

## **MARINE MAMMAL MONITORING PLAN**

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# Final Marine Mammal Monitoring Plan for Waterfront Repairs at U.S. Coast Guard Station Monterey, Monterey, California

Contract No. HSCG50-14-D-PSL002  
Task Order No. HSCG88-16-J- PQQ094



Prepared for:



## **UNITED STATES COAST GUARD**

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**ACRONYMS AND ABBREVIATIONS**

AOI	Area of Impact
dB	Decibels
IHA	Incidental Harassment Authorization
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
USCG	US Coast Guard
USFWS	US Fish and Wildlife Service

## **SECTION 1 INTRODUCTION**

US Coast Guard (USCG) Station Monterey is located at 100 Lighthouse Avenue at the southern end of Monterey Bay in Monterey, California (Figure 1-1). Station Monterey occupies an upland site and adjacent waterside structures including a 1,700-foot breakwater, a wharf constructed over the breakwater, and floating docks to the east of the wharf. The USCG is intending to conduct maintenance on the existing wharf which is used to berth vessels that are critical to support Station Monterey’s mission (Figure 1-2).

### **1.1 MONITORING PURPOSE AND OBJECTIVES**

The objective of monitoring for marine mammals is to eliminate the potential to injure marine mammal species (Level A harassment) and reduce the potential for behavioral disturbance (Level B harassment) of marine mammal species that may occur in the vicinity of the project. Maintenance activities will include the extraction of 17 existing piles and installation of 17 new piles using either a vibratory hammer, an impact hammer, or both. These activities will require monitoring as they would result in elevated underwater and airborne noise that has the potential to disturb marine mammals.

This Monitoring Plan establishes procedures to ensure compliance with regulatory and permit requirements. The following sections provide information on species expected to occur in the area as well as conservation measures to be applied to the project prior to and during construction. It also provides monitoring protocols and procedures, and provides guidelines for reporting.

### **1.2 BACKGROUND INFORMATION AND MARINE MAMMAL SPECIES OCCURRENCE**

Repairs would require a maximum of 60 work days for completion. An average work day (beginning 2 hours after sunrise and ending 2 hours before sunset) lasts approximately 8 to 9 hours, depending on the month. Based on the proposed repairs, it is assumed that 2 to 8 piles per day would be both extracted and installed depending on potential restrictions associated with installation in and around armor stone. Pile-driving activities would therefore occur for an



No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.



**FIGURE 1-2**

**Project Site**

No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.

estimated minimum of 3 days and a maximum of 8 days of the total 60-day construction duration. It is assumed that driving time would be about 20 minutes per pile for vibratory or impact pile driving, but may increase significantly if piles must be posted (i.e., cementing replacement piles to existing armoring/riprap). It is assumed that vibratory extraction of the existing piles would take about 10 minutes per pile. Pile driving and extraction would therefore result in an estimated 240 minutes per day depending on the rate of pile extraction and installation. This would total 510 minutes for the total project or approximately 8.5 hours of underwater and airborne noise generation from pile driving over the course of the project construction. Work would be conducted during the approved in-water work window of June 15 and October 15.

The USCG is consulting with National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS) for an Incidental Harassment Authorization (IHA), pursuant to the Marine Mammal Protection Act (MMPA) of 1972. The IHA request/application was submitted to NMFS for potential Level B harassment to California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), Risso's dolphin, (*Grampus griseus*), bottlenose dolphin (*Tursiops truncatus*), gray whale (*Eschrichtius robustus*), humpback whale (*Megaptera novaeangliae*), and killer whale (*Orcinus orca*) and to USFWS for potential Level B harassment to the Southern sea otter (*Enhydra lutris*).

California sea lions, Pacific harbor seals, and sea otters occur on a regular basis in the project area and are expected to be present during construction. Further, California sea lions haul out on the jetty and pier.

The IHA application provides a thorough assessment of marine mammal acoustic thresholds, the area of potential effect, the potential for marine mammal occurrence within the area of potential effect, and conservation measures proposed to reduce the potential effect to marine mammals resulting from the proposed action. The IHA application is included as Appendix A.

### 1.3 CONSERVATION MEASURES

Prior to and during construction, the following conservation measures would be used to minimize potential impact:

- Noise Attenuation During Impact Pile Driving:
  - Noise attenuation systems (i.e., bubble curtains and hammer cushion pads) would be used during all impact pile driving to interrupt the acoustic pressure, decrease the noise impacts, and reduce the impact on marine mammals. By reducing underwater sound pressure levels at the source, bubble curtains and hammer cushion pads would reduce the area over which both Level A and B harassment would occur, thereby potentially reducing the numbers of marine mammals affected.
    - Because the existing seafloor conditions include sloped topography and riprap, care would be taken when placing the bubble curtain to ensure a good seal is formed.
  - Pre-drilling would be performed and would be discontinued when the pile tip is approximately 5 feet above the required pile tip elevation. Pre-drilling is a method that starts the “hole” for the new pile; the pile is inserted after the hole has been pre-drilled which creates less friction and overall noise and turbidity during installation. Pre-drilling is also beneficial for overall pile stability as it reduces the stress and, therefore, chance of breakage or damage to the pile during installation.
  - Marine mammal monitoring would be conducted by qualified observers familiar with marine mammal species and their behavior. The observer would monitor the exclusion zone from the most practicable vantage point possible (the pier itself, the breakwater, adjacent boat docks in the harbor, or a boat) to determine whether marine mammals enter the exclusion zone (Figure 2-2). Additional details and protocols are identified in this Monitoring Plan.
  - Hydroacoustic monitoring would be conducted during impact pile driving as described in the hydroacoustic monitoring plan included in Appendix B.
  - Exclusion zones would be established to include all areas where underwater sound pressure levels are expected to reach or exceed Level A harassment criteria for marine mammals. To provide a margin of safety, a provisional, conservative exclusion zone would be established during initial pile extraction and driving efforts, while hydroacoustic measurements are made to establish actual

field conditions. These exclusion zones will be adjusted once field conditions have been established through hydroacoustic monitoring.

- A “soft-start” would be implemented to allow marine mammals to vacate the area before the pile driver reaches full power. For vibratory hammers, the contractor would initiate the driving for 15 seconds at reduced energy, followed by a 1-minute waiting period when there has been downtime of 30 minutes or more. This procedure would be repeated two additional times before continuous driving is started. This procedure would also apply to vibratory pile extraction. For impact driving, an initial set of three strikes would be made by the hammer at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets before initiating continuous driving.
- All work would be conducted during daylight hours within the approved in-water work window from June 15, 2018 to October 15, 2018.
- To the maximum extent possible, project-related debris would not be allowed to enter the water; any project-related debris that inadvertently enters the water would be removed.
- If posting (i.e., cementing replacement piles to existing armoring/riprap) is required, watertight formwork would be placed and concrete would be pumped into the form until full. Care would be taken not to spill or overtop the forms.
- Construction equipment would be kept in good repair without leaks of hydraulic or lubricating fluids. If such leaks or drips do occur, they would be cleaned up immediately. Drip pans would be utilized when vehicles are parked. Equipment maintenance and/or repair would be confined to one location. Runoff from this area would be controlled to prevent contamination of soils and water. Fueling of land-based vehicles and equipment would take place at least 50 feet away from the water (and away from drains), preferably over an impervious surface. Fueling of vessels would be performed at approved fueling facilities. Staging would occur in the parking lot adjacent to the Station.
- To the maximum extent practicable, equipment and material would be lowered to the seafloor in a controlled manner. This could include the use of cranes, winches, or other equipment that affect positive control over the placement and rate of descent.
- Spill kits would be kept at Station Monterey at all times.
- The contractor would be required to implement a Storm Water Pollution Prevention Plan to control/eliminate storm water runoff from entering the harbor.

- A site-specific spill control plan would be prepared for the project.
- A containment system would be placed under the deck during removal and installation of decking and associated fittings. The containment system would be used to catch splintering wood, fittings, etc.
- A silt curtain/turbidity curtain would be installed around the project area to reduce the potential for sediments to leave the immediate vicinity.

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## **SECTION 2 MONITORING PROTOCOLS**

The following discussion provides monitoring protocols to be used during pile driving and/or extraction activities to ensure that marine mammals are not present in the zone of hearing loss, discomfort, or injury (Level A harassment), and that potential behavioral disturbance (Level B harassment) is minimal.

### **2.1 EXCLUSION ZONE(S)**

As described in the IHA application, various Areas of Impact (AOIs) were identified that would experience noise levels in excess of the Level A criteria for marine mammals. Because of this, the establishment of exclusion zones around each pile will be implemented to prevent Level A harassment to individual species (Figure 2-1). The exclusion zone includes all areas where underwater sound pressure levels are expected to reach or exceed the Level A harassment criteria for marine mammals. To be conservative, we have used the isopleths for impact pile driving which extend the farthest out. These correspond to the following distances:

- 1.9 meters for the Risso’s dolphin, bottlenose dolphin, and killer whale
- 0.9 meters for the California sea lion
- 27.9 meters for the Pacific harbor seal
- 52.1 meters for the gray whale and humpback whale
- 62.1 meters for the harbor porpoise
- 10 meters for the Southern sea otter

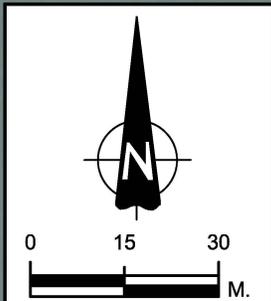
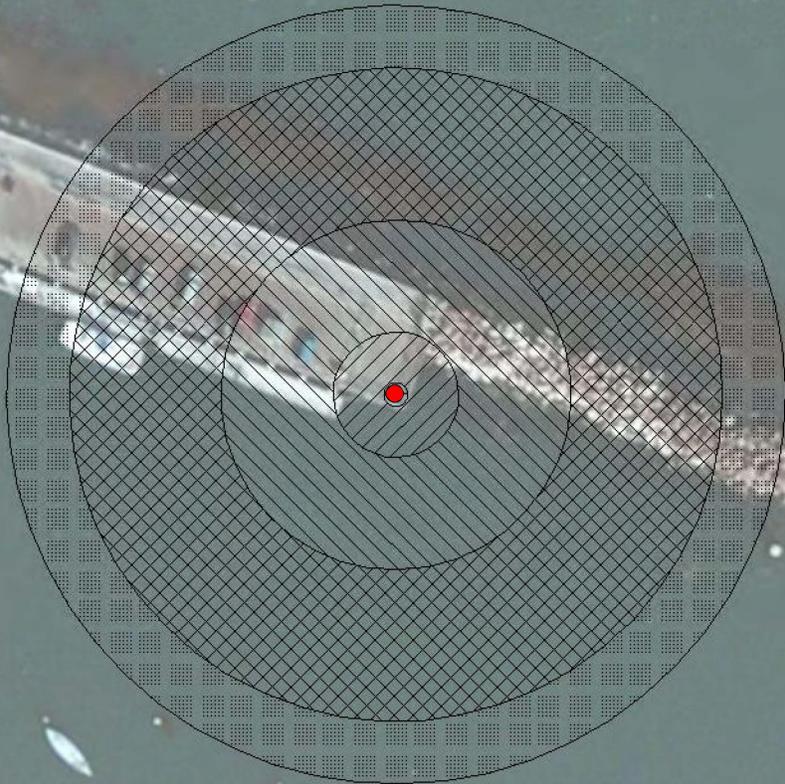
### **2.2 MARINE MAMMAL MONITORING**

The USCG has prepared two monitoring plans – a Marine Mammal Monitoring Plan and an HydroAcoustic Monitoring Plan – that will be implemented prior to and during construction of the project. Both plans provide means and methods for ensuring that no lethal take occurs, that behavioral take is kept to a minimum, and that construction activities and marine mammal sightings and behavior are documented. This document represents the Marine Mammal Monitoring Plan which includes visual monitoring and reporting elements. Marine mammal observers will be required to monitor marine mammals throughout pile driving.

Monterey Bay

**LEGEND:**

- Project Location
-  California Sea Lion (0.9 meters)
-  Risso's Dolphin, Bottlenose Dolphin & Killer Whale (1.9 meters)
-  Southern Sea Otter (10 meters)
-  Pacific Harbor Seal (27.9 meters)
-  Gray Whale & Humpback Whale (52.1 meters)
-  Harbor Porpoise (62.1 meters)



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USCG STATION MONTEREY  
MONTEREY, CALIFORNIA

EXCLUSION ZONE

DATE  
NOVEMBER 2017

SCALE  
1" = 30 meters

PROJECT NO.  
336010017

FIGURE  
2-1

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Qualification and duties of observers are described in Sections 2.2.1 and 2.2.2 below. A brief description of the HydroAcoustic Monitoring Plan is given in Section 2.2.3 below and the plan itself is included as Appendix B.

### **2.2.1 Minimum Qualifications for Marine Mammal Observers**

1. Visual acuity in both eyes (correction is permissible) sufficient to discern moving targets at the water's surface with ability to estimate target size and distance. Use of binoculars or spotting scope may be necessary to correctly identify the target.
2. Advanced education in biological science, wildlife management, mammalogy, or related field (Bachelor's degree or higher is preferred).
3. Experience and ability to conduct field observations and collect data according to assigned protocols (this may include academic experience).
4. Experience or training in the field identification of marine mammals (cetaceans and pinnipeds).
5. Sufficient training, orientation, or experience with vessel operation and pile-driving operations to provide for personal safety during observations.
6. Writing skills sufficient to prepare a report of observations. Reports should include such information as the number, type, and location of marine mammals observed; the behavior of marine mammals in the area of potential sound effects during construction; dates and times when observations and in-water construction activities were conducted; dates and times when in-water construction activities were suspended because of marine mammals; etc.
7. Ability to communicate orally – by radio or in person – with project personnel to provide real-time information on marine mammals observed in the area, as needed.

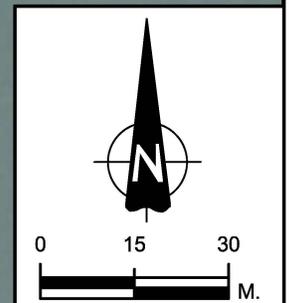
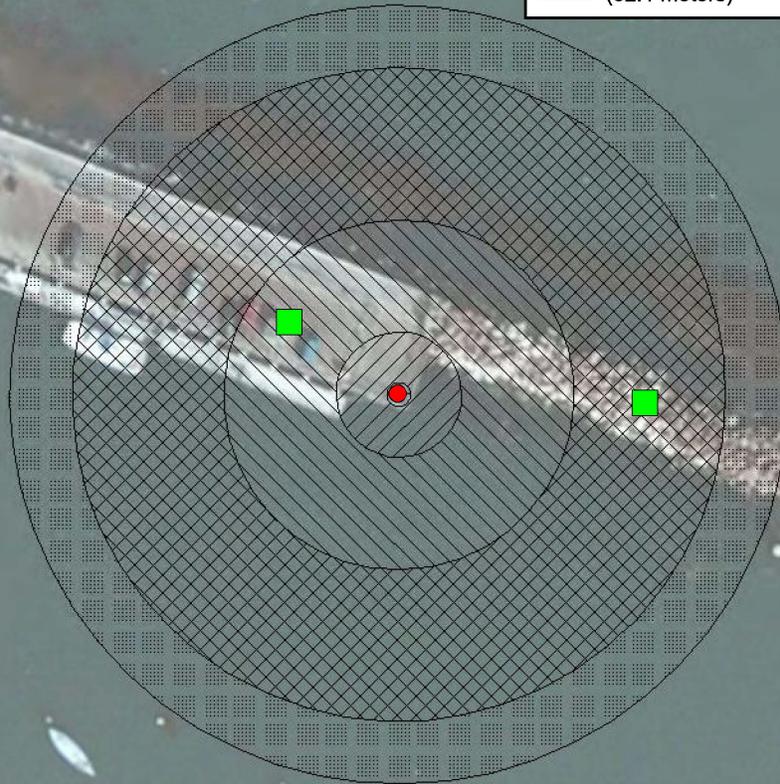
### **2.2.2 Visual Monitoring Protocols**

1. A minimum of three marine mammal observers will be on site at all times during pile-driving activities. Each observer must meet the list of qualifications for marine mammal observers (Section 2.2.1) to be considered qualified, or undergo training to meet the qualifications before the start of pile-driving activities.
2. Monitoring will be conducted by qualified observers familiar with marine mammal species and their behavior. Observer(s) shall monitor the exclusion zone from the most practicable vantage point possible (Figure 2-2) to determine whether marine mammals enter the exclusion

Monterey Bay

**LEGEND:**

- Project Location
- Marine Mammal Observer Location
-  California Sea Lion (0.9 meters)
-  Risso's Dolphin, Bottlenose Dolphin & Killer Whale (1.9 meters)
-  Southern Sea Otter (10 meters)
-  Pacific Harbor Seal (27.9 meters)
-  Gray Whale & Humpback Whale (52.1 meters)
-  Harbor Porpoise (62.1 meters)



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USCG STATION MONTEREY  
MONTEREY, CALIFORNIA

DATE  
NOVEMBER 2017

SCALE  
1" = 30 meters

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MARINE MAMMAL  
OBSERVER LOCATIONS

PROJECT NO.  
336010017

FIGURE  
2-2

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- zone. Observer(s) shall be equipped with radios or cell phones for maintaining contact with work crews.
- a. Vessel-based visual monitoring within the 120-decibels (Db) and 160-dB AOI shall be conducted during 10 percent of the vibratory pile driving and removal and impact pile driving activities, respectively.
3. Baseline Biological Monitoring will be conducted by an observer prior to the start of construction and will include the following:
    - a. Level A and B harassment zones will be surveyed on two (2) separate days within one (1) week before the first day of construction to establish a baseline of present marine mammals and common behavior within the exclusion zone, construction area, and project vicinity.
    - b. Biological information collected during baseline monitoring will be used for comparison with results of monitoring during pile-driving and pile-removal activities.
  4. Pile driving shall occur only during daylight hours when marine mammals can be visually monitored.
  5. If the observer(s) notice marine mammals (i.e., California sea lions/harbor seals) have hauled-out on the understory structure of the pier where construction would occur, they shall contact the contractor lead and USCG lead. Physical, non-lethal, directed deterrence can be used to deter the animals from the work space.
  6. To aid in monitoring, observer(s) shall scan the waters within the area of potential sound effects using binoculars (10X42 or similar) or spotting scopes (20-60 zoom or equivalent), as well as with the naked eye, 30 minutes prior to construction, for the entirety of pile driving activities, and 30 minutes post-pile driving.
  7. Observer(s) shall use a hand-held or boat-mounted GPS device or rangefinder to verify the required monitoring distance from the project site.
  8. If weather or sea conditions restrict the observer's monitoring abilities, or become unsafe for monitoring vessel(s) to operate, pile installation shall cease until conditions allow for monitoring to resume.
  9. The observer(s) shall monitor the exclusion zone for 30 minutes prior to any pile extraction and driving activities to ensure that the area is clear of any marine mammals. If an individual mammal is observed, pile extraction or driving shall not commence until the individual has left the

exclusion zone for a minimum of a 15-minute period (pinnipeds and small cetaceans) or a 30-minute period (large cetaceans).

10. If a marine mammal enters the exclusion zone during pile replacement work, the observer(s) shall contact notify the USCG and construction crew and activity shall stop until the individual leaves the exclusion zone. Work shall not commence for a period of 15 minutes (pinnipeds and small cetaceans) or a 30-minute period (large cetaceans) after the mammal has left the exclusion zone.
11. During monitoring, observer(s) shall record the following data on daily data sheets (see *Section 3: Reporting* for more details on reporting):
  - a. Date and time of observation start and end
  - b. Activity being monitored (e.g., vibratory or impact pile driving) including:
    - i. Type of driving activity (vibratory or impact)
    - ii. Date/time that pile replacement work begins and end
    - iii. Duration of drive
    - iv. Distance of pile to thresholds
    - v. Attenuation devices utilized
  - c. Count of all pinnipeds, mustelidae, and cetaceans by species
  - d. Size/age/gender (when possible)
  - e. Description of animal behavior
  - f. Any observed behavior changes
  - g. Location and direction of movement
  - h. Time of the observation
  - i. Daily environmental conditions including:
    - i. Weather
    - ii. Visibility
    - iii. Temperature
    - iv. Tide level
    - v. Intensity and direction of current
    - vi. Sea state (e.g., choppy, smooth, etc.)
  - j. The same information identified above (b-h) shall be recorded for any species observed that has not been included in the IHA request and for dead or dying marine mammal species.

- k. Record the date/time of suspension of work due to presence of a marine mammal.
12. If a species is observed within the level A or B zones, that has not been included in this IHA request, the observer(s) shall contact the construction site and request that work immediately cease. Delay procedures including a 30-minute wait period shall be implemented.
13. If a humpback whale is observed within the Level A or B zones, the observer(s) shall contact the construction site and request that work cease until the whale(s) leaves these zones. Work shall not commence until 30 minutes after the last sighting within these zones.
14. If the observer(s) see any dead or dying marine mammal species in the action area, regardless of known cause the observer(s) shall:
  - a. record the species type (if known), date, time, and location of the observation
  - b. take a photograph of the specimen
  - c. suspend all operations and immediately notify NOAA NMFS (for sea otters, notify USFWS)

### **2.2.3 HydroAcoustic Monitoring**

The hydroacoustic monitoring plan has been developed in conjunction with NMFS and USFWS and is included as Appendix B. Key elements of the plan include:

- Using a qualified monitor during pile extraction and driving
- Monitoring timing requirements
- Reference point locations for monitoring
- Details regarding marine mammal exclusion zones and plans to adjust those zones to maintain a safe zone for mammal during construction

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### **SECTION 3 REPORTING**

The observer(s) shall compile daily observation sheets and write a weekly monitoring report summarizing monitoring results, construction activities, and environmental conditions. Daily data sheets and weekly report shall be submitted to NMFS and USFWS on a weekly basis. Non-lethal deterrence reports shall be submitted by the USCG to the Secretary of the Interior (USFWS) and the Secretary of Commerce (NMFS) every 6 months during construction, if non-lethal deterrence is use. Within 90 days of the completion of construction activities, a draft monitoring report shall be submitted to NMFS and USFWS.

#### **3.1 DAILY DATA SHEETS**

Daily monitoring data sheets shall include the following data<sup>1</sup>:

- a. Date and time of observation start and end
- b. Activity being monitored (e.g., vibratory or impact pile driving) including:
  - i. Type of driving activity (vibratory or impact)
  - ii. Date/time that pile replacement work begins and end
  - iii. Duration of drive
  - iv. Distance of pile to thresholds
  - v. Attenuation devices utilized
- c. Count of all pinnipeds, mustelidae, and cetaceans by species
- d. Size/age/gender (when possible)
- e. Description of animal behavior
- f. Any observed behavior changes
- g. Location and direction of movement
- h. Time of the observation
- i. Daily environmental conditions including:
  - i. Weather
  - ii. Visibility

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<sup>1</sup> Example Monitoring Data Sheets can be found at:  
[http://www.westcoast.fisheries.noaa.gov/publications/protected\\_species/marine\\_mammals/killer\\_whales/mm-observ-sheet.pdf](http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/mm-observ-sheet.pdf)

- iii. Temperature
- iv. Tide level
- v. Intensity and direction of current
- vi. Sea state (e.g., choppy, smooth, etc.)
- j. Same information identified above (b-h) for any species observed that has not been included in the IHA request and for dead or dying marine mammals.
- k. Record the date/time of suspension of work due to presence of a marine mammal.

### **3.2 WEEKLY REPORTS**

A summary report shall be submitted to NMFS and USFWS on a weekly basis. The report shall include the following:

- a. Description of the materials and methods used during the weeks monitoring activities.
- b. Summary of weather and sea conditions.
- c. Summary of pile-driving activities, including duration of pile driving, specific pile driving activity (vibration or impact), specific piles being removed and replaced, and mitigations used during pile driving.
- d. Summary of all observations of marine mammals made during daily monitoring (e.g., mammals observed, age, size, behavior, time observed, etc.).
- e. Summary of any species observed within the Level A or B zones that are not included in the IHA request.
- f. Report any pile-driving activities that were ceased due to marine mammal presence.
- g. Summary of dead or dying marine mammal species in the action area, including location and photos (when possible).
- h. Estimate and description of the number of takes (if any) which have occurred thus far.
- i. Summary of hydroacoustic monitoring data.
- j. Copies of daily data sheets.

### **3.3 MARINE MAMMAL MONITORING REPORT**

A draft Marine Mammal Monitoring Report shall be submitted to NMFS and USFWS within 90 days after completion of pile-driving activities. The draft report shall include:

- a. Description of the monitoring protocol, including materials and methods used in monitoring.
- b. An overall summary of the monitoring results.
- c. An estimation of the number of animals harassed during construction.
- d. A discussion on the effectiveness of the monitoring program and mitigation measures utilized during construction.

If comments are received from NMFS or USFWS on the draft Marine Mammal Monitoring Report, a final Marine Mammal Monitoring Report shall be prepared and submitted to both agencies within 30 days of receiving comments. If no comments are received, the draft report will be considered the final product.

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**Appendix A**  
**IHA Application**

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# Revised Request for Incidental Harassment Authorization for Waterfront Repairs at U.S. Coast Guard Station Monterey Monterey, California

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**Request for Incidental Harassment  
Authorization for  
Waterfront Repairs  
at USCG Station Monterey  
Monterey, California**

**Contract Number: HSCG50-14-D-PSL002  
Order Number: HSCG88-16-J-PQQ094**

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**December 2017**

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### ACRONYMS AND ABBREVIATIONS

AOI	Area of Influence
CDFW	California Department of Fish and Wildlife
dB	Decibels
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ESA	Endangered Species Act
HAPC	Habitat Area of Particular Concern
Hz	hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometers
km <sup>2</sup>	square kilometers
L <sub>max</sub>	maximum noise level
LOA	Letter of Authorization
MBNMS	Monterey Bay National Marine Sanctuary
MMPA	Marine Mammal Protection Act
NCCOS	National Center for Coastal Ocean Science
NMFS	National Marine Fisheries Service
NM	nautical miles
NOAA	National Oceanic and Atmospheric Administration
PCFG	Pacific Coast Feeding Group
PTS	Permanent Threshold Shift
PVC	polyvinyl chloride
RMS	root mean square
SPL	sound-pressure Level
UME	unusual mortality event
U.S.	United States
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WFA	Weighting factor adjustment

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## **SECTION 1 DESCRIPTION OF THE ACTIVITY**

### **1.1 INTRODUCTION**

U.S. Coast Guard (USCG) Station Monterey is located at 100 Lighthouse Avenue at the southern end of Monterey Bay in Monterey, California. Station Monterey occupies an upland site and adjacent waterside structures including a 1,700-foot breakwater, a wharf constructed over the breakwater, and floating docks to the east of the wharf. The USCG intends to conduct maintenance on the existing wharf which is used to berth vessels that are critical to support Station Monterey’s mission.

The wharf is constructed of timber and steel material and is supported by 64 piles. In 1995, 47 of the original timber piles were replaced with 14-inch steel pipe piles and the remaining 17 timber piles had polyvinyl chloride (PVC) pile wraps installed. The 17 remaining timber piles are bearing piles that have exceeded their service life partially due to marine bores and the harsh marine environment to which they are exposed, and they need to be replaced. A detailed description of the Proposed Action is provided in Section 1.2 below.

The area including the breakwater, wharf, floating docks, and adjacent waters are used by a variety of marine species and wildlife including seabirds, reptiles, invertebrates, and marine mammals. Species observed include California sea lions, Pacific harbor seals, harbor porpoises, Risso’s dolphins, bottlenose dolphins, southern sea otters, and – in rare instances – gray whales, humpback whales, and killer whales (i.e., West Coast transient, eastern North Pacific offshore, or southern resident stocks).

### **1.2 PROPOSED ACTION**

The proposed replacement of the 17 timber piles requires removal of the existing timber deck, replacing stringers, steel pipe caps, steel support beams, and hardware in order to access the timber piles. The timber piles, approximately 16 to 18 inches in diameter, will be removed using a vibratory extractor. Each timber pile will be replaced with a 14-inch steel pipe pile installed using a vibratory

hammer (the preferred method) and each pipe pile will be positioned and installed in the footprint of the extracted timber pile. Pile proofing will be conducted via impact hammer. If, due to substrate or breakwater armor, a pipe pile is unable to be driven to 30 feet below the mud line using a vibratory hammer, then an impact hammer will be used; and if the pile cannot be driven with an impact hammer, the pipe pile would be posted onto the armor stone. The steel pipe piles would not be filled with concrete. Materials and hardware removed to allow access to conduct pile work would be replaced with in-kind materials.

Pile-driving activities are expected to occur for an estimated minimum of three (3) days and a maximum of eight (8) days of the total construction time. It is assumed that driving time would be approximately 20 minutes per pile for vibratory or impact pile driving. It is assumed that vibratory extraction of the existing piles would take approximately 10 minutes per pile. Pile driving and extraction would therefore result in an estimated of 240 minutes per day; 510 minutes for the total project or approximately 8.5 hours of underwater and airborne noise generation from pile driving/extraction activities over the course of the project construction.

Pile extraction and pile driving activities are expected to result in take of marine mammals as these activities exceed the National Marine Fisheries Service (NMFS) underwater and airborne noise threshold levels for marine mammals. It is anticipated that incidental take by Level B harassment, as defined by Title 50, Code of Federal Regulations, Part 216.3, would result from implementation of the proposed project. Detailed information on take estimates and anticipated impacts are provided in Sections 6 and 7, respectively.

Levels of harassment for marine mammals are defined in the Marine Mammal Protection Act (MMPA) of 1972. Level A harassment is defined as “Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” Level B harassment is defined as “Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.”

In addition to incidental take resulting from noise during pile driving and/or extraction, intentional take to encourage animals to leave the work zone may be allowed under Section 109(h)(1) of the MMPA. This section permits federal, state, and local officials to take marine mammals in the course of official duties (e.g., the protection or welfare of a marine mammal, protection of public health and welfare, and non-lethal removal of nuisance animals). Because this take is intentional in nature, authorization is not requested in this incidental harassment application package.

Sound attenuation measures including implementation of a bubble curtain and cushion pads during impact pile driving would be used. Pile extraction and driving equipment would be located on a barge and no staging would be located on the existing wharf. The extensive use of the breakwater and wharf by seabirds and California sea lions poses a challenge for conducting the waterfront repairs because they have become accustomed to a noisy waterfront and are not easily deterred. However, the USCG has successfully completed other construction activities at the project site, including installation of the Hawksbill floating dock in 2004, replacement of an Aid to Navigation device in 2008, and conducting repairs to the small boat and patrol boat floating docks between November 2008 and February 2009. Monitoring of seabirds and marine mammals at the project site was conducted by the USCG during these construction projects and behavioral disturbance of seabirds and marine mammals was determined to be minor and did not cause long-term or permanent changes in behavior (Phillips and Harvey 2004; Hoover and Harvey 2008; Harvey and Hoover 2009).

A full list of mitigation measures has been developed to avoid Level A (injury) harassment and reduce the potential effects from Level B (disturbance) harassment to marine mammals during pile-extraction and pile-driving activities and is included in Section 10.



No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.



FIGURE 1-2

Project Site

IHA

No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.

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## SECTION 2

### DATES, DURATION, AND SPECIFIED GEOGRAPHIC REGION

The proposed pile extraction and driving activities will occur between June 15 and October 15, 2018. No work will begin until all necessary permits and approvals are acquired and an approved monitoring plan is in place.

Under the Proposed Action, the repairs will require a maximum of 60 work days for completion, with up to 8 days of pile driving and/or extraction activities. Pile driving and extraction is estimated to take 240 minutes per day (4 hours), and approximately 8.5 hours over the course of project construction.

#### 2.1 SPECIES AND NUMBERS OF MARINE MAMMALS

There are 9 marine mammal species that may occur or move through the waters near or within the project area. These include the California sea lion, Pacific harbor seal, harbor porpoise, Risso’s dolphin, bottlenose dolphin, southern sea otter, and—in rare instances—gray whales, humpback whales, and killer whales (West Coast transient, eastern North Pacific offshore, or southern resident stocks). With the exception of the southern sea otter, which is under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS), these marine mammals are managed under the jurisdiction of the NMFS, a division of the National Oceanic and Atmospheric Administration (NOAA).

##### 2.1.1 California Sea Lion

The California sea lion (*Zalophus californianus*) belongs to the “eared seal” family, Otariidae, referring to the external ear flaps not shared by other pinniped families. California sea lions are sexually dimorphic: males reach average lengths of 7.5 feet long and weigh approximately 700 pounds, whereas females are smaller, at approximately 6 feet long and 240 pounds. They have broad foreflippers and a long, narrow snout. Males have a robust body, broad forehead, and dark brown coats, while females and juveniles have a more slender body with a slightly lighter coat. Sexual maturity occurs within 4 to 5 years, and their lifespan is 20 to 30 years. California sea lions are social animals and can be observed in groups of several hundred individuals onshore. They are fast, agile swimmers and are able to dive

to depths of up to 1,760 feet deep. They feed mainly in upwelling areas on a variety of prey such as squid, anchovies, mackerel, rockfish, and sardines, as well as taking fish from commercial fishing gear, sport-fishing lines, and at fish passage facilities (NOAA 2015a). Although California sea lions forage and conduct many activities in the water, they also use “haul-outs” – shoreline areas where pinnipeds congregate to rest, socialize, breed, and molt. California sea lions breed in Southern California and along the Channel Islands during the spring. After the breeding season, males migrate northward up the Pacific Coast and enter Monterey Bay, where they primarily haul-out at Año Nuevo State Park (in San Mateo County) and the Monterey Breakwater. Immature and/or nonbreeding males are year-round residents at the Monterey Breakwater. California sea lions are the most abundant marine mammal in the project area and regularly use the Monterey Breakwater and portions of the pier as a haul-out site.

### **2.1.2 Pacific Harbor Seal**

The Pacific harbor seal is 1 of 5 subspecies of *Phoca vitulina*, or the common harbor seal. They are part of the “true seal” family, Phocidae, with a rounded head, visible ear canal, short, concave, dog-like snouts, and short forelimbs, which limit locomotion on land. Males are slightly larger than females, weighing up to 245 pounds and reaching approximately 6 feet in length. Their coloring is generally blue-gray on the back with light and dark speckling. Although generally solitary in the water, harbor seals tend to come ashore at haul-outs (usually rocks, reefs, or beach), which are used for rest, thermoregulation, social interaction, birthing, nursing pups, and to avoid predators. Their prey consists mainly of fish, shellfish, and crustaceans, and Pacific harbor seals are capable of both shallow and deep dives during hunting depending on prey availability. Mating occurs at sea, and females give birth during the spring and summer. Pups are ready to swim minutes after being born, and are nursed for 24 days on average (NOAA 2015b). They display year-round site fidelity, though they do travel approximately 185 to 310 miles to find food or suitable breeding areas. In California, there are approximately 400 to 600 haul-out sites located on a mixture of rock shores, intertidal sand bars, and beaches associated with the mainland and offshore islands (NOAA 2015c). Pacific harbor seals are not known to regularly use the Monterey Breakwater as a haul-out site, but may use beaches or other relatively low-gradient areas to haul-

out in the project area, and in areas nearby such as beaches along Cannery Row in the City of Monterey.

### **2.1.3 Harbor Porpoise**

The harbor porpoise (*Phocoena phocoena*) is a member of the Phocoenidae family. They generally occur in groups of 2 to 5 individuals and are considered to be shy, nonsocial animals. The harbor porpoise has a small, robust body with a short, blunt beak and medium-sized triangular dorsal fin. They can grow to approximately 5 to 5.5 feet in length and weigh approximately 135 to 170 pounds. Females are slightly larger than the males, reach sexual maturity at 3 to 4 years, and may give birth every year for several years in a row. Gestation lasts for 10 to 11 months, and calves are nursed for 8 to 12 months. They are typically found in waters less than 250 feet deep within bays, estuaries, and harbors. Their prey base consists of demersal and benthic species, mainly schooling fish and cephalopods (NOAA 2014a). The harbor porpoise is a resident species of Monterey Bay and could occur within the project area.

### **2.1.4 Risso's Dolphin**

Risso's dolphin (*Grampus griseus*), sometimes called the "gray dolphin," is a member of the Delphinidae family. They can reach lengths of approximately 8.5 to 13 feet and weigh from 660 to 1,100 pounds, with males and females usually approximately the same size. Their head is bulbous with a vertical crease and indistinguishable beak. Their dorsal fin is curved or sickle-shaped and is located mid-way down the back. Calves are black, dark gray, or brown with a dark cape and saddle with little or no scarring on the body. As they age, their coloration lightens to pale gray or almost white, with bodies displaying heavy scarring. Risso's dolphins generally occur in groups of 5 to 50 individuals, but typically average from 10 to 30 individuals. The majority of their diet consists of squid, but they also feed on fish, krill, and other cephalopods mainly at night when their prey is closer to the surface. Not much is known about reproduction, but individuals become sexually mature when they reach a length of approximately 8.5 to 9 feet. Breeding and calving may occur year-round with a gestation period of 13 to 14 months and most births occurring from fall to winter in California waters. The estimated lifespan of a Risso's dolphin is at least 35 years. They are found in waters

generally greater than 3,300 feet and seaward of the continental shelf and slopes. The California/Oregon/Washington stock is estimated to be between 13,000 and 16,000 individuals (NOAA 2012). They have a low potential to occur within the project area.

### **2.1.5 Bottlenose Dolphin**

The bottlenose dolphin (*Tursiops truncatus*) is a member of the Delphinidae family. The bottlenose dolphin has a robust body and a short, thick beak, with coloration ranging from light gray to black with lighter coloration on the belly. Inshore animals are smaller and lighter in color, and offshore animals are larger, darker in color, and have smaller flippers. Bottlenose dolphins range in length from 6 to 12.5 feet and in weight from 300 to 1,400 pounds, with males slightly larger than females. Females reach sexual maturity at 5 to 13 years, and males at 9 to 14 years, with sexual maturity varying by population. Calving occurs every 3 to 6 years on average, after a 12-month gestation period, and are weaned at 18 to 20 months of age. The lifespan for males is 40 to 45 years, and is more than 50 years for females. They generally occur in groups of 2 to 15 individuals, with offshore herds sometimes including several hundred individuals (NOAA 2015d). California coastal bottlenose dolphins are typically found within approximately 0.6 miles of shore (NOAA 2008). They are generalists in their feeding habits and prey on a variety of organisms endemic to their habitat, foraging both individually and cooperatively. Coastal bottlenose dolphins prey on benthic invertebrates and fish and use high frequency echolocation to locate and capture prey. They use multiple feeding strategies, including “fish whacking,” in which they strike a fish with their flukes and knock it out of the water (NOAA 2015d). The California coastal bottlenose dolphin has been consistently sighted in and around Monterey Bay and could occur within the project area (NOAA 2008).

### **2.1.6 Southern Sea Otter**

One species of the Mustelidae family is known to occur within the central California coast: the southern sea otter (*Enhydra lutris nereis*). The southern sea otter was listed as threatened under the Endangered Species Act (ESA) on January 14, 1977. The southern sea otter is the largest member of the Mustelidae and the smallest species of marine mammal in North America. Southern sea otters have

evolved to inhabit a narrow ecological zone, adapting to the nearshore ecosystem and preferring rocky shoreline with kelp beds. Adult sea otters average approximately 65 pounds for males and 45 pounds for females; average lengths are approximately 4.5 feet and 4 feet for males and females, respectively. The forepaws of southern sea otters are clawed and used for feeding and grooming, while the hind limbs are posteriorly oriented and flipper-like for swimming. The tail is less than one-third the body length, and of uniform thickness from base to tip. The southern sea otter feeds on a variety of benthic invertebrates (e.g., sea urchins, abalone, octopus, crabs) and are usually found in areas where the water depth is less than 60 feet. Adult female sea otters typically give birth to one pup each year, with births peaking in the spring and fall. Male sea otters aggregate at the northern and southern limits of their range in winter and early spring. Southern sea otters may live for 15 to 20 years in the wild. Kelp beds provide important foraging and shelter habitat for this species (USFWS 2003). The southern sea otter is a resident species of Monterey Bay and is regularly observed within the Monterey Harbor. They have a high potential to occur within the project area.

### **2.1.7 Whales**

Whales would typically travel offshore within coastal waters; however, in rare instances, whales could occur within or near Monterey Harbor. The 3 species most likely to occur would be gray, killer, and humpback whales.

**Gray Whale.** Gray whales (*Eschrichtius robustus*) are large baleen whales and the only species in the Eschrichtiidae family. They grow to approximately 50 feet in length and weigh approximately 80,000 pounds, with females slightly larger than males. They are one of the most frequently seen whales along the California coast, easily recognized by their mottled gray color and lack of dorsal fin; instead, they have a “dorsal hump” and a series of 8 to 14 small bumps, known as “knuckles.” Adult whales carry heavy loads of attached barnacles, which add to the mottled appearance. Gray whales are the only baleen whales known to feed on the sea floor, where they scoop up bottom sediments to filter out benthic crustaceans, mollusks, and worms. They are found mainly in shallow coastal waters in the North Pacific Ocean and make one of the longest annual migrations of any mammal, migrating in the fall from their summer feeding grounds in the northern Bering and Chukchi seas and the northern Pacific coast, south along the coast of

North America to spend winter in their breeding and calving areas off the coast of Baja California, Mexico. From mid-February to May, the Eastern North Pacific stock of gray whales can be seen migrating northward with their calves along the West Coast (NOAA 2013a). Although gray whales are not resident species within the project area, during their annual migration they can occur within approximately 2 miles of the coast of Monterey Bay (Monterey Bay National Marine Sanctuary [MBNMS] 2014).

**Killer Whale.** The killer whale (*Orcinus orca*) is a member of the Delphinidae family and is characterized by its distinct black and white color pattern. It is black on top, with white undersides and white patches near its eyes, and has a variable gray or white saddle behind its dorsal fin. They exhibit sexual dimorphism; the males reach up to 32 feet and 22,000 pounds, while the females reach up to 28 feet and 16,500 pounds. Males live for approximately 30 years, but can live as long as 50 to 60 years, while females usually live for approximately 50 years, but can live as long as 100 years. Female killer whales become sexually mature after reaching approximately 15 to 18 feet and carry their calves for close to a year and a half. They live within matriarchal societies and are highly social animals, relying on underwater sound for orientation, feeding, and communication. Their diet, which often depends on location or specific stock, consists of fish, sharks, sea birds, and other marine mammals. Three distinct forms of killer whales are recognized: resident, transient (Bigg's), and offshore. *Resident whales* have a rounded dorsal fin that is curved and tapering, primarily eat fish, and occur in large "pods" of social groups. *Transient whales* have a straighter dorsal fin and only have two patterns of saddle patch pigmentation, feed almost exclusively on other marine mammals, and are found in social units of less than 10 whales. *Offshore whales* are similar to resident whales, but have multiple nicks on the edge of their dorsal fin, smaller overall size, and males and females tend to be more similar in size. They often occur 9 miles or more offshore, in groups of 20 to 75 individuals, and feed primarily on fish and occasionally sharks (NOAA 2016a). Transient killer whales prey on gray whales and California sea lions within the Monterey Bay National Marine Sanctuary (MBNMS), and have the potential to occur in the project area (MBNMS 2014).

**Humpback Whale.** The humpback whale (*Megaptera novaeangliae*) is known for its long pectoral fins, which can reach up to 15 feet long and give them increased

maneuverability. They frequently perform aerial displays such as breaching or slapping the surface of the water with their pectoral fins, tails, or heads. Like all baleen whales, adult females are larger than adult males, reaching up to 60 feet in length and weighing from 25 to 40 tons. Their body coloration is mostly dark gray with a variable amount of white on their pectoral fins and belly. This variation is so distinctive between individuals that the pigmentation pattern on the undersides of their flukes is used to identify individual whales. Humpbacks in the Pacific Ocean can be found in high latitude feeding grounds such as the Gulf of Alaska during the summer, and migrate to calving grounds in subtropical or tropical waters such as the Hawaiian Islands during the winter; it is the farthest migration of any mammal. Humpbacks spend the majority of their time in the summer feeding and building up fat stores to live off of during the winter. They filter feed on tiny crustaceans (mostly krill), plankton, and small fish, and can consume up to 3,000 pounds of food per day. They use air bubbles, including a unique variant called “bubble netting,” to herd, corral, or disorient fish. Mating occurs in their wintering grounds, during which males sing complex songs that can last up to 20 minutes and be heard 20 miles away. Gestation lasts approximately 11 months, and newborns are 13 to 16 feet long and weigh approximately 1 ton (NOAA 2016b). Humpback whales are one of the more commonly observed large baleen whales in the MBNMS, mostly seen during summer and fall as they are feeding (NOAA 2014b). Both the Mexico Distinct Population Segment (DPS) and the Central America DPS can occur in the vicinity of the project area.

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**SECTION 3**  
**AFFECTED SPECIES STATUS AND DISTRIBUTION**

**3.1 INTRODUCTION**

There are 9 marine mammal species that may occur or transit the waters near the project area. Three of these species are listed under the federal ESA: Southern sea otters, which are expected to regularly occur in Monterey Harbor; the southern resident killer whale and the humpback whale Central America DPS, both of which are considered rare in Monterey Bay. Table 3-1 presents a stock assessment and relative occurrence of marine mammal species that may occur in the project area.

**Table 3-1. Stock Assessment of Marine Mammals Present in the Vicinity of the Monterey Breakwater**

Species	Stock(s)	Stock(s) Abundance	Relative Occurrence in Monterey Breakwater Vicinity	Season(s) of Occurrence
California sea lion <i>Zalophus californianus</i>	United States (U.S.) stock (Pacific temperate)	296,750	Common	Year-round
Pacific harbor seal <i>Phoca vitulina</i>	California stock	30,968	Common	Year-round
Harbor porpoise <i>Phocoena</i>	Monterey Bay stock	3,715	Rare to occasional	Year-round
Risso's dolphin <i>Grampus griseus</i>	California/Oregon/ Washington stock	6,272	Rare to occasional	Year-round
Bottlenose dolphin <i>Tursiops truncatus</i>	California coastal stock	323	Rare to occasional	Year-round
Southern sea otter <i>Enhydra lutris nereis</i>	Mainland and San Nicolas Island stock	2,941	Common	Year-round
Gray Whale <i>Eschrichtius robustus</i>	Eastern North Pacific stock	20,990	Rare to occasional	Year-round
Killer whale <i>Orcinus orca</i>	West Coast transient stock	240	Rare to occasional	Year-round
	Eastern North Pacific offshore stock	243	Rare to occasional	Year-round
	Southern resident stock	78	Rare to occasional	During winter months
Humpback whale <i>Megaptera novaeangliae</i>	California/Oregon/ Washington stock	1,918	Rare to occasional	Year-round

Sources: (NOAA 2008, 2011a, 2011b, 2013b, 2014c, 2014d, 2015c, 2015e, 2015f, 2015g; USFWS 2014).

### **3.2 CALIFORNIA SEA LION**

Based on genetic variations in the mitochondrial DNA, there are five genetically distinct populations of California sea lions: Pacific temperate, Pacific subtropical, Southern Gulf of California, Central Gulf of California, and Northern Gulf of California. Members of the Pacific temperate population, which range between Canada and Baja California, occur within the project area. Because all age and sex classes are not all ashore at the same time, instead of counting the entire population of sea lions, population assessment is based on pup counts during the breeding season. Population size is then estimated from the number of births and proportion of pups in the population. Based on pup counts for rookeries in Southern California in 2008, the population estimate is 296,750 individuals. More recent pup counts made in 2011 totaled 61,943 individuals, the highest recorded to date. Estimates of population size based on these counts are currently being developed, along with new estimates of the fraction of newborns in the population. Statistical analysis of the pup counts from 1975 through 2011 determined an approximate 5.4 percent annual growth rate between 1975 and 2008. However, this does not take into account decreases associated with El Niño years observed in 1983, 1984, 1992, 1993, and 2003. During these periods, pup counts decreased by between 20 and 64 percent. As a result of the large numbers of sea lion strandings in 2013, NOAA declared an unusual mortality event (UME). The exact causes of this UME are still unknown, but hypotheses include nutritional stress of pups resulting from lack of forage fish available to lactating mothers, and unknown disease agents. The U.S. stock is not listed as *endangered* or *threatened* under the ESA or as depleted under the MMPA (NOAA 2015e).

### **3.3 PACIFIC HARBOR SEAL**

Widely distributed in both the North Atlantic and North Pacific, Pacific harbor seals have the broadest range of any pinniped. In the eastern North Pacific, they are found in near-shore coastal and estuarine habitats from Mexico to Alaska. Of the 3 recognized populations of Pacific harbor seals along the West Coast, the California stock occurs within California coastal waters. Although the different populations are genetically distinct, like the California sea lion, the geographical boundary between the Oregon/Washington Coastal stock (Oregon and Washington Outer Coast and Inland Waters of Washington) and the California

stock is determined by the boundary between Oregon and California. Similar to the California sea lion, population assessments are extrapolated by observations of the number of Pacific harbor seals ashore at a given time. However, unlike other pinnipeds, a complete pup count is not possible due to the fact that harbor seal pups enter the water almost immediately after birth. The estimated population of the California stock is 30,968, based on the most recent harbor seal counts performed during May-July 2012. Between 1981 and 2004, population counts increased, followed by a decrease in population in subsequent surveys conducted in 2009 and 2012. A partial reason for this decrease could be mortalities associated with shootings, interactions with recreational hook and line fisheries, separation of mothers and pups due to human disturbance, dog bites, entrainment in power plants, and vessel and vehicle strikes (NOAA 2015c).

### **3.4 HARBOR PORPOISE**

Harbor porpoises have a broad range in both the Atlantic and Pacific oceans. In the Pacific, they are found from Point Conception, California to Alaska and across to Kamchatka and Japan. The harbor porpoise population along the Pacific coastline consists of 8 distinct stocks (the Monterey Bay, San Francisco-Russian River, northern California/southern Oregon, northern Oregon/Washington coast, Inland Washington, Southeast Alaska, Gulf of Alaska, and Bering Sea stocks). The Monterey Bay stock, consisting of 3,715 individuals, is the population that could occur within the project area. These estimates are based on aerial surveys conducted in 2011 along the coast out to either the 200-meter depth contour or 15 nautical miles (NM) from shore. The latest population abundance estimate is significantly greater than previous estimates dating to 1988, but further analyses is required to estimate current population trends. The Harbor porpoise in California is listed neither as *threatened* or *endangered* under the ESA nor as *depleted* under the MMPA (NOAA 2014c).

### **3.5 RISSO'S DOLPHIN**

The California/Oregon/Washington stock of Risso's dolphin is commonly observed on the shelf in the Southern California Bight and in slope and offshore waters of California, Oregon, and Washington. Dolphins found off California during winter months are thought to shift northward into Oregon and

Washington as water temperatures increase in late spring and summer. Current population estimates are taken from 2 shipboard surveys within 300 NM of the coasts of California, Oregon, and Washington in the summer and autumn of 2005 and 2008. The 2005-2008 geometric mean abundance estimate for the California/Oregon/Washington stock based on the 2 most recent ship surveys is 6,272 individuals. This multi-year average abundance estimate is the most appropriate for management within U.S. waters since as oceanographic conditions vary, Risso's dolphins may spend time outside the U.S. Exclusive Economic Zone. Abundance estimates range from approximately 4,000 to 11,000 individuals in California waters for 5 separate surveys conducted between 1991 and 2008, with no apparent trend in abundance, likely due to inter-annual variability in the distribution of animals within the ship survey area. There are no known habitat issues of concern for this species, and they are not listed as *threatened* or *endangered* under the ESA or as *depleted* under the MMPA (NOAA 2011a).

### **3.6 BOTTLENOSE DOLPHIN**

The California coastal bottlenose dolphin population ranges primarily from Point Conception south into Mexican waters, but have been consistently sighted in central California as far north as San Francisco since the 1982-83 El Niño, which resulted in increased water temperatures off California. California coastal bottlenose dolphins move in and out of areas along the coast; over 80 percent of the dolphins identified in Santa Barbara, Monterey, and Ensenada (Baja California) have also been identified off San Diego. The most recent estimate of the California coastal stock is 323 individuals, based on photographic mark-recapture surveys conducted along the San Diego coast in 2004 and 2005. However, this estimate does not reflect that approximately 35 percent of dolphins encountered lack identifiable dorsal fin marks; which could make the true population size closer to 450 to 500 individuals. The population size has been stable for approximately 20 years, based on a comparison of mark-recapture abundance estimates for the periods 1987-89, 1996-98, and 2004-05. The California coastal stock is listed neither as *threatened* or *endangered* under the ESA nor as *depleted* under the MMPA (NOAA 2008).

### **3.7 SOUTHERN SEA OTTER**

Southern sea otters currently range from San Mateo County in the north to Santa Barbara County in the south. Historically, southern sea otters ranged along the coast of Oregon, California, and as far south as Punta Abreojos, Baja California, before hunting of southern sea otters for pelts in the 1700s and 1800s extirpated the species throughout most of its range, except for a small population near Bixby Creek in Monterey County. They have gradually expanded northward and southward along the central California coast since receiving protection under the International Fur Seal Treaty in 1911. The official population count in 2013 was 2,941 individuals, which included the 3-year running average for the mainland population (2,882) and the previous year’s high count at San Nicolas Island (59). The 2011 mainland spring census was not completed due to weather conditions; so this 3-year average is calculated from the 2012 and 2013 raw counts. The overall growth trend for the past five years has been generally flat, although there is considerable regional variation within their range. The southern sea otter is listed as a federally *threatened* species under the ESA, is designated as a fully protected mammal under California state law, and is considered to be a *strategic stock* and *depleted* under the MMPA (USFWS 2014). The Southern sea otter is expected to be present in the project area during construction.

### **3.8 WHALES**

Although all whales are infrequent visitors within the Level A and Level B zones, the USCG will stop construction activities if any of these individuals enter either of these zones.

**Gray Whale.** Although gray whales were once found in three populations across the globe, the Atlantic population is believed extinct, and the species is now limited to the Pacific Ocean, where they are divided into eastern and western stocks. Eastern North Pacific gray whales migrate each year along the West Coast of North America. Most whales in the Eastern North Pacific stock feed in the Chukchi, Beaufort, and northwestern Bering seas, except for a group of approximately 200 whales referred to as the “Pacific Coast Feeding Group” (PCFG) that summer and feed along the Pacific coast between Kodiak Island, Alaska, and northern California. The most recent abundance estimate for the

Eastern North Pacific population is from the 2010/2011 southbound survey count and is 20,990 individuals. The 2012 abundance estimate for the range of the PCFG is 209. The population size of this stock has increased over several decades despite an UME in 1999 and 2000, and has remained stable since the mid-1990s. This stock of gray whales was removed from the List of Endangered and Threatened Wildlife in 1994 (NOAA 2015f).

**Killer Whale.** Killer whales are found in all parts of the oceans, with the most abundant populations occurring in cooler waters off the coast of Antarctica, Norway, and Alaska. There are 8 killer whale stocks occurring within the North Pacific Ocean that are further classified as being either *resident*, *transient*, or *offshore* populations. These populations differ according to genetics, morphology, behavior, and ecology. Three stocks have potential to occur in the project vicinity: the West Coast transient, eastern North Pacific offshore, and the southern resident populations.

The West Coast transient killer whale stock includes killer whales occurring from California to southeastern Alaska. From 1975 to 2012, 521 individual whales have been identified, with 217 part of the “outer coast” subpopulation and 304 belonging to the more well-known “inner coast” population. Based on a 2006 mark-recapture study, the entire West Coast transient population is currently estimated at 243 individuals, although this estimate does not include the “outer coast” subpopulation or whales from California. The difference in these numbers can be attributed to differing sampling methods, geographic range of individual pods, or newly identified individuals. Between the mid-1970s and mid-1990s, the West Coast transient stock increased due to higher birth and survival rates, coupled with an increase of individuals immigrating into the area. This growth overlapped with a decrease in their primary prey, the Pacific harbor seal. Since the mid-1900s, growth of the West Coast transient stock has slowed. This stock is not designated as *depleted* under the MMPA or listed as *threatened* or *endangered* under the ESA (NOAA 2013b). This population has potential to occur in Monterey Bay during the work period.

The eastern North Pacific offshore killer whale stock occurs between California and Alaska. The current population estimate, based on shipboard line-transect surveys conducted between 2005 and 2008, is 240 individuals, with a minimum

population of 162 individuals. However, this is a conservative estimate, due to the lower frequency in observations of offshore stock. According to NOAA's *Killer Whale: Eastern North Pacific Offshore Stock Assessment*, there are no data available on the current population trend for the eastern North Pacific offshore stock. They are listed neither as *threatened* or *endangered* under the ESA nor as *depleted* under the MMPA (NOAA 2011b). This population of killer whale has potential to occur in Monterey Bay during the work period.

Resident killer whales that may occur off the coast of California belong to the eastern North Pacific southern resident killer whale population (J, K, and L pods). Although this killer whale population's spring, summer, and fall range typically includes the Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait, they have been sighted as far south as Monterey Bay and central California during winter months. The most recent population count taken in 2014 is 78 whales, an estimate which serves as both a best estimate of abundance and a minimum estimate of abundance. Since the first complete census of this stock in 1974 (71 animals counted), the population number has fluctuated annually. Since the peak census count of 99 individuals in 1995, the population has declined. They were listed as *endangered* under the ESA in 2005, and the stock is considered as a *strategic stock* under the MMPA (NOAA 2015g). This population has a low potential to be present in Monterey Bay or Harbor during the work period.

**Humpback Whale.** The California/Oregon/Washington stock of humpback whales includes animals that appear to be part of two separate feeding groups, one group in California and Oregon and the other in northern Washington and southern British Columbia. The best estimate of population size for the California and Oregon group is taken as the 2008-2011 Darroch estimate of 1,729 individuals. The best population estimate for the Washington and British Columbia group is 189 individuals, taken from a range of photographic mark-recapture abundance estimates taken in 2005. Combining these abundance estimates gives an estimate of 1,918 whales for the California/Oregon/Washington stock. The current population trend for this stock is a 6 to 7 percent growth rate. The Mexico DPS was listed as *threatened* and the Central America DPS was listed as *endangered* in December 2016. The Central America DPS is known to feed along the west coast of the US and has the potential to occur in the vicinity of the project area.

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## SECTION 4 TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

### 4.1 TAKE AUTHORIZATION REQUEST

The USCG requests an authorization from the NMFS and USFWS, Under Section 101 (a)(5)(D) of the MMPA, for incidental take by Level B harassment (as defined by Title 50 Code of Federal Regulations, Part 216.3) of small numbers of marine mammals, specifically California sea lions, Pacific harbor seals, harbor porpoise, Risso’s dolphin, bottlenose dolphin, Southern sea otter, gray whales, killer whales, and humpback whales during performance of repairs to the pier at USCG Station Monterey in Monterey Bay. With implementation of the measures outlined in Section 10 of this request, no injury to marine mammals (i.e., Level A harassment) is anticipated. The USCG requests an Incidental Harassment Authorization (IHA) for the incidental take of marine mammals as described in this application. The USCG may request an annual renewal of the IHA if the project is not completed within the authorized year. The USCG is not requesting a multi-year Letter of Authorization (LOA) at this time because the activities described herein are not expected to rise to the level of injury or death, which would require an LOA.

A detailed description of the acoustic exposure assessment methodology used to quantify potential exposures to marine mammals resulting from underwater and airborne noise generated during pile extraction and pile driving can be found in Section 6 of this request. The methodology used generates conservative take estimates because all animals are assumed to be exposed 100 percent of the time. Temporary behavioral responses are expected to occur as a result of the Proposed Action; however, the extent of the response would depend on the species, received level of sound, and distance from the work area.

### 4.2 METHOD OF TAKE

The Proposed Action has the potential to result in Level B incidental take of marine mammals resulting from underwater and airborne noise disturbance during the removal of existing piles and driving of new piles. Our evaluation assumes underwater noise will encompass all takes and therefore airborne takes are not separated out to avoid double

counting species. With implementation of mitigation measures described in Section 10, Level A harassment is not anticipated.

## SECTION 5 TAKE ESTIMATES FOR MARINE MAMMALS

This section describes potential impacts and take estimates resulting from noise levels expected to be generated during pile driving and extraction activities.

### 5.1 APPLICABLE NOISE CRITERIA

In 2010, NMFS established interim thresholds regarding the exposure of marine mammals to high-intensity noise that may be considered take under the MMPA. *Level A harassment* is defined as “Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” *Level B harassment* is defined as “Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering.”

Updated NOAA guidance on assessing the effects of underwater noise on marine mammals for agency impact analysis was finalized in August 2016 (NOAA 2016d). This guidance is primarily related to Level A harassment. Changes from the 2010 interim guidance to the final 2016 guidance include expanding the thresholds to account for factors such as distance, duration, and source. Note that this project had an approved IHA in 2015 using a detailed sound assessment and independent model for both Level A and B effects. We have revised species stock information and associated Level B take using the 2010 interim thresholds and have revised the Level A (exclusion zone) using the updated 2016 noise guidance as shown in Table 5-1.

There are no official thresholds for airborne noise; however, guideline thresholds have been established based on pinniped haul-out behavioral disturbance from airborne construction noise (Washington State Department of Transportation [DOT] 2016). Acoustic criteria for marine mammals are shown in Table 5-1.

**Table 5-1. Injury and Behavioral Disruption Thresholds for Airborne and Underwater Noise**

Functional Hearing Group	Airborne Marine Construction Criteria (Impact and Vibratory Pile Driving)	Underwater Continuous Noise Criteria (e.g., vibratory pile driving)		Underwater Pulsed Noise Criteria (e.g., impact pile driving)		
	Level B Threshold <sup>1</sup>	Level A Threshold (PTS)	Level B Threshold	Level A Threshold		Level B Threshold
	dB Threshold	dB SEL <sub>cum</sub>	dB RMS	Peak SPL	dB SEL <sub>cum</sub>	dB RMS
Low-Frequency Cetaceans (Gray whale, Humpback whale)	N/A	199	120	219	183	160
Mid-Frequency Cetaceans (Risso's dolphin, bottle nose dolphin, killer whale)	N/A	198	120	230	185	160
High-Frequency Cetaceans (Harbor porpoise)	N/A	173	120	202	155	160
Phocid Pinnipeds (Pacific harbor seals)	90	201	120	218	185	160
Otariid Pinnipeds (California sea lions)	100	219	120	232	203	160
Mustelids (Southern sea otter <sup>2</sup> )	100	180	120		180	160

<sup>1</sup> The airborne disturbance guideline applies to hauled-out pinnipeds or surfaced southern sea otters.

<sup>2</sup> NMFS does not have specific criteria for Southern sea otters.

*Notes:*

dB = decibel

μPa = microPascal

RMS = root mean square

PTS = Permanent Threshold Shift PTS

Because species in the vicinity are counted in the take estimates for underwater noise, we are not including “take” as it relates to airborne noise per personal communication with Stephanie Egger (NOAA NMFS May 30, 2017). Based on the proposed construction methods and mitigation measures (e.g. shutting down when individuals enter the exclusion zone), no Level A harassment is anticipated as a result of implementation of the Proposed Action.

## **5.2 ESTIMATION OF PILE EXTRACTION AND DRIVING SOUND**

Pile installation methods to be used in implementing the Proposed Action have not been confirmed at this time; however, either an impact (i.e., diesel or hydraulic) hammer or vibratory hammer will be used. If a vibratory hammer is used, an impact hammer would still be used to proof load bearing piles. Because installation and extraction methods have not been confirmed, an analysis of both pile driving methods was conducted; however, because take would only be counted once we have used the method of vibratory pile driving as it provides the more conservative method of take.

The following section summarizes the distances to the various sound thresholds that are used in the Area of Influence (AOI) and resulting estimate of potential take of marine mammals.

### **5.2.1 Underwater Noise from Vibratory Pile Extraction and Driving**

Level B analysis:

The NMFS and USFWS typically use the practical spreading model to estimate transmission loss of sound through water. Applying the practical spreading model, the distance to the 120 dB RMS (Level B threshold for marine mammals) would extend miles beyond the source. However, that model does not take into consideration underwater sound barriers that would stop or diffuse sound, such as the Monterey Breakwater, for the proposed project.

To more accurately estimate the extent of underwater noise, the software package *SoundPlan* was used to simulate the effect of the Monterey Breakwater in reducing underwater sound transmission from the proposed project (Illingworth and Rodkin, Inc. 2012). Table 5-2 shows the results of the modeled underwater noise analysis for where 120 dB RMS (Level B threshold) levels would stop, and Figure 5-1 shows the pattern of sound expected from vibratory pile extraction and pile installation, taking into account shielding from the Monterey Breakwater. From these data, an AOI of approximately 7.3 square kilometers (km<sup>2</sup>) was established. The modeled distances shown in the table below are likely an overestimate of the



FIGURE 5-1

Unattenuated Underwater RMS Levels During Vibratory Pile Extraction and Driving

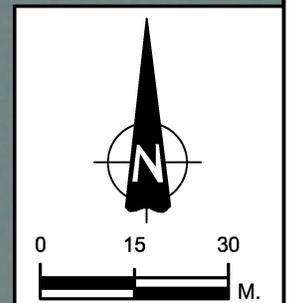
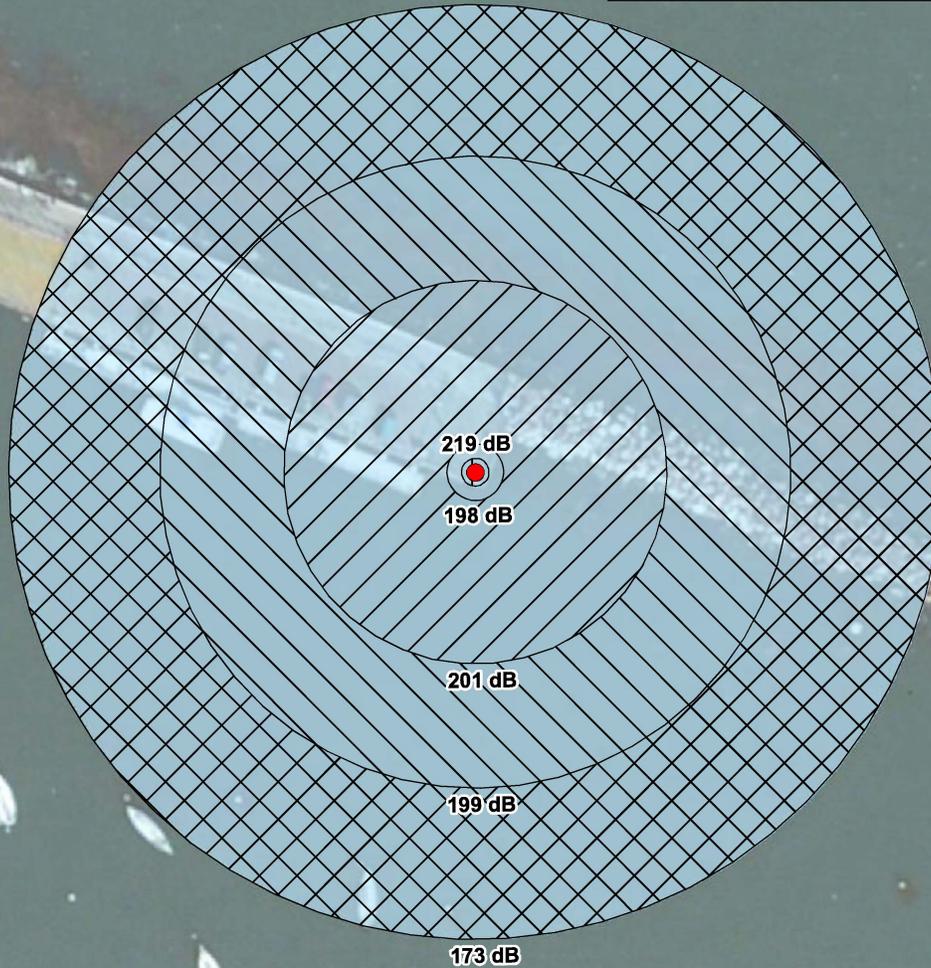
IHA

No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.

Monterey Bay

**LEGEND:**

- Project Location
- Area of Influence (0.02 km<sup>2</sup>)
- Otariid Pinnipeds (2.2 meters, 219 dB)
- Mid-Frequency Cetaceans (4.5 meters, 198 dB)
- Phocid Pinnipeds (30.6 meters, 201 dB)
- Low-Frequency Cetaceans (50.4 meters, 199 dB)
- High-Frequency Cetaceans (74.5 meters, 173 dB)



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LEVEL A ISOPLETHS  
VIBRATORY PILE DRIVING

DATE  
JUNE 2017

SCALE  
1" = 30 meters

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FIGURE  
5-2

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**Table 5-2. Modeled Extent of Underwater Sound Pressure Levels (SPLs) from Vibratory Pile Extraction and Driving**

<b>Modeling Scenario</b>	<b>Distance to 120 dB RMS (Level B Threshold)</b>
Modeled north	2,000 meters
Modeled northeast shoreline	2,400 meters
Modeled east to shoreline	1,800 meters
Modeled south to shoreline	550 meters
<b>Area of Influence</b>	<b>7.3 km<sup>2</sup></b>

*Notes:*

dB = decibel

RMS = root mean square

extent of underwater noise, because the NMFS practical spreading loss assumptions of  $15 \log_{10}$  sound propagation were assumed, and that Monterey Breakwater would reduce noise considerably faster than assumed.

Per the sound assessment completed for the project and included in Appendix A the following assumptions and parameters were used for the analysis: *For vibratory pile installation, it is estimated that it would take approximately 20 minutes (1,200 seconds) to vibrate in each pile and between one to two minutes of impact driving of each pile with the impact hammer to proof them. It is also estimated that the pile driving crew could vibrate several piles in one day and complete the impact driving the following day. Approximately 100 blows were assumed for proofing of piles with an impact hammer.*

*Based on feedback from NOAA NMFS, the sound source levels have been revised to be 162 dB (10 meters) to characterize the sound that would be produced from vibratory pile installation. All references to underwater sound are noted as unweighted.*

A copy of the completed sound assessment is included as Appendix A.

Level A analysis:

To calculate Level A isopleths, we used the NOAA NMFS 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NOAA 2016d). Specifically, we used the “alternative methodology” presented in Appendix D of the 2016 guidance. The alternative methodology allows for the application of updated acoustic thresholds, using a set of alternative

tools including a “user spreadsheet”, to assist with incorporation of weighting factor adjustments (WFA) to determine the isopleths for PTS onset. The sound level (RMS SPL) input used for this analysis was based on NOAA NMFS feedback. The calculations incorporated a source level of 162dB, activity duration used was 4 hours, and the distance to source was 10 meters. The extent of anticipated Level A injury during vibratory pile extraction and driving is presented in Table 5-3 below. In addition, copies of the spreadsheet and related input factors are included in Appendix B.

**Table 5-3. Extent of Anticipated Level A Injury During Vibratory Pile Extraction and Driving**

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL <sub>cum</sub> Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	20.1	1.8	29.7	12.2	0.9

### 5.2.2 Underwater Noise from Impact Pile Driving

Level B analysis:

The extent of underwater noise from impact pile driving was predicted using the *SoundPlan* software package as described above for vibratory pile driving. Table 5-4 shows the extent of noise levels for the NMFS marine mammal and fish criteria, assuming the use of noise attenuation (bubble curtain). Figure 5-3 shows the extent of attenuated (use of a bubble curtain) noise levels for impact pile driving out to the NMFS behavioral criterion of 160 dB RMS. The area encompassed by the 160 dB criterion is approximately 0.27 km<sup>2</sup>.

Per the sound assessment completed for the project and included in Appendix A the following assumptions and parameters were used for the analysis: *For the scenario that requires mostly impact pile driving, pile installation are estimated to require up to 20 minutes of pile driving. However, there is no reliable estimate of the pile driving time.*

**LEGEND:**  
 Project Location

*Monterey Bay*

190 dB  
  
 180 dB

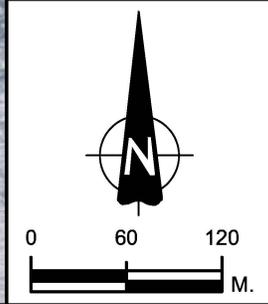
160 dB

Lighthouse Ave  
 Oliver St  
 Lighthouse Pt

Fishermans Wharf

Municipal Wharf

SOURCE: Ilingworth and Rodkin Inc.; URS 2013.



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ATTENUATED UNDERWATER  
 RMS LEVELS DURING  
 IMPACT PILE DRIVING

SCALE  
 1" = 120 meters

PROJECT NO.  
 336010017

FIGURE  
 5-3

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**Table 5-4. Modeled Extent of Underwater SPLs from Impact Pile Driving**

Modeling Scenario	Distance to Marine Mammal Criteria
	RMS (dB re: 1µPa)
	160 (Level B Threshold)
Modeled attenuated noise transmission north and northeast (through breakwater)	76 meters
Modeled attenuated noise transmission in all directions (except north and northeast)	465 meters

*Notes:*

Assumes 10 dB of underwater noise attenuation by using a bubble curtain during pile driving

Distances and method of calculation are presented in Appendix A.

– = Criteria would not be exceeded over any distance

dB = decibel

µPa = microPascal

RMS = root mean square

*Assuming a hammer is used that moves the pile at about 30 to 40 blows per minute, up to 20 minutes of impact pile driving would be required for each pile. A full pile driving event was assumed to require 685 pile strikes. The project would install up to 3 piles in one day.*

*“unattenuated near-source impact pile driving levels applicable to this project are 208 dB peak, 195 RMS and 175 dB SEL. Note, a substantially higher RMS level of 195 dB was assumed..... Typically, there is an approximately 10 to 15 dB difference in peak and RMS sound pressure levels. Assuming the higher peak pressure of 208 dB, an RMS level of 195 dB would typically occur. To provide a conservative estimate, the higher RMS sound pressure level was assumed for this assessment.*

**Level A analysis:**

To calculate Level A isopleths for injury, we used the alternative methodology presented in Appendix D of the updated guidance (NOAA 2016d). Specifically, our analysis depends on the “user spreadsheet” to assist with incorporation of WFAs to determine the isopleths for PTS onset. Source level and distance information was referenced using data provided for similar piles and substrate identified in the California Department of Transportation Compendium of Pile Driving Sound Data Report (Caltrans 2007) and information provided directly by NOAA NMFS on October 25, 2017 via personal communication. Referenced data includes a source level (in SEL) of 172 at a distance of 10 meters, an average strike

per pile of 30, with a maximum piles driver per day of 5. The potential area within the thresholds for estimated underwater Level A injury from impact pile extraction and driving is presented in Table 5-5.

**Table 5-5. Extent of Underwater Level A Injury from Impact Pile Extraction and Driving.**

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL <sub>cum</sub> Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	52.1	1.9	62.1	27.9	2.0

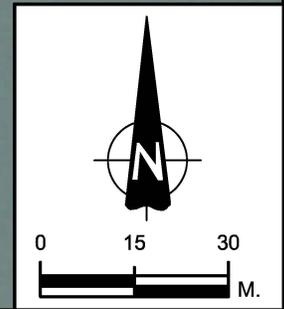
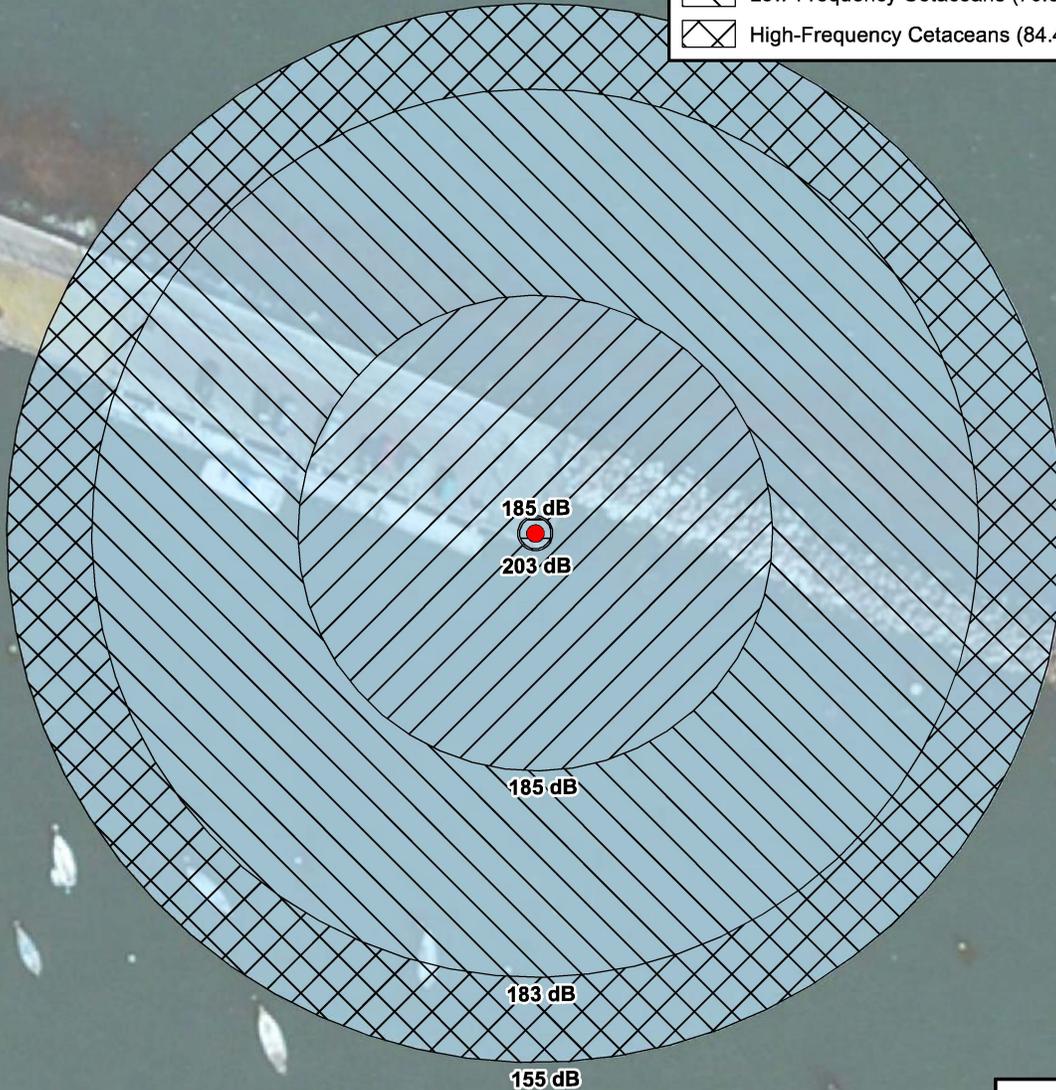
To prevent Level A take, marine mammal observers will be monitoring the exclusion zone for marine mammals. Note that the Level A exclusion zone is slightly larger than the Level B zone; however, to be conservative we have shown Level A and Level B isopleths both at 62.1 meters as we will be shutting down for high frequency cetaceans within that zone. They will alert work crews to the presence of marine mammals in or near the exclusion zones (i.e., area where SELs can exceed the adapted Level A criteria), and advise when to begin or stop work to avoid Level A harassment.

Conservation measures including bubble curtains and cushion pads will be used during construction to reduce noise from impact pile driving. Attenuated noise values shown in Table 5-4 assume that underwater noise could be reduced 10 dB with the use of a properly designed and deployed air bubble curtain attenuation system. Special care will be taken to form a tight seal with the bottom in the uneven substrate characteristic of the project site, to achieve the noise reduction of 10 dB assumed for this analysis. As a result of these measures, as well as others described in Section 10, there will be no Level A take.

Monterey Bay

**LEGEND:**

- Project Location
- Area of Influence (0.02 km<sup>2</sup>)
- Mid-Frequency Cetaceans (2.5 meters, 185 dB)
- Otariid Pinnipeds (2.8 meters, 203 dB)
- Phocid Pinnipeds (37.9 meters, 185 dB)
- Low-Frequency Cetaceans (70.8 meters, 183 dB)
- High-Frequency Cetaceans (84.4 meters, 155 dB)



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USCG BASE ALAMEDA  
MONTEREY, CALIFORNIA

DATE  
JUNE 2017

SCALE  
1" = 30 meters

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LEVEL A ISOPLETHS  
IMPACT PILE DRIVING

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FIGURE  
5-4

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### 5.2.3 Airborne Noise

Pile driving generates airborne noise that could potentially result in behavioral disturbance to pinnipeds and sea otters that are either hauled-out or at the water’s surface. The practical spreading model was used to determine the extent over which sound levels may result in harassment of marine mammals. A 20 log<sub>10</sub> attenuation rate was used to calculate the distances to the various NMFS thresholds.

Airborne noise levels from vibratory and impact driving used in this analysis are based on measurements made during the Navy Test Pile Project in Bangor, Washington (Navy 2012). For vibratory driving, the greatest unweighted maximum noise level ( $L_{max}$ ) measured was 102 dB, and the average  $L_{max}$  was 97 dB at 50 feet or 15 meters. For impact driving, the greatest  $L_{max}$  was 112 dB, and the average  $L_{max}$  was 103 dB at 50 feet or 15 meters.

Table 5-6 provides distances using  $L_{max}$  levels, which should conservatively estimate the distance to the NMFS criterion. Figures 5-5 and 5-6 show the areal extent of these noise levels.

**Table 5-6. Modeled Extent of SPLs for Airborne Noise**

Threshold	Distance		Area	
	100 dB	90 dB	100 dB	90 dB
Vibratory Extraction and Driving	20 meters	60 meters	0.001 km <sup>2</sup>	0.011 km <sup>2</sup>
Impact Driving	60 meters	190 meters	0.011 km <sup>2</sup>	0.113 km <sup>2</sup>

*Note:*  
dB = decibel

### 5.3 DESCRIPTION AND ESTIMATION OF TAKE

The USCG is seeking authorization to expose marine mammals to Level B harassment that may result from pile replacement work associated with the repairs to the USCG pier. The take is expected to have no more than a behavioral effect on individual animals and no effect on the populations of these species. Any effects experienced by individual marine mammals are anticipated to be limited to short-term disturbance of normal behavior, or temporary displacement of animals near the source of the noise.

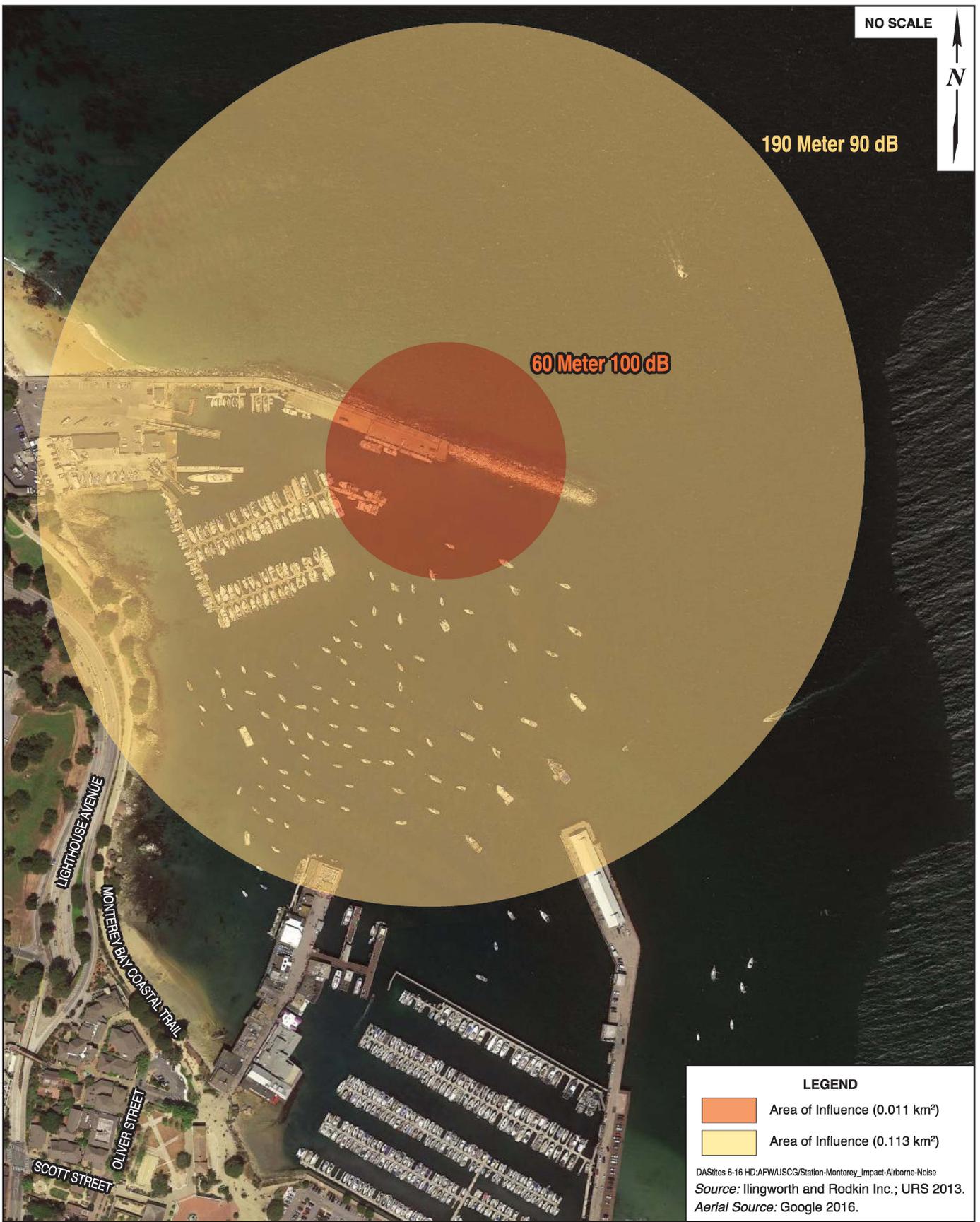


IHA

**Airborne Noise Exposure Areas During  
 Vibratory Pile Extraction and Driving**

**FIGURE  
 5-5**

No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.



IHA

**Airborne Noise Exposure Areas During Impact Pile Driving**

**FIGURE 5-6**

No warranty is made by the USCG as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This map is a "living document," in that it is intended to change as new data become available and are incorporated into the GIS database.

Marine mammal monitoring will ensure that no cetaceans or pinnipeds are present in their respective Level A harassment zones during pile driving.

The take analysis presented here relies on the best data currently available for marine mammal populations at the Monterey Breakwater and in the nearby waters of Monterey Bay. The population data used are discussed in each species take calculation subsection below.

Estimated take of each marine mammal species was calculated using the following equation:

$$\text{Take Estimate} = (n * \text{AOI}) * 8 \text{ days of activity}$$

Where:

n (number of animals per unit area) = The density estimate used for each species. For southern sea otter, the unit of area is linear km of coastline. For all other species, the unit of area is km<sup>2</sup>.

Multiplying n \* AOI produces an estimate of the abundance of animals that could be present in the area of exposure per day. The final take estimate is rounded up to the next whole number.

Application of the equation above assumes the following:

- All piles to be installed would have a noise disturbance distance equal to the pile that causes the greatest noise disturbance (i.e., the piling furthest from shore, in this case the farthest east pile along Monterey Breakwater);
- An average of 2 or 3 piles will be installed and removed per day; we have assumed 3 piles for our calculations.
- Pile driving would occur over a period of up to 8 days;
- A noise attenuation system such as a bubble curtain and cushion pad would be used during impact pile driving;
- An individual animal can only be taken once per method of installation during a 24-hour period.

The exposure assessment methodology estimates the number of individuals that would potentially be exposed to Type B harassment during pile extraction and driving activities due to noise levels that exceed established NMFS thresholds. Results of the acoustic impact exposure assessments should be regarded as conservative estimates that are strongly influenced by limited biological data, and therefore exposure of harassment to marine mammals presented below is over estimated. Furthermore, the short duration and limited extent of the repairs would limit actual exposures.

### **5.3.1 California Sea Lion Take**

NMFS conducts annual surveys of pinnipeds using aerial photography. Counts of California sea lions hauled-out at the Monterey Breakwater and harbor area were obtained from Mr. Mark Lowry of NMFS (Lowry 2016). Data were available for 18 surveys conducted annually from 1998 to 2013, with the exception of the years 2000 and 2010. The surveys are generally conducted each year in July, though the data included one survey each from June, September, and December 1998, when additional funds were available for surveys.

The numbers of individuals identified each year varied over the course of the surveys, ranging from 1 (1999 and 2013) to 1,124 (December 1998) individuals. The highest number of individuals was recorded during the December 1998 survey, an El Niño year with warmer ocean temperatures in the winter. The December 1998 count was not typical, because many individuals stay north during years with warmer winter ocean temperatures, rather than traveling south to the typically warmer waters of the Channel Islands, where most breeding and pupping occurs (Lowry 2012). In recent years (2012 and 2013) counts have been lower, with 101 individuals identified in 2012 and only one individual identified in 2013. The overall average number of California sea lions identified per survey, for all of the surveys of the Monterey Breakwater combined, was 250 individuals per survey year.

The exposure calculation for take of individual California sea lions at sea is limited to exposure to underwater noise. The calculations below assume an average density of 8.62 individuals/km<sup>2</sup>.

The exposure calculation provided below for breakwater animals accounts for the average density of individuals hauled out on the breakwater (250 individuals) as well as animals presumed to be underwater and not counted on any given survey. Per NOAA NMFS we have assumed all individuals will be hauled out over the 9 days and therefore represent a total of 2,000 individuals.

To estimate the densities of California sea lions exposed to airborne harassment, the average annual counts of out-of-water animals was used (i.e., 250 individuals), distributed over the area encompassed by the pier and the exposed rock portion of the Monterey Breakwater. Using the take estimate equation described previously, Table 5-7 presents the number of acoustic harassments that are estimated from vibratory pile driving for underwater noise.

**Table 5-7. Number of Potential Exposures of California Sea Lions within the Acoustic Threshold Zone During Vibratory Pile Driving**

California Sea Lions	Calculated exposure for underwater noise	
	Level A Threshold (219 dB)	Level B Threshold (120 dB)
Area of Influence	n/a	7.3 km <sup>2</sup>
Estimated Take	0	504
Estimated take of California sea lions at breakwater haul-out (assumes 250 animals at haulout)	–	2,000

*Notes:*  
dB = decibel  
km<sup>2</sup> = square kilometer

### 5.3.2 Pacific Harbor Seal Take

Pacific harbor seals are much less abundant in the project area than California sea lions, and only two annual surveys conducted since 1998 identified any individuals. The 2004 annual Pinniped survey conducted by NMFS counted 28 Pacific harbor seals in Monterey Harbor in 2004, and 1 in 2005 (Lowry 2012). Pacific harbor seals hauled-out along Cannery Row, north of the Monterey Breakwater, ranged from 1 to 24 in 2002, 2004, and 2009. During repairs on the Pier in 2009, Pacific harbor seals were occasionally observed in the nearby waters, but were never observed to haul-out on the breakwater (Harvey and Hoover 2009).

For purposes of this take estimate, 28 individuals (the most observed during any single survey) were assumed to be in the water at any given time. To conservatively estimate the density of Pacific harbor seals in the AOI, we assumed all 28 individuals are within the 29 square kilometer (km<sup>2</sup>) foraging area. The calculated density is therefore 0.96 individuals/km<sup>2</sup>.

Based on the limited available data, it appears that it is rare for Pacific harbor seals to haul-out on the Monterey Breakwater in the immediate vicinity of the project. Therefore, it is assumed that the population of Pacific harbor seals that could potentially be exposed to airborne noise are the same individuals for the in-water calculations, and therefore the same population density and exposure estimates are the same for underwater noise.

Table 5-6 shows the number of acoustic harassments that are estimated from vibratory pile driving for underwater noise.

**Table 5-8. Number of Potential Exposures of Pacific Harbor Seals within Acoustic Threshold Zones During Vibratory Pile Driving**

Pacific Harbor Seals (assume density of 0.96/km <sup>2</sup> )	Calculated exposure for underwater noise	
	Level A Threshold (201 dB)	Level B Threshold (120 dB)
Area of Influence	n/a	7.3 km <sup>2</sup>
Estimated take	0	57

*Notes:*  
dB = decibel  
km<sup>2</sup> = square kilometer

### 5.3.3 Harbor Porpoise Take

A conservative estimate of the density of harbor porpoise in the southern portion of Monterey Bay nearshore is approximately 2.321 per km<sup>2</sup> (Forney et al. 2014). Exposures were calculated using the equation presented above. Table 5-9 shows the number of acoustic harassments that are estimated from underwater noise generated by vibratory pile driving during construction.

**Table 5-9. Number of Potential Exposures of Harbor Porpoise within Acoustic Threshold Zones During Vibratory Pile Driving**

Harbor Porpoise (estimated density 2.32 per km <sup>2</sup> )	Calculated exposure for underwater noise	
	Level A Threshold (173 dB)	Level B Threshold (120 dB)
Area of Influence	n/a	7.3 km <sup>2</sup>
Estimated Take	0	136

*Note:*  
dB = decibel  
km<sup>2</sup> = square kilometer

In order to minimize the number of potential exposures, marine mammal observers will be monitoring the exclusion zone for cetaceans. They will alert work crews to the presence harbor porpoise and other marine mammals in or near the exclusion zones (i.e., area where SPLs can exceed the adapted Level A criteria), and advise when to begin or stop work to avoid Level A harassment. These impact minimization measures will reduce potential takes by behavioral disturbance (Level B harassment) to the extent that the take would have a negligible short-term effect on individual harbor porpoises, and would not result in population-level impacts.

### 5.3.4 Risso’s Dolphin Take

According to the MBNMS, Risso’s dolphins are relatively common off California, and typically occur in pods of 10-30 individuals. The most recent publicly available stock assessment of Risso’s dolphin was published in 2010 (NOAA 2011a). The stock assessment estimated that for the period of 2005-2008, the geometric mean of the population for California, Oregon, and Washington waters was 6,272. Assuming that the length of shoreline extending throughout the Washington, Oregon, and California coast is 2,080 km, and the surveys extended 556 km from shore, the average density of Risso’s dolphins is approximately 0.005 per km<sup>2</sup>. This low density would provide a vanishingly small take estimate of Risso’s dolphin. As stated above, Risso’s dolphins typically occur in pods of 10-30 animals, and therefore are not likely to be observed or “taken” as individual animals. As a result, the take estimate for Risso’s dolphin for the purpose of this document is a single occurrence of a small pod of 10 individuals.

Disturbances from underwater noise on Risso's dolphin are not expected to be significant. Marine mammal monitors will alert work crews to the presence of marine mammals in or near the exclusion zones. Level B harassment would have a negligible short-term effect on individual Risso's dolphins and would not result in population-level impacts.

### **5.3.5 Bottlenose Dolphin Take**

Bottlenose dolphins are relatively common residents in Monterey Bay, frequently spotted within 1 km of shore along sandy beaches, travelling just outside of the breakers (MBNMS 2016). Abundance and densities of cetaceans in the California Current ecosystem were conducted from 1991 to 2005 (Barlow, Forney 2007). The results of the surveys indicate that bottlenose dolphin population density throughout the entire west coast shoreline is 1.78 individuals per 100 km<sup>2</sup>. During the same survey, the mean group size for bottlenose dolphins observed in Central California was four individuals. Other, more recent data suggest that densities may be up to 0.04 per km<sup>2</sup> (Weller 2016).

Even using the higher density estimate, using a density-based approach for estimating take results in very low numbers (<1 over the entire period of construction). Rather than using density calculations to estimate take, the estimate of take for the purpose of this document would be a small pod of 10 bottlenose dolphins. Again, the level of take associated with Level B harassment would have a negligible short-term effect on individual bottlenose dolphins and would not result in population-level impacts.

### **5.3.6 Killer Whale Take**

Killer whales (both West Coast transients and Eastern North Pacific offshore stocks) visit the MBNMS on an intermittent and unpredictable basis. Killer whales have been seen attacking other marine mammals such as gray whales and California sea lions which are their primary prey in the sanctuary. Killer whales have been observed by local kayakers in recent years, but it is unknown from which stock they belong.

Due to the low frequency and unpredictability of killer whales entering the AOI, the application of a density equation is not reasonable for predicting take. It is not unusual for killer whales to enter Monterey Bay, typically in groups of 3 to 8 at a time (Guzman 2016). To be conservative, the take estimate for this assessment is based on the largest of the typical group size, 8 animals.

As with other species described above, potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual whales, and would not result in population-level impacts.

### **5.3.7 Gray Whale Take**

As described above, the occurrence of gray whales would be extremely rare near shore in the project area. The NOAA National Center for Coastal Ocean Science (NCCOS) reported densities of gray whales at 0.1 to 0.5 per km<sup>2</sup> (NCCOS 2007); however, it is unclear how applicable these data are for the very near-shore environment of the project area. Gray whales would be more likely to encroach on the project area during the spring migration north, when they tend to stay closer to shore than during the winter southern migration. It is highly unlikely that take of gray whales would occur by impact driving because there are no reported sightings of gray whales actually entering the Monterey Harbor area. During vibratory driving, the 120 dB contour (criteria for continuous noise) extends farther offshore to the north of the Monterey Breakwater. If there is take of whales by harassment, it is more likely to be during vibratory driving activities.

As with other species described above, potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual whales, and would not result in population-level impacts.

### **5.3.8 Humpback Whale Take**

Humpback whales are typically found further offshore than gray whales, and therefore would not be affected by a nearshore pile driving, but since 2014 higher numbers of humpback whales have been observed in and near Monterey Bay by whale-watching vessels. Because conservation measures include a complete

shutdown if any humpback whale is observed, we anticipate no take of humpback whales.

As with other species described above, potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual whales, and would not result in population-level impacts.

### 5.3.9 Southern Sea Otter Take

Southern sea otter Census data for 2012 indicate that there are approximately eight southern sea otters per kilometer of coast line within Monterey Harbor and nearby shoreline areas (U.S. Geological Survey [USGS] 2015). At this density, we expect approximately 8 southern sea otters within Monterey Harbor and approximately 40 to 48 throughout the entire AOI for vibratory pile driving.

Table 5-10 depicts the estimated take for Southern sea otters as a result of underwater noise generated by vibratory pile driving during construction.

**Table 5-10. Number of Potential Exposures of Southern Sea Otter within Various Acoustic Threshold Zones**

Density of Southern Sea Otter	Underwater			Airborne	
	Impact Level A Threshold	Impact Level B Threshold (160 dB)	Vibratory Level B Threshold (120 dB)	Impact Level B Threshold (100 dB)	Vibratory Level B Threshold (100 dB)
At-sea underwater: 8 per km of coastline	0	36	384	–	–
At-sea above water: 8 per km of coastline	–	–	–	8	4

*Notes:*

– = Not Applicable

dB = decibel

km = linear kilometer

Southern sea otters that are taken could exhibit behavioral reactions. Marine mammal observers will alert work crews to the presence of southern sea otters in or near the exclusion zone (i.e., area where SPLs can exceed the adapted Level A criteria for pinnipeds), and advise when to begin or stop work to reduce the potential for acoustic harassment. Outside of the exclusion zone, southern sea otters maybe exposed to underwater noise that result in behavioral effects, such as

startling or the cessation of feeding (Level B harassment). Based on the exposure analysis, southern sea otters are anticipated to experience airborne SPLs that would qualify as harassment, and individuals that are rafting or at the surface may exhibit behavioral reactions to the airborne noise. This harassment would have a negligible short-term effect on individual southern sea otters, and would not result in population-level impacts.

### 5.3.10 Summary

Based on the modeling results presented above, the total number of takes that the USCG is requesting for the 6 marine mammal species that may occur in the project area during construction is presented below in Table 5-11. These estimates are conservative to reflect the presence of a substantial haul-out site within the work area.

**Table 5-11. Summary of Potential Take for All Species**

Species	Vibratory Driving	
	Level B Underwater	Total Estimated Take
California sea lion	1,504	1,504
Pacific harbor seal	57	57
Harbor porpoise	136	136
Risso's dolphin	10	10
Bottlenose dolphin	10	10
Gray whale	4	4
Humpback whale	6	6
Killer whale	8	8
Southern sea otter	384	388

Marine mammal observers will be monitoring an exclusion zone for the presence of marine mammals. They will alert work crews to the presence of marine mammals in or near the exclusion zone (i.e., area where noise pressure levels can exceed Level A criteria) and advise when to begin or stop work to reduce the potential for acoustic harassment.

Based on the exposure analysis, the marine mammal species described above are anticipated to experience underwater noise pressure levels that would qualify as Level B harassment, and individuals that are hauled-out may exhibit behavioral

reactions to the airborne noise. Potential take from behavioral disturbance (Level B harassment) would have a negligible short-term effect on individuals, and would not result in population-level impacts.

## SECTION 6 ANTICIPATED IMPACT OF THE ACTIVITY

### 6.1 EFFECTS OF UNDERWATER NOISE ON MARINE MAMMALS

Pile driving may result in either physiological or behavioral effects on marine mammals including masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or nonauditory physical effects such as damage to other organs (Richardson et al. 1995). In assessing the potential effects of noise, Richardson et al. (1995) has suggested criteria for evaluating different zones of these effects. These zones are summarized as follows:

- **The zone of hearing loss, discomfort, or injury:** Direct effects that result in discomfort or tissue damage to auditory or other systems including a temporary threshold shift, a temporary loss in hearing, a permanent threshold shift and a loss in hearing at specific frequencies or deafness.
- **The zone of masking:** Where noise may interfere with the detection of other sounds, including communication calls and prey sounds. The applicable criteria for the zone where this effect occurs are 160 dB for impact noise and 120 dB for continuous noise.
- **The zone of responsiveness:** The area within which marine mammals change their behavior. Temporary behavioral effects may not indicate long lasting consequence for exposed individuals are typically considered Level B harassment (160 dB for impact noise and 120 dB for continuous noise) (Richardson et al. 1995; Southall et al. 2007).
- **The zone of audibility** is the area in which the marine mammal may hear the noise. Marine mammals as a group have functional hearing ranges of 10 hertz (Hz) to 180 kilohertz (kHz), with best thresholds near 40 dB (Southall et al. 2007).

No physiological damages are expected from pile driving operations occurring during the pier repairs. Impact and vibratory pile driving can produce noise levels in excess of the Level A criteria; however, USCG will implement measures (Section 10) that will greatly reduce the chance that a marine mammal may be exposed to sound pressure levels that could cause physical harm. As described previously and detailed in Section 10, when impact pile driving equipment is employed, a noise attenuation system (i.e., bubble curtains and cushion pads)

would be used to reduce sound pressure levels and a marine mammal monitoring program would be implemented.

## **6.2 EXPECTED RESPONSES TO PILE EXTRACTION AND DRIVING**

The response of marine mammals to pile replacement depends largely on the change between ambient background noise and the construction-related noise. The background noise at Monterey Harbor is relatively high due to boat traffic, foot traffic, noise from Station Monterey, and other boats. Therefore, marine mammals that frequent the area (pinnipeds in particular) are habituated to the background noise, and may be less affected by construction-related noise.

With any of the pile driving options, the greatest potential for disturbance to non-resident marine mammals is at the onset of activities, resulting in temporary, short-term changes in typical behavior and/or avoidance of the affected area. Potential behavioral changes may include noticeable startle response, avoidance of the area, increased swimming speed, and increased surface time. Pinnipeds may increase their time hauled out on land to avoid in-water disturbance. Because pile replacement work would occur for a few hours a day over a relatively short period of time, it is unlikely to result in permanent displacement of animals.

## **6.3 EFFECTS OF AIRBORNE NOISE ON MARINE MAMMALS**

Marine mammals that occur in the project area would be exposed to airborne noise associated with pile replacement work that has the potential to cause harassment, depending on their distance from pile extraction and driving activities. Airborne noise is most likely to affect marine mammals hauled out on the adjacent jetty (California sea lions) and Southern sea otters that are at the surface during pile driving. Airborne noise would likely cause behavioral responses similar to those discussed above in relation to underwater noise. For example, the noise generated could cause hauled-out pinnipeds to exhibit changes in their normal behavior, such as causing them to temporarily abandon their habitat and move farther from the noise source.

However, due to the high levels of background noise in Monterey Harbor, increased sound levels that might flush Pinnipeds in areas of low disturbance may

not elicit a response in Monterey Harbor. In 2004, construction activities on the pier generated noise from drilling and coring equipment. Disturbance to hauled-out California sea lions was minimal and included small behavioral responses such as barking and head turning. Construction noise did not cause any animals to flush (Phillips and Harvey 2004).

#### **6.4 EFFECTS OF HUMAN DISTURBANCE ON MARINE MAMMALS**

As described previously, the breakwater experiences moderate to heavy foot traffic from fishermen and tourists, and therefore, the California sea lions which use the breakwater are habituated to human activity. To avoid potential injury to both workers and/or California sea lions, there may be times when it becomes necessary to deter hauled-out animals to safely gain access to the work site. Because the animals who routinely use the jetty as a haul out site are habituated to human disturbance and noise associated with marina activities, use of a noise deterrent is not recommended. Instead, the use of non-lethal, physical deterrence are suggested, such as marine hose or sprayer aimed at the rump or chest of animals that must be deterred. Such an action would be allowable under Section 109 of the MMPA, which permits federal, state, and local officials to take marine mammals in the course of official duties.

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**SECTION 7  
ANTICIPATED IMPACTS ON SUBSISTENCE USES**

There are no relevant subsistence uses of marine mammals implicated by this action. No subsistence uses of marine mammals occur within Monterey Bay.

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## SECTION 8 ANTICIPATED IMPACTS ON HABITAT

No permanent long-term effects on marine habitat are proposed or are anticipated to result from project implementation. Specifically, implementation of the Proposed Action would not increase the pier's existing footprint and no new structures would be installed that would result in the loss of additional habitat.

Short-term changes to the marine environment and marine mammal habitat may occur during construction. Construction may result in a short-term loss of foraging habitat. Just as marine mammals may be disturbed by underwater noise as described throughout this document, acoustic energy created during pile replacement work would have the potential to disturb forage fish within the vicinity of the pile replacement work. As a result, the affected area could temporarily lose foraging value to marine mammals. Hastings and Popper (2005) identified several studies that suggest fish will relocate to avoid areas of damaging noise energy. Therefore, if fish leave the area of disturbance, pinniped foraging habitat may have temporarily decreased foraging value when piles are driven using impact hammering. The duration of fish avoidance of this area after pile driving stops is unknown. However, the affected area represents an extremely small portion of the total area within foraging range of marine mammals that may be present in the project area.

Monterey Bay is classified as Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act. Monterey Bay is classified as an EFH for 118 species of commercially important fish, 30 of which have potential to occur within the project area. In addition to EFH designations, portions of the Monterey Bay are designated as a Habitat Area of Particular Concern (HAPC) for various fish species within the Pacific Groundfish, Pacific Coast Salmon, Highly Migratory Species, and Coastal Pelagic Fisheries management plans. These HAPC areas include kelp forest and rocky reef habitats, both of which occur in and adjacent to the Project Area. Given the short daily duration of increased underwater and airborne noise levels associated with the project, the relatively small areas being affected, and the impact avoidance and minimization measures (Section 10), the proposed project is not likely to have a permanent, adverse effect on EFH.

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**SECTION 9  
ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE  
MAMMALS**

The Proposed Action's activities are not expected to result in any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or populations. Foraging and dispersal habitat for marine mammals will be temporarily modified by disturbance from increased airborne and underwater noise levels during pile extraction and driving. As described in Section 9, this modification is expected to have no impact on the ability of marine mammals to disperse and forage in undisturbed areas within their foraging range. There would be no increase in permanent habitat loss as a result of the project.

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## **SECTION 10 MITIGATION MEASURES**

Mitigation measures to avoid Level A (injury) harassment and reduce the potential effects from Level B (disturbance) harassment to marine mammals during pile-extraction and pile-driving activities include:

### 1. Noise Attenuation During Impact Pile Driving

- Noise attenuation systems (i.e., bubble curtains and cushion pads) will be used during all impact pile driving to interrupt the acoustic pressure and reduce the impact on marine mammals. By reducing underwater sound pressure levels at the source, bubble curtains would reduce the area over which both Level A and B harassment would occur, thereby potentially reducing the numbers of marine mammals affected.
- Pre-drilling would be performed and would be discontinued when the pile tip is approximately 5 feet above the required pile tip elevation. Pre-drilling is a method that starts the “hole” for the new pile; the pile is inserted after the hole has been pre-drilled which creates less friction and overall noise and turbidity during installation. Pre-drilling also is beneficial for overall pile stability as it reduces the stress and therefore chance of breakage or damage to the pile during installation.
- Because the existing conditions include sloped topography and riprap, care would be taken when placing the bubble curtain to ensure a good seal is formed.

### 2. Exclusion Zone

- As discussed in Section 6, various AOIs were identified that would experience noise levels in excess of the Level A criteria for marine mammals. Because of this, the establishment of exclusion zones around each pile will be implemented to prevent Level A harassment to individual species. The exclusion zone includes all areas where underwater sound pressure levels are expected to reach or exceed the Level A harassment criteria for marine mammals. To be conservative we have used the isopleths for impact pile driving which extend the farthest out. These correspond to the following distances:

- 1.9 meters for the Risso’s dolphin, bottlenose dolphin, and killer whale (203 dB)
- 0.9 meters for the California sea lion (185 dB)
- 27.9 meters for the harbor seal (185 dB)
- 52.1 meters for the gray whale and humpback whale (183 dB)
- 62.1 meters for the harbor porpoise (155 dB)
- 10 meters for the Southern sea otter (180 dB)
- To provide a margin of safety, a provisional, conservative exclusion zone will be established during initial pile extraction and driving efforts, while hydroacoustic measurements are made to establish actual field conditions. These exclusion zones will be adjusted once field conditions have been established through hydroacoustic monitoring.

### 3. Visual Monitoring for Marine Mammals

- The exclusion zone will be monitored for 30 minutes prior to any pile extraction and driving activities to ensure that the area is clear of any marine mammals. If an individual is observed, pile extraction or driving will not commence until the individual has left the exclusion zone for a minimum of a 15-minute period (pinnipeds and small cetaceans) or a 30-minute period (large cetaceans).
- If a marine mammal enters the exclusion zone during pile replacement work, activity will stop until the individual leaves the exclusion zone. Work would not commence for a period of 15-minutes (pinnipeds and small cetaceans) or a 30-minutes period (large cetaceans) after they have left the exclusion zone.
- Monitoring will be conducted by qualified observers familiar with marine mammal species and their behavior. The observer will monitor the exclusion zone from the most practicable vantage point possible (i.e., the pier itself, the breakwater, adjacent boat docks in the harbor, or a boat) to determine whether marine mammals enter the exclusion zone. Monitors would be equipped with radios or cell phones for maintaining contact with work crews.
  - Vessel-based visual monitoring within the 120-dB and 160-dB AOI shall be conducted during 10% of the vibratory pile driving and removal and impact pile driving activities, respectively.

- If a species is observed within the level A or B zones that has not been included in this IHA request, work would immediately cease and delay procedures including a 30-minute wait period would be implemented.
- If a humpback whale is observed within the Level A or Level B zones, work will cease until they leave these zones. Work would not commence until 30-minutes after the last sighting within these zones.

4. Acoustic Monitoring

- Hydroacoustic monitoring will be conducted during pile driving.

5. Daylight Construction Period

- Work would occur only during daylight hours.

6. Soft Start (for impact pile driving only)

- A “soft-start” technique is intended to allow marine mammals to vacate the area before the pile driver reaches full power. An initial set of three strikes would be made by the hammer at 40-percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets before initiating continuous driving.

7. Safe Access to Work Zone

- Should any serious injury or mortality to marine mammals result during the course of the proposed activity, the USCG will suspend operations and will immediately contact NMFS. If sea otters are injured during implementation of the project, the USCG will suspend operations and immediately contact the Monterey Bay Aquarium’s sea otter 24-hour emergency line.

### **10.1 MITIGATION EFFECTIVENESS**

With implementation of the above mitigation measures, marine mammals will be protected from Level A harassment and potential behavioral effects classified as Level B harassment will be reduced; however, if mitigation is not conducted properly the potential for effect increases. Measures such as visual observations and hydroacoustic monitoring are being implemented to ensure that mitigation

measures are effective. Biologists and hydroacoustic monitors will have the required qualifications to conduct respective monitoring. Monitors will be required to check in frequently to ensure mitigation measures are working. For example, visual monitors will monitor the exclusion zone for marine mammals and will stop work if marine mammals enter exclusion zone. Additionally, monitors will ensure the appropriate exclusion zone is placed for protection of Level A harassment. If hydroacoustic monitoring indicates that mitigation measures are not reducing sound to appropriate levels, monitors will work with the construction crew to adjust measures and/or they will expand the exclusion zone as needed for the protection of marine mammals.

**SECTION 11  
ARCTIC PLAN OF COOPERATION**

Not applicable. The proposed activity would take place in Monterey Bay and no activities would occur in or near a traditional Arctic subsistence hunting area.

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## SECTION 12 MONITORING AND REPORTING

The USCG prepared two monitoring plans – an Acoustic Monitoring Plan and a Marine Mammal Monitoring Plan – that will be implemented prior to and during pile replacement activities. Both plans will provide means and methods for ensuring no lethal take, that behavioral take is kept to a minimum, and that activities are documented.

The Acoustic Monitoring Plan was developed in conjunction with NMFS and USFWS. Key elements of the plan include:

- Using a qualified hydroacoustic monitor during pile extraction and driving
- Monitoring timing requirements
- Reference point locations for monitoring
- Details regarding acoustic thresholds for marine mammal exclusion zones
- Plans to adjust exclusion zones based on in situ acoustic monitoring to maintain a safe zone for marine mammals during pile replacement activities

The USCG has prepared a Marine Mammal Monitoring Plan for the proposed project that will be revised in coordination with NMFS and USFWS during the permitting process, as needed. Key elements of the marine mammal monitoring plan include:

- Biological monitoring will be performed by a trained observer in marine mammal identification and behaviors
- Baseline Biological Monitoring:
  - Baseline biological monitoring shall be conducted to survey the potential Level A and B harassment zones on two (2) separate days within one (1) week before the first day of construction.
  - Biological information collected during baseline monitoring will be used for comparison with results of monitoring during pile driving and removal activities.
- Observation would be conducted for 30 minutes prior to, continuously during, and for 30 minutes after pile driving and extraction activities.

Observations will be conducted using high-quality binoculars as necessary (e.g., Zeiss, 10 x 42 power)

- Data collection will consist of a count of all pinnipeds, mustelidae, and cetaceans by species, a description of behavior (if possible), location, direction of movement, time that pile replacement work begins and ends, any observed behavior changes, and time of the observation. Environmental conditions such as weather, visibility, temperature, tide level, current and sea state would also be recorded on a daily observation sheet
- Biological monitoring would occur from monitoring locations that allow full observation of the AOI, including USCG pier and Monterey Breakwater, adjacent docks within the harbor or watercraft, to maintain an excellent view of the exclusion zone and adjacent areas during the survey period. Monitors would be equipped with radios or cellular telephones for maintaining contact with work crews
  - Vessel-based visual monitoring within the 120-dB and 160-dB AOIs shall be conducted during 10% of the vibratory pile driving and removal and impact pile driving activities, respectively
- During pile extraction and driving, the underwater exclusion zone will be monitored for 30 minutes prior to commencing work. If marine mammals are within the exclusion zone, the start of extraction or driving will be delayed until no animals are sighted within the zone for a minimum of 15-minutes (pinnipeds and small cetaceans) or 30-minutes (large cetaceans)
- Daily observation sheets will be compiled on a weekly basis and submitted with a weekly monitoring report that summarize the monitoring results, construction activities, and environmental conditions would be submitted to NMFS and USFWS
- A final report would be submitted to NMFS and USFWS within 90 days after completion of the proposed project.

## **SECTION 13 SUGGESTED MEANS OF COORDINATION**

Construction activities will be conducted in accordance with federal, state and local regulations and the minimization measures proposed in Section 10 to protect marine mammals. In addition, the USCG will coordinate all activities with the relevant federal and state agencies including, but are not limited to: NMFS, USFWS, United States Army Corps of Engineers, and California Department of Fish and Wildlife.

Further marine mammal and acoustic monitoring reports will be developed in coordination with USFWS and NMFS. The USCG will share field data and behavioral observations on marine mammals that occur in the project area. Results of each monitoring effort will be provided to NMFS and USFWS in a summary report at the conclusion of monitoring. This information could be made available to Federal, State and local resource agencies, scientists and other interested parties upon written request to NMFS or USFWS.

In addition, NOAA research scientists have expressed interest in collecting data to further characterize the behavioral response of harbor porpoises during pile driving activities. The proposed USCG pier repair project offers a unique opportunity to conduct a study of the effect of pile-driving on harbor porpoises off the U.S. coast. This would fill an important knowledge gap, as most previous studies of this type have been conducted on harbor porpoises in Europe. Harbor porpoises are particularly sensitive to acoustic disturbance, and harm can result either from exposure to sound or from secondary effects of displacement (e.g., reduced foraging success, stress, exposure to other threats). The location of this project along the coast of Monterey Bay would allow a small-scale study to monitor porpoise distribution and abundance before, during, and after the pile-driving activities, using a network of passive acoustic instruments located at varying distances, ideally combined with periodic aerial surveys. The acoustic moorings would be deployed a few months before construction begins to provide a baseline of porpoise distribution and abundance. Moorings would remain in place throughout the construction phase and for a few months after project completion, to examine potential changes in porpoise distribution and habitat use through time. The aerial surveys would provide additional spatial snapshots of

porpoise distribution at key time periods. NMFS Southwest Fisheries Science Center has relevant expertise and some of the needed equipment to perform such a study if funding is made available. The USCG will provide notification to allow NOAA research scientists the opportunity to collect data during construction.

**SECTION 14  
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## **Appendix A**

### **Final Analysis of Underwater and Airborne Sound Levels for Waterfront Repairs at United States Coast Guard Station Monterey, Monterey, California**

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# *Final Analysis of Underwater and Airborne Sound Levels for Waterfront Repairs at United States Coast Guard Station Monterey Monterey, California*

November 8, 2012

*Prepared for*

**United States Coast Guard  
Civil Engineering Unit Oakland  
Oakland, California**

*Prepared on behalf of  
URS Group, Inc. by:*

**ILLINGWORTH & RODKIN, INC.**  
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Project No: 12-113

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## INTRODUCTION

This study is an assessment of potential sound levels generated by planned pile driving activities involved with the waterfront repairs at the United States Coast Guard (USCG) Station Monterey, in Monterey, California. The USCG proposes to remove and replace the 17 piles supporting the pier; replace the existing potable water line; and improve associated structures to maintain the structural integrity of the pier and potable water line. The purpose of the project is to provide repairs and maintenance of these structures to support the operational requirements of Station Monterey, as well as a National Oceanic and Atmospheric Administration (NOAA) boat, which also uses these facilities.

The proposed project would involve removing the existing timber deck, timber stringers, steel pile caps, steel support beams, and hardware to access the 17 timber piles. The timber piles would then be removed through use of a vibratory extractor. Each timber pile would be replaced with a minimum 14-inch-diameter (up to a maximum of 18-inch-diameter) steel-pipe pile that would be positioned and installed in the footprint of the extracted timber pile. The majority of the pile driving would be conducted with a vibratory hammer, and an impact hammer would be used for proofing the piles. The new steel-pipe piles would not be filled with concrete. Other material and hardware removed to conduct the pile replacement would be replaced with in-kind materials. This project is proposed for construction in the 2013 fiscal year.

This report includes the prediction of underwater and airborne sound levels calculated based on the results of measurements for similar projects. Predicted underwater sound levels are compared against interim thresholds that have been accepted by the Federal Highway Administration (FHWA), Caltrans, and NOAA National Marine Fisheries Service (NMFS). These thresholds are discussed in this report.

Pile driving will produce underwater and airborne noise in and around Monterey Bay. Most of the pile driving activities will be in water about 30 feet deep or less that is adjacent to the jetty.

There is no way to accurately predict underwater sound levels from these activities, other than to rely on acoustic data measured from previous projects. Available underwater sound data for projects involving the installation of similar piles were reviewed. The sound levels for proposed pile driving activities were estimated using these data combined with an understanding of how and where these activities would occur. These predictions are essentially a best estimate based on empirical data and engineering judgment, but by their very nature contain a degree of uncertainty. The duration of driving for each pile installation and number of piles strikes was also estimated as part of the noise prediction process, based on available data from similar projects and engineering estimates. The availability of data for this type of environment (i.e. fairly deep open water) is limited.

Pile driving also causes elevated airborne sound levels, which usually cause annoyance to humans nearby. There is concern that these sound levels may affect marine mammals in the area. This study also reports airborne sounds associated with pile driving, based on measurements of similar pile driving activities.

## UNDERWATER SOUNDS FROM PILE DRIVING

### Fundamentals of Underwater Noise

Sound is typically described by the *pitch* and loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. *Loudness* is intensity of sound waves combined with the reception characteristics of the auditory system. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe sound. A *decibel (dB)* is a unit of measurement describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. For underwater sounds, a reference pressure of 1 micro pascal ( $\mu\text{Pa}$ ) is commonly used to describe sounds in terms of decibels. Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1  $\mu\text{Pa}$ . Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc.

When a pile driving hammer strikes a pile a pulse is created that propagates through the pile and radiates sound into the water, the ground substrate, and the air. Sound pressure pulse as a function of time is referred to as the waveform. In terms of acoustics, these sounds are described by the peak pressure, the root-mean-square pressure (RMS), and the sound exposure level (SEL). The peak pressure is the highest absolute value of the measured waveform, and can be a negative or positive pressure peak. For pile driving pulses, RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that comprise that portion of the waveform containing the vast majority of the sound energy.<sup>1</sup> The pulse RMS has been approximated in the field for pile driving sounds by measuring the signal with a precision sound level meter set to the “impulse” RMS setting and is typically used to assess impacts to marine mammals. Another measure of the pressure waveform that can be used to describe the pulse is the sound energy itself. The total sound energy in the pulse is referred to in many ways, such as the “total energy flux,”<sup>2</sup> The “total energy flux” is equivalent to the un-weighted SEL for a plane wave propagating in a free field, a common unit of sound energy used in airborne acoustics to describe short-duration events referred to as dB re  $1\mu\text{Pa}^2\text{-sec}$ . Peak pressures and RMS sound pressure levels are expressed in dB re 1  $\mu\text{Pa}$ . The total sound energy in an impulse accumulates over the duration of that pulse. Figure 1 illustrates the descriptors used to describe the acoustical characteristics of an underwater pile driving pulse. Table 1 includes the definitions of terms commonly used to describe underwater sounds.

The variation of instantaneous pressure over the duration of a sound event is referred to as the waveform. Studying the waveforms can provide an indication of rise time; however, rise time differences are not clearly apparent for pile driving sounds due to the numerous rapid fluctuations that are characteristic to this type of impulse. A plot showing the accumulation of sound energy over the duration of the pulse (or at least the portion where much of the energy accumulates)

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<sup>1</sup> Richardson, Greene, Malone & Thomson, *Marine Mammals and Noise*, Academic Press, 1995 and Greene, personal communication.

<sup>2</sup> Fineran, et. al., *Temporary Shift in Masked Hearing Thresholds in Odontocetes after Exposure to Single Underwater Impulses from a Seismic Watergun*, Journal of the Acoustical Society of America, June 2002.

illustrates the differences in source strength and rise time. An example of the characteristics of a typical pile driving pulse is shown in Figure 1.

**Table 1 - Definitions of Underwater Acoustical Terms**

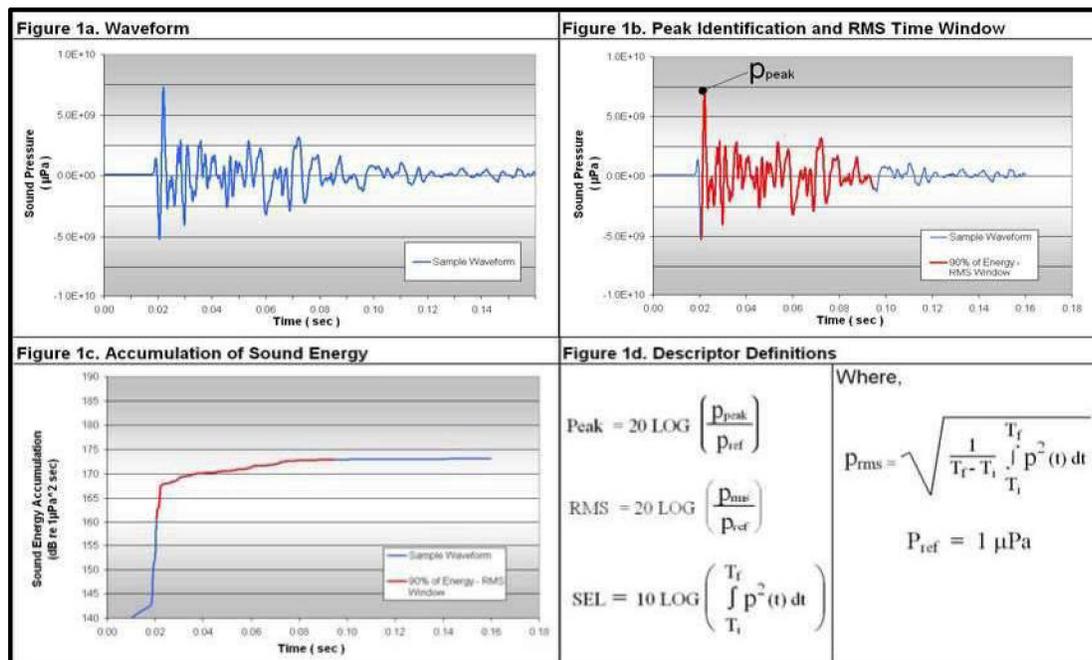
<b>Term</b>	<b>Definition</b>
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro pascals (μPa) and 1 μPa for underwater.
Equivalent Noise Level, $L_{eq}$	The average noise level during the measurement period.
$L_{01}$ , $L_{10}$ , $L_{50}$ , $L_{90}$	The sound levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Peak Sound Pressure, unweighted (dB)	Peak sound pressure level based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to a pressure of 1
RMS Sound Pressure Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile driving impulse. <sup>3</sup>
Sound Exposure Level (SEL), dB re 1 μPa <sup>2</sup> sec	Proportionally equivalent to the time integral of the pressure squared and is described in this report in terms of dB re 1 μPa <sup>2</sup> sec over the duration of the impulse. Similar to the unweighted Sound Exposure Level (SEL) standardized in airborne acoustics to study noise from single events.
Cumulative SEL	Measure of the total energy received through a pile-driving event (for this project defined as pile driving over one day or maximum of 3 piles)
Waveforms, μPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of μPa over time (i.e., seconds)
Frequency Spectra, dB over frequency range	A graphical plot illustrating the distribution of sound pressure vs. frequency for a waveform, dimension in rms pressure and defined frequency bandwidth

SEL is an acoustic metric that provides an indication of the amount of acoustical energy contained in a sound event. For pile driving, the typical event can be one pile driving pulse or many pulses such as pile driving for one pile or for one day of driving multiple piles. Typically, SEL is measured for a single strike and a cumulative condition. The cumulative SEL associated with the driving of a pile can be estimated using the single strike SEL value and the number of pile strikes through the following equation:

$$SEL_{CUMULATIVE} = SEL_{SINGLE STRIKE} + 10 \log (\# \text{ of pile strikes})$$

For example, if a single strike SEL for a pile is 165 dB and it takes 1,000 strikes to drive the pile, the cumulative SEL is 195 dBA (165 dB + 30 dB = 195 dB), where  $10 * \log_{10}(1000) = 30$ .

<sup>3</sup> The underwater sound measurement results obtained during the Pile Installation Demonstration Project indicated that most pile driving impulses occurred over a 50 to 100 millisecond (msec) period. Most of the energy was contained in the first 30 to 50 msec. Analysis of that underwater acoustic data for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard “impulse exponential-time-weighting” (35-msec rise time) correlated to the RMS (impulse) level measured over the duration of the impulse.



**Figure 1.** Characteristics of a Pile Driving Pulse

## Underwater Sound Thresholds

Underwater sound affects to fish and marine mammals are discussed below. In this report, peak pressures and RMS sound pressure levels are expressed in decibels re  $1 \mu\text{Pa}$ . Sound exposure levels are expressed as  $\text{dB re } 1\mu\text{Pa}^2\text{-sec}$ .

### *Fish*

A Fisheries Hydroacoustic Workgroup (FHWG) that consisted of transportation officials, resources agencies, the marine construction industry (including Ports), and experts was formed in 2003 to address the underwater sound issues associated with marine construction. The first order of business was to document all that was clearly known about the effects of sound on fish, which was reported in *The “Effects of Sound on Fish.”*<sup>4</sup> This report provided recommended preliminary guidance to protect fish. A graph showing the relationship between the SEL from a single pile strike and injurious effects to fish based on size (i.e., mass) was presented. Fish with a mass of about 0.03 grams were expected to have no injury for a received SEL of a pile strike below 194 dB and suffer 50% mortality at about 197 dB. The report also described possible effects to the auditory system (i.e., auditory tissue damage and hearing loss), based on a received dose of sound. The recommendations were frequency dependent, based on the hearing thresholds of fish or most sensitive auditory bandwidths. For salmonids, hearing effects would be expected at or near the thresholds for injury based on the single strike SEL. Further investigations into the effects of pile driving sounds on fish was also recommended.

Caltrans commissioned a subsequent report to provide additional explanation of, and a practical means to apply, injury criteria recommended in *The Effects of Sound on Fish*. This report is entitled “Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper”,

<sup>4</sup> Hastings, M and A. Popper. 2005. The Effects of Sound on Fish. Prepared for the California Department of Transportation. January 28 (revised August 23).

(White Paper).<sup>5</sup> The White Paper recommended a dual criterion for evaluating the potential for injury to fish from pile driving operations. The dual approach considered that a single pile strike with high enough amplitude, as measured by zero to peak (either negative or positive pressure) could cause injury. A peak pressure threshold for a single strike was recommended at 208 dB. In 2007, Carlson et al provided an update to the White Paper in a memo titled "Update on Recommendation for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities."<sup>6</sup> In this memo, they propose criteria for each of three different effects on fish; 1) hearing loss due to temporary threshold shift, 2) damage to auditory tissues, and 3) damage to non-auditory tissues. These criteria vary due to the mass of the fish and if the fish is a hearing specialist or hearing generalist. In preparing this update, Dr. Mardi Hastings summarized information from some current studies in a report titled "Calculation of SEL for Govoni et al. (2003, 2007) and Popper et al. (2007) Studies."

On June 12, 2008, NMFS; U.S. Fish and Wildlife Service; California, Oregon, and Washington Departments of Transportation; California Department of Fish and Game; and the U.S. Federal Highway Administration generally agreed in principal to interim criteria to protect fish from pile driving activities, as shown in Table 2. Note that the peak pressure criteria of 206 dB was adopted (rather than 208 dB), as well as accumulated SEL criteria for fish smaller than 2 grams. NMFS interpretation of the interim criteria is described by Woodbury and Stadler (2009)<sup>7</sup>.

**Table 2 - Adopted Impact Pile Driving Acoustic Criteria for Fish**

<b>Interim Criteria for Injury</b>	<b>Agreement in Principle</b>
Peak	206 dB for all size of fish
Cumulative SEL	187 dB for fish size of two grams or greater. 183 dB for fish size of less than two grams.
Behavior effects threshold 150 dB RMS	

The primary difference between the adopted criteria and previous recommendations is that the single strike SEL was replaced with a cumulative SEL over a day of pile driving. NMFS does not consider sound that produces an SEL per strike of less than 150 dB to accumulate and cause injury. The adopted criteria listed in Table 2 are for pulse-type sounds (e.g., pile driving) and do not address sound from vibratory driving of piles; there are no acoustic thresholds that apply to the lower amplitude noise produced by vibratory pile driving. In fact, the acoustic thresholds developed for fish only apply to impact pile driving.

The Bureau of Ocean Energy Management, (BOEM -formerly Minerals Management Service), Caltrans, and National Cooperation of Highway Research Programs (NCHRP 25–

<sup>5</sup> Popper, A., Carlson, T., Hawkins, A., Southall, B. and Gentry, R. 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper. May 14.

<sup>6</sup> Carlson, T, Hastings, M and Poper, A. 2007. Memo to Suzanne Theiss, California Department of Transportation, Subject: Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. December 21.

<sup>7</sup> Stadler, J. and Woodbury, D. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. Proceedings of inter-noise 2009, Ottawa, Canada. August 23-26.

28)/Transportation Research Board (TRB) have funded studies to identify the onset of injury to fish from impact pile driving. One of the goals of these studies was to provide quantitative data to define the levels of impulsive sound that could result in the onset of barotrauma injury to fish.<sup>8</sup> Laboratory simulation of pulse-type pile driving sounds enabled careful study of the barotrauma effects to Chinook Salmon. The neutrally buoyant juvenile fish were exposed to impulsive sounds and subsequently evaluated for barotrauma injuries. Significant barotrauma injuries were not observed in fish exposed to 960 pulses at 180 dB SEL per pulse or 1,920 pulses at 177 dB per pulse. In both exposures, the resulting accumulated SEL was 210 dB SEL. Results of these studies are under review. At this time, the criteria in Table 2 are used by NMFS to assess impacts to fish. Potential behavior impacts that might occur above 150 dB RMS are not used to restrict pile driving.

### *Marine Mammals*

Under the Marine Mammal Protection Act, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as “Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” Level B harassment is defined as “Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering.”

Current NMFS practice regarding exposure of marine mammals to high level sounds is that cetaceans and pinnipeds exposed to impulsive sounds of 180 and 190 dB RMS or greater, respectively, are considered to have been taken by Level A (i.e., injurious) harassment. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds 160dB RMS or greater for impulse sounds (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile driving). The application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. For continuous sounds, NMFS Northwest Region has provided guidance for reporting RMS sound pressure levels. RMS levels are based on a time-constant of 10 seconds; RMS levels should be averaged across the entire event. For impact pile driving, the overall RMS level should be characterized by integrating sound for each acoustic pulse across 90 percent of the acoustic energy in each pulse and averaging all the RMS for all pulses.

NMFS Northwest Region has defined the estimated auditory bandwidth for marine mammals<sup>9</sup>. For this project location, the functional hearing groups are low-frequency cetaceans (humpback and gray whales), high-frequency cetaceans (harbor porpoises) and pinnipeds (Stellar and California sea lions, harbor and northern elephant seals). For pile driving, the majority of the acoustic energy is confined to frequencies below 2 kHz and there is very little energy above 20 kHz. The underwater acoustic criteria for marine mammals are shown in Table 3.

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<sup>8</sup> Halvorsen MB, Casper BM, Woodley CM, Carlson TJ, Popper AN (2012) Threshold for Onset of Injury in Chinook Salmon from Exposure to Impulsive Pile Driving Sounds. PLoS ONE 7(6): e38968. doi:10.1371/journal.pone.0038968

<sup>9</sup> Note that NMFS Southwest Region has not provided guidance for measuring sound levels from pile driving, so guidance from the Northwest Region is used in this assessment.

**Table 3 - Adopted Underwater Acoustic Criteria for Marine Mammals<sup>10</sup>**

Species	Underwater Noise Thresholds (dB re: 1µPa)			
	Vibratory Pile Driving Disturbance Threshold	Impact Pile Driving Disturbance Threshold	Injury Threshold	Frequency Range
Cetaceans	120 dB RMS	160 dB RMS	180 dB RMS	7 Hz to 20 kHz (Low) 150 Hz to 20 kHz (Mid) 200 Hz to 20 kHz (High)
Pinnipeds	120 dB RMS	160 dB RMS	190 dB RMS	75 Hz to 20 kHz

### Underwater Sound Generating Activities

For the proposed project, the primary sources of underwater sound would be from the driving of round steel piles to support the pier. The options for installing these piles range from driving the piles the full length with an impact hammer (either diesel or hydraulic) to vibrating in the piles with limited impact driving to proof the pile bearing. At this time it is not known what method will be used, so an analysis of the different methods is provided. The pile sizes will be between 14-inch and 18-inch-diameