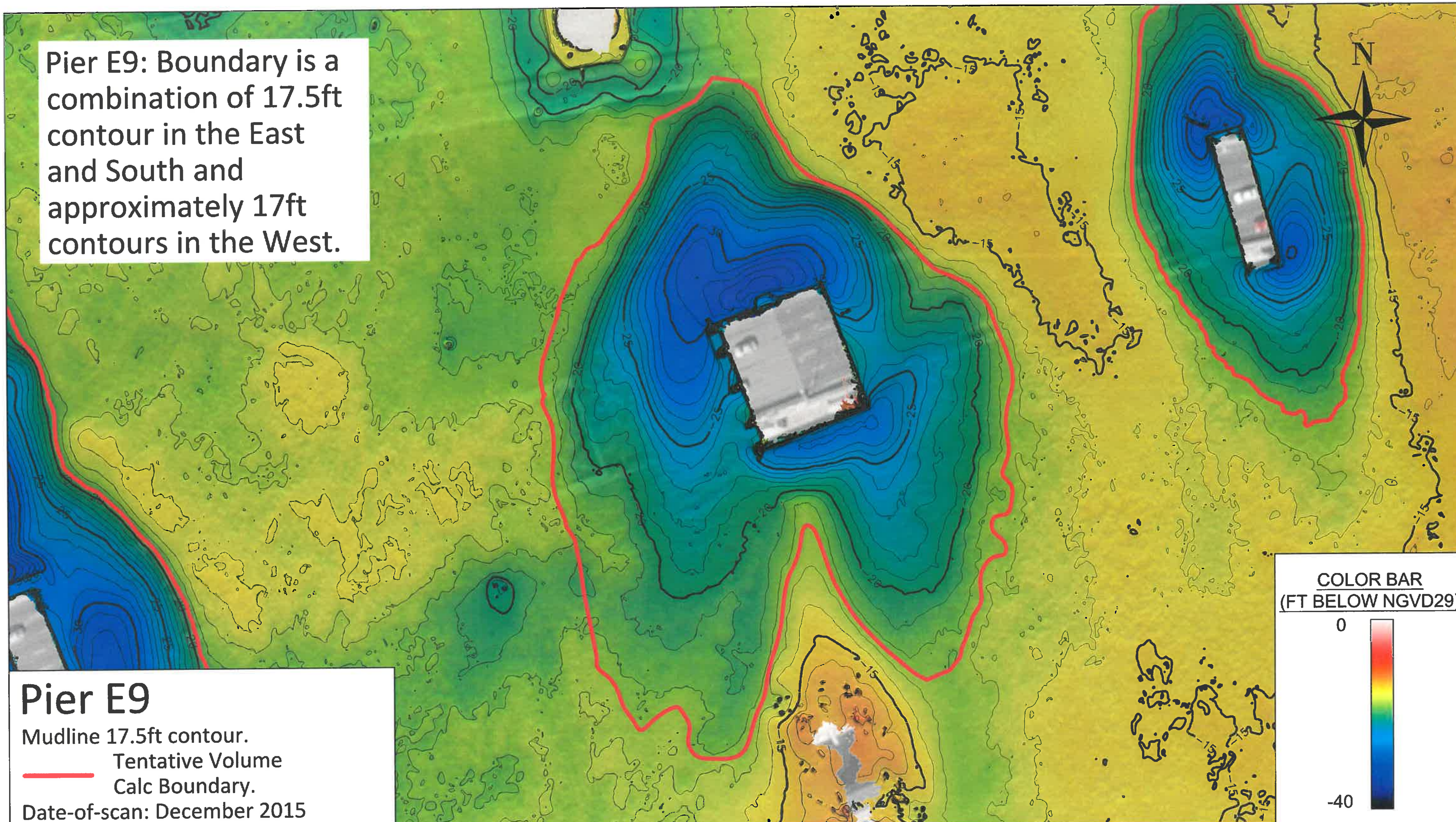
ACCRETION ANALYSIS
BOUNDARIES

E8 BOUNDARY

Reference Number:

S7



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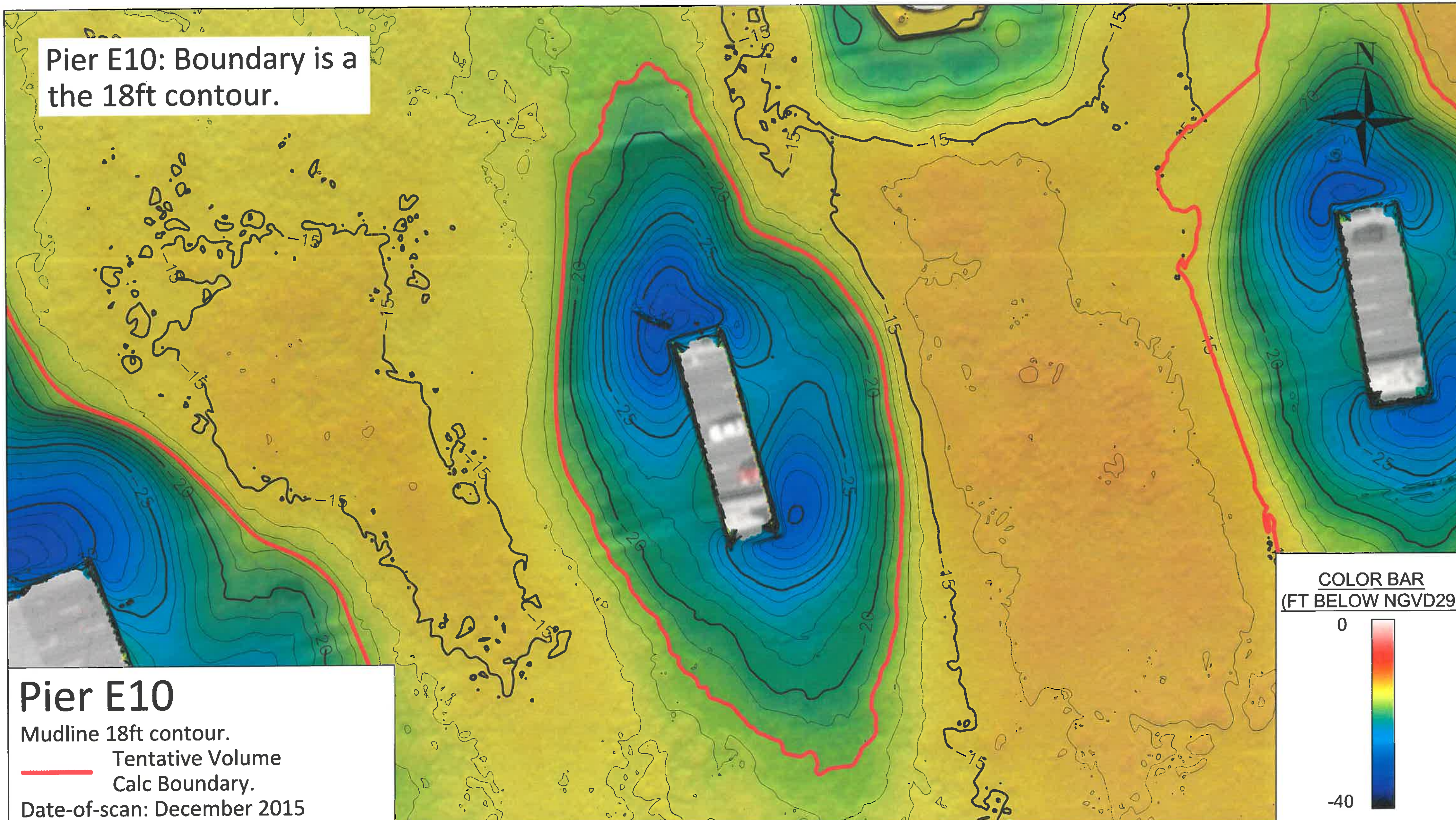
E9 BOUNDARY

Reference Number:
S8

Pier E10: Boundary is a the 18ft contour.



Pier E10

Mudline 18ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

20 0 10 20 40

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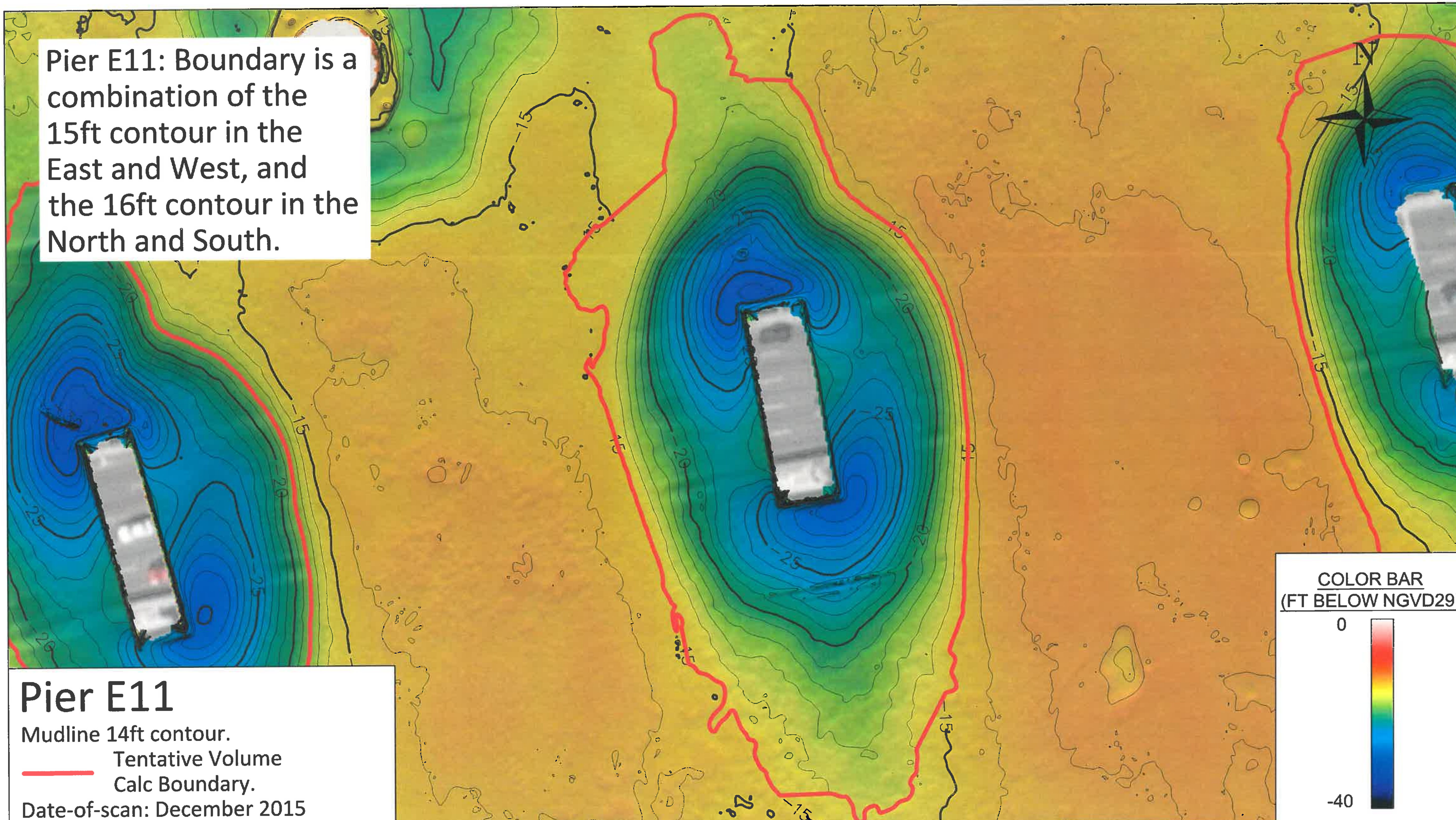
E10 BOUNDARY

Reference Number:

S9



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CONTRACT #:
PERMIT#: EPISODE#
Caltrans Project # 04-013574

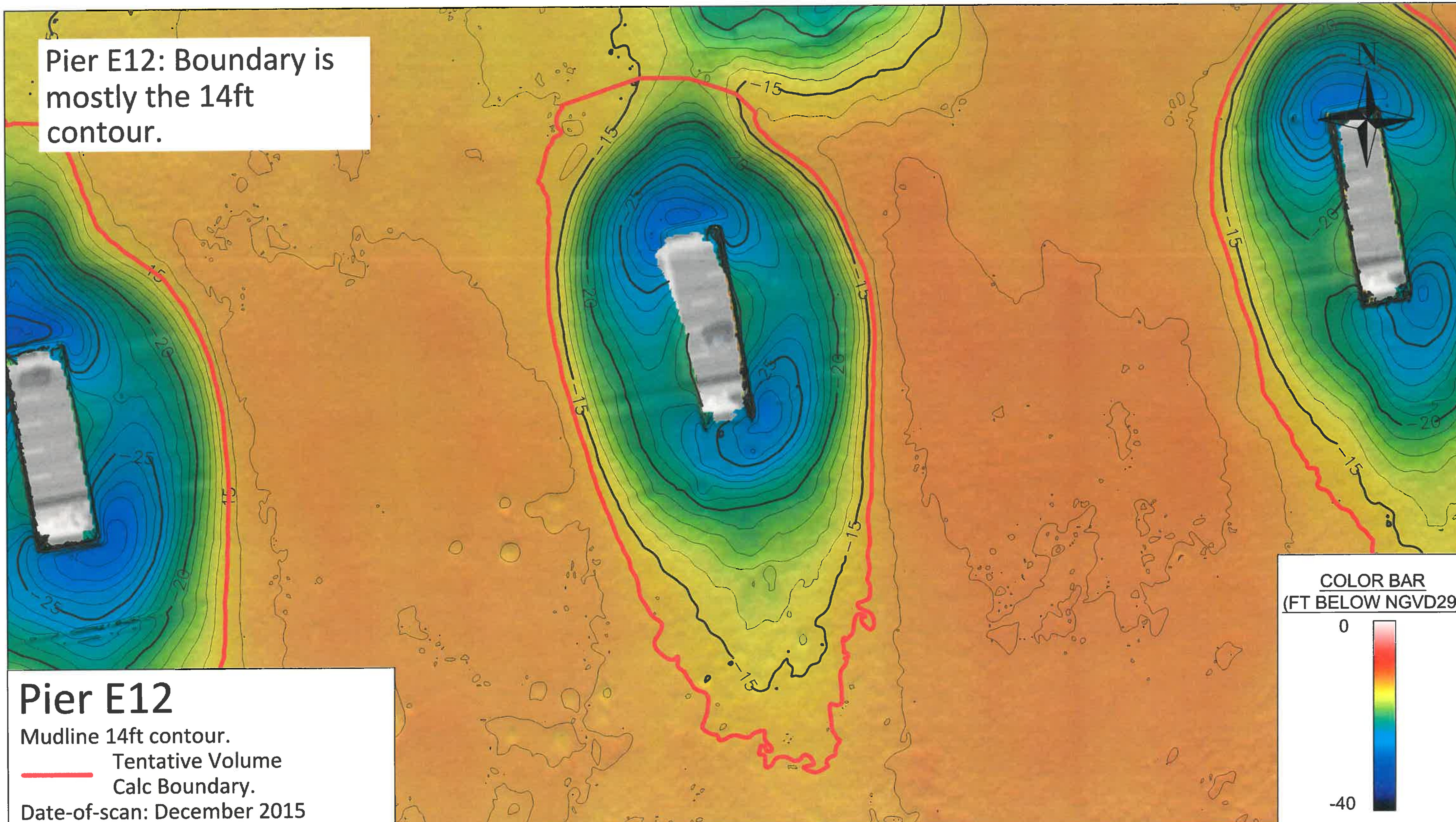
SAN FRANCISCO BAY BRIDGE
ACCRETION ANALYSIS
BOUNDARIES

E11 BOUNDARY

Reference Number:

S10

Pier E12: Boundary is mostly the 14ft contour.



Pier E12

Mudline 14ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

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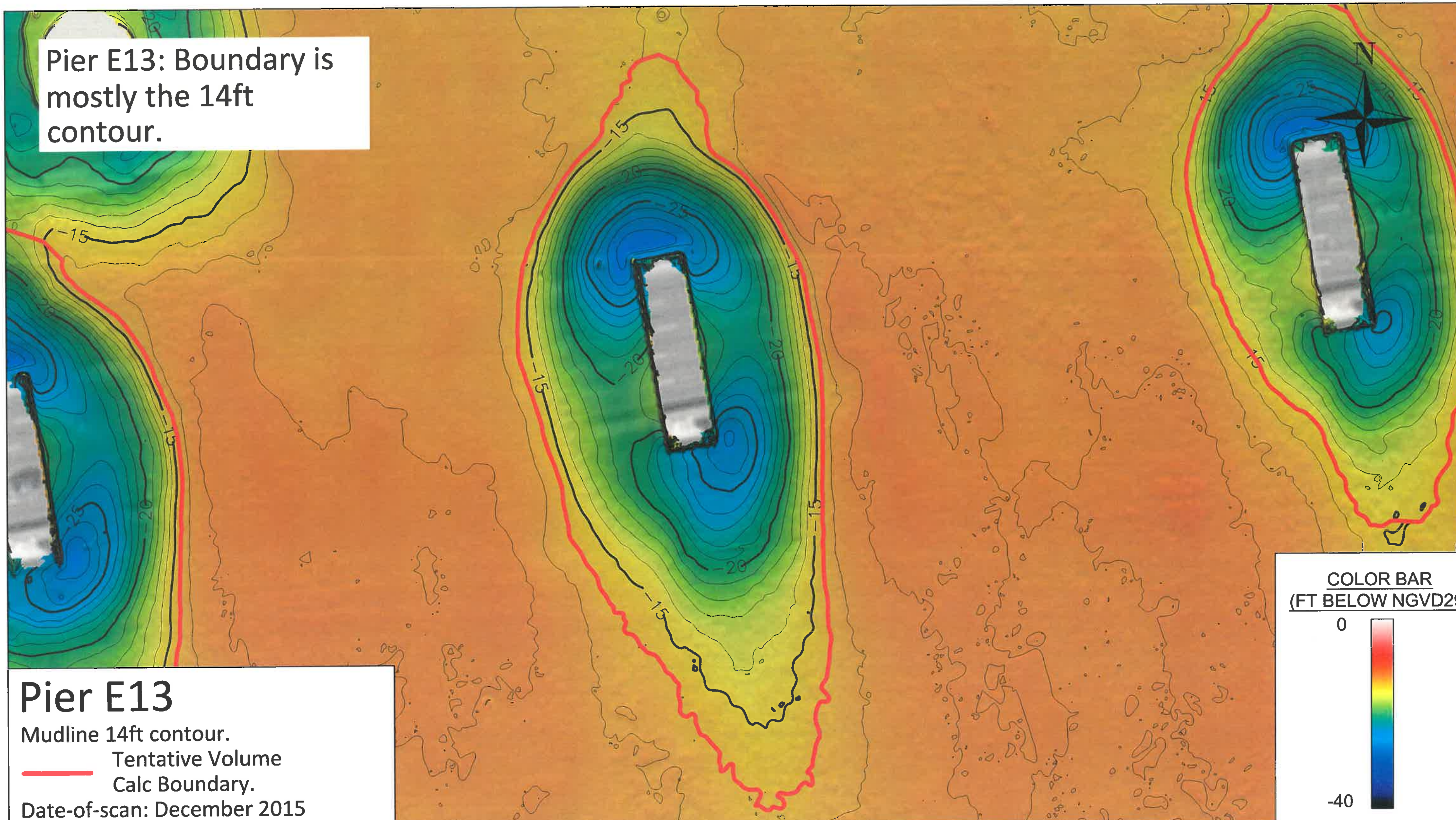
SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES

E12 BOUNDARY

Reference Number:

S11

Pier E13: Boundary is mostly the 14ft contour.



Pier E13

Mudline 14ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

COLOR BAR (FT BELOW NGVD29)

0

-40

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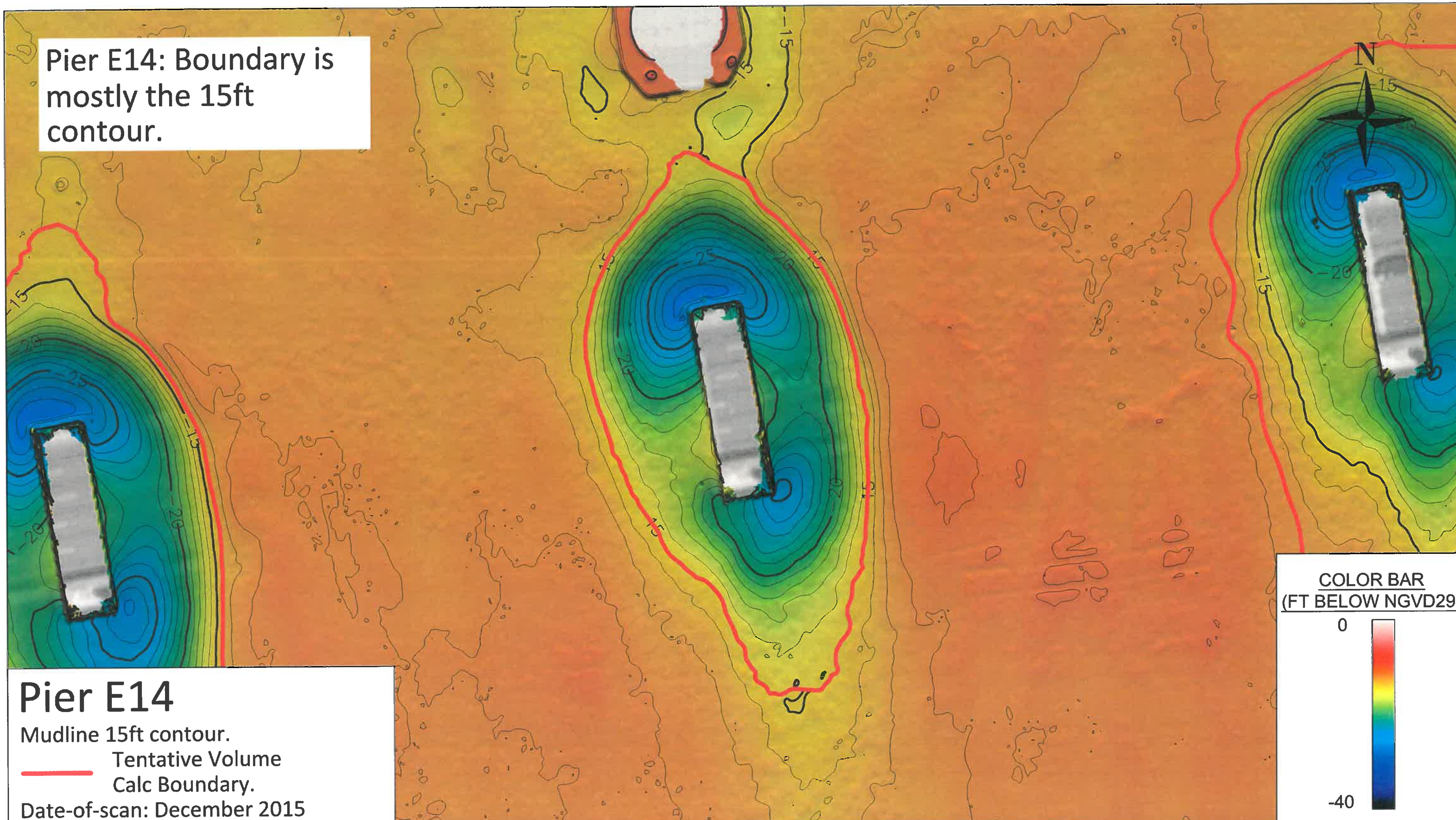
SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES

E13 BOUNDARY

Reference Number:

S12

Pier E14: Boundary is mostly the 15ft contour.



Pier E14

Mudline 15ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

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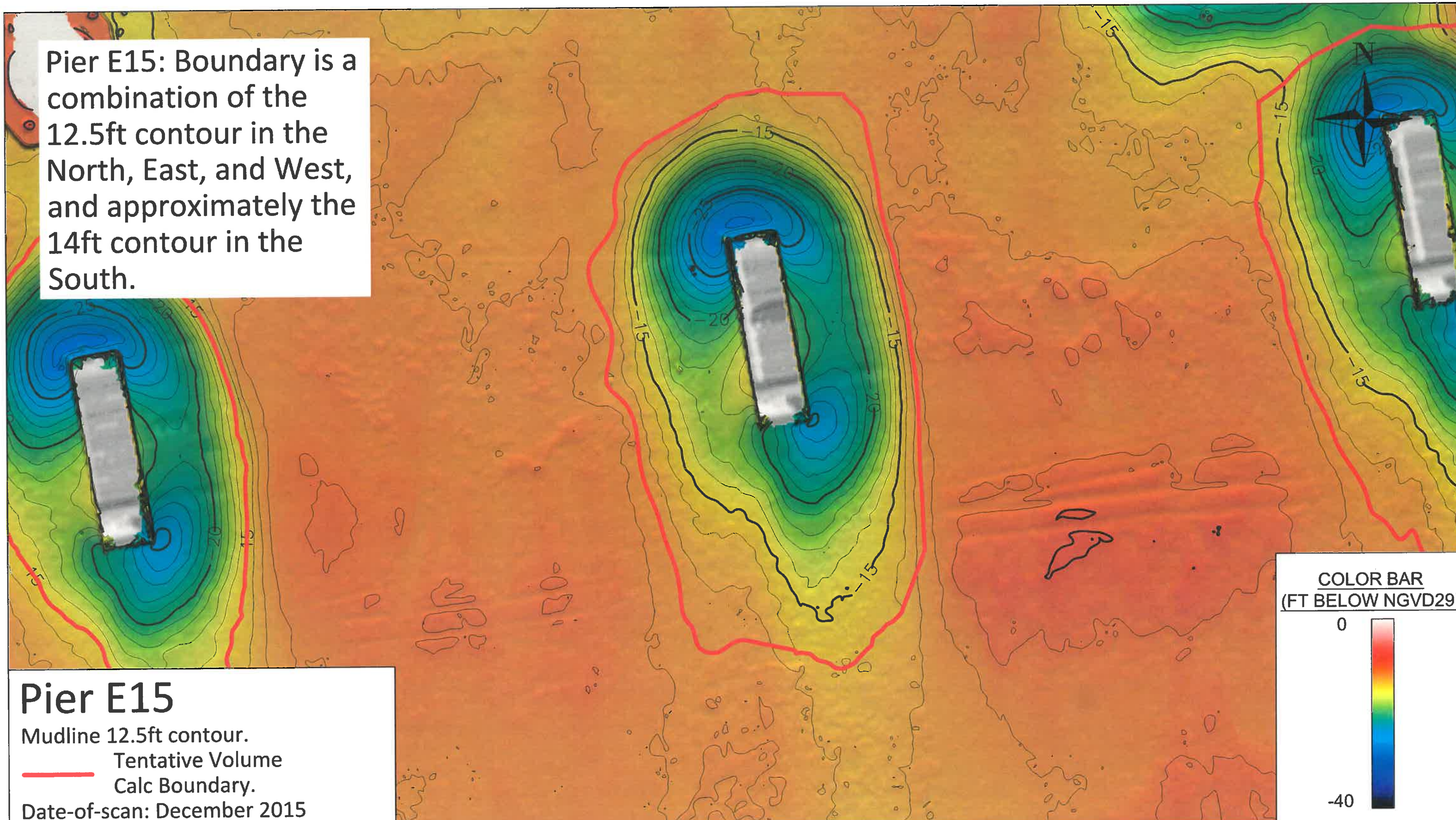
SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES

E13 BOUNDARY

Reference Number:

S13

Pier E15: Boundary is a combination of the 12.5ft contour in the North, East, and West, and approximately the 14ft contour in the South.



Pier E15

Mudline 12.5ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

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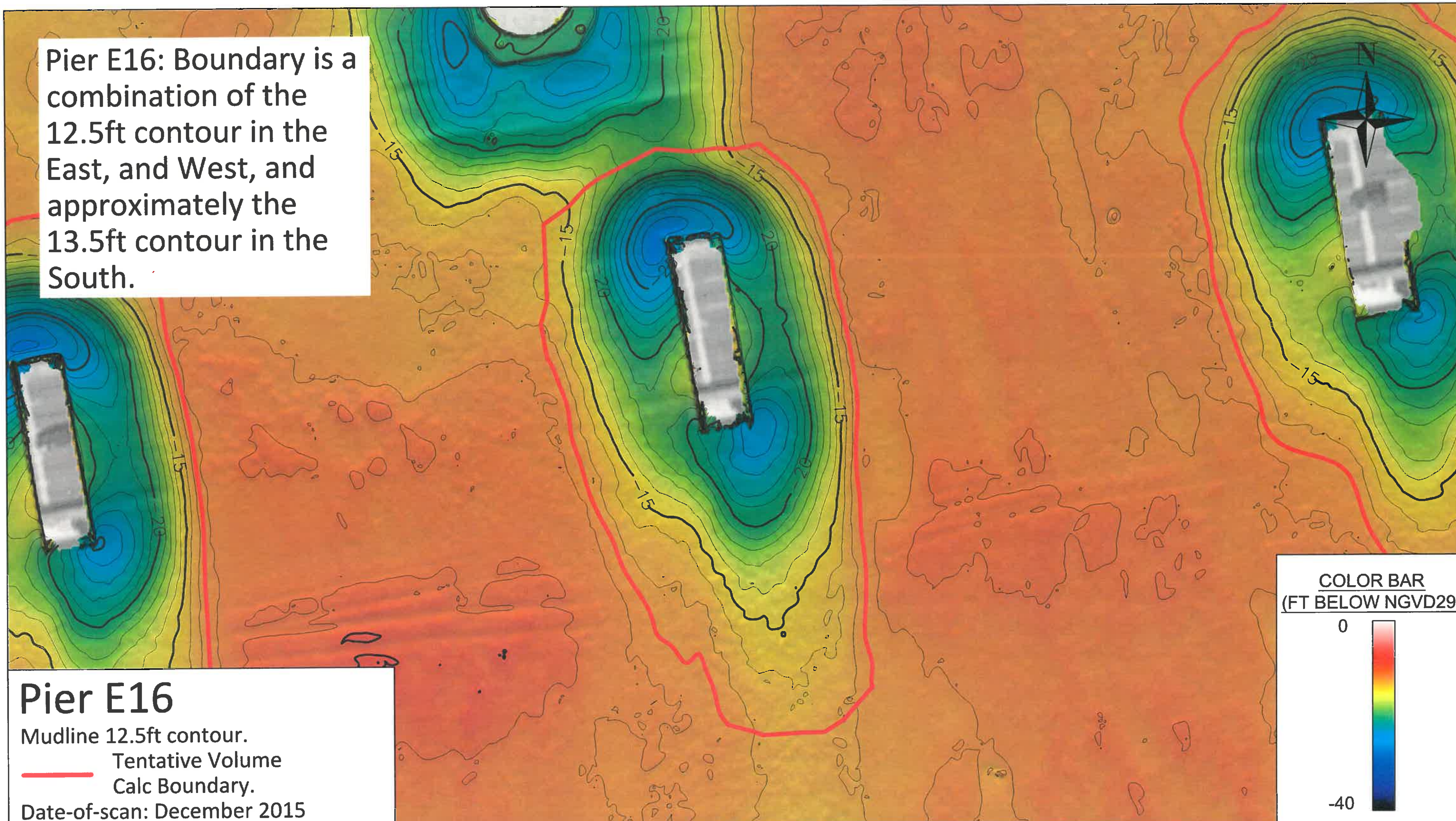
SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES

E15 BOUNDARY

Reference Number:

S14



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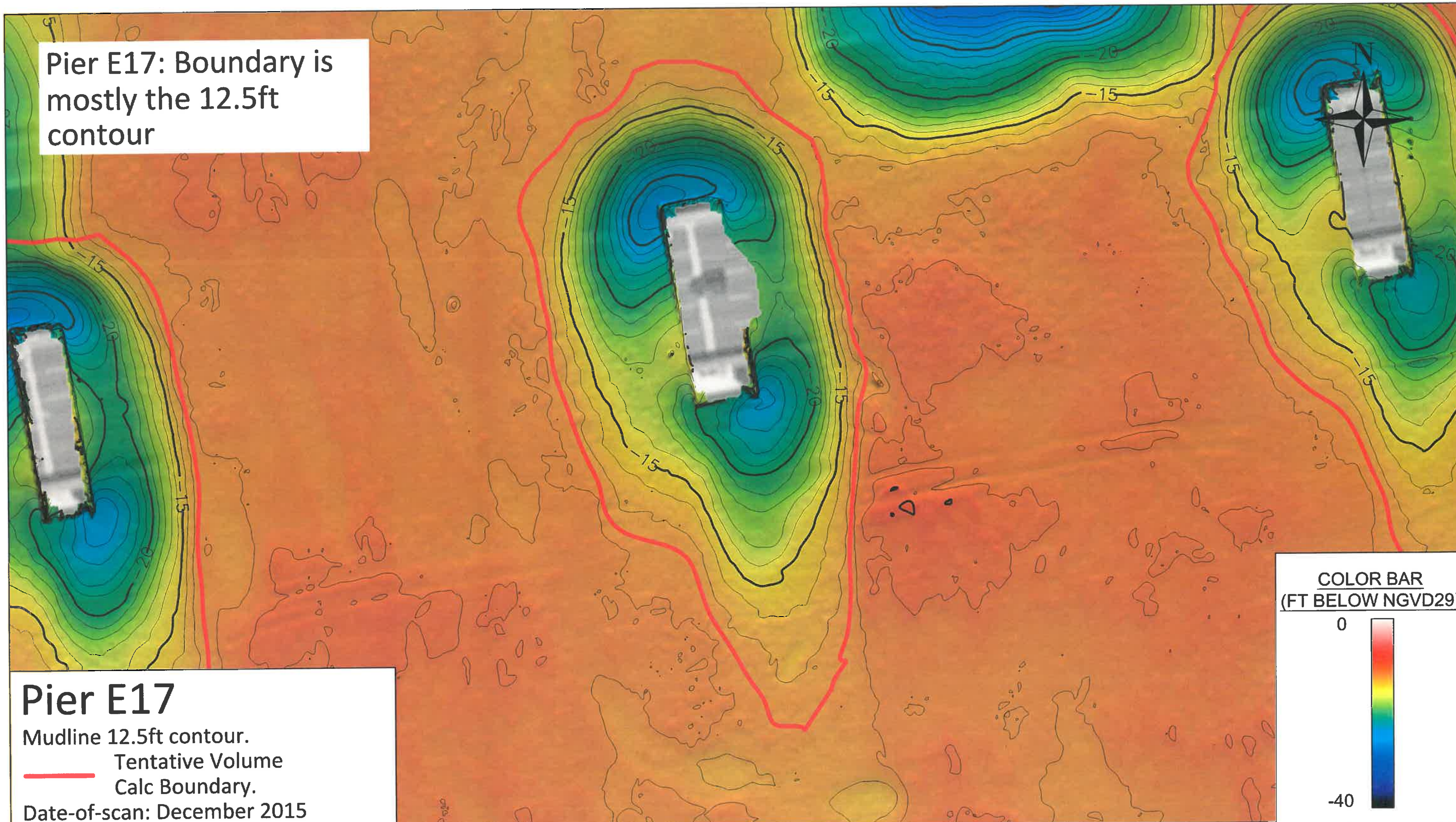
SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES

E16 BOUNDARY

Reference Number:

S15



SCALE: 1" = 30'

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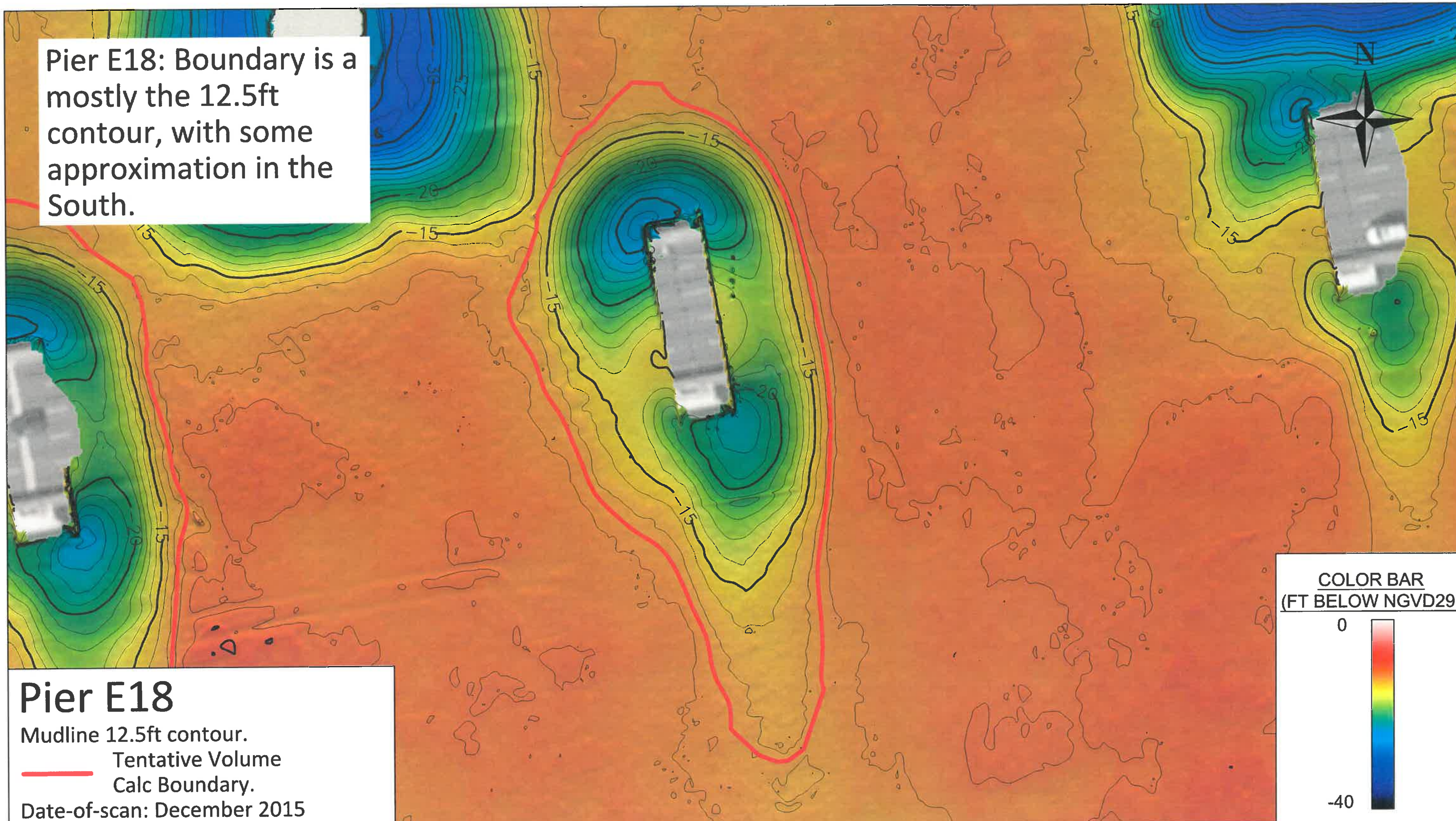
SAN FRANCISCO BAY BRIDGE
ACCRETION ANALYSIS
BOUNDARIES
E17 BOUNDARY

Reference Number:
S16

Pier E18: Boundary is a mostly the 12.5ft contour, with some approximation in the South.



Pier E18

Mudline 12.5ft contour.

Tentative Volume Calc Boundary.

Date-of-scan: December 2015

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SAN FRANCISCO BAY BRIDGE ACCRETION ANALYSIS BOUNDARIES

E18 BOUNDARY

Reference Number:

S17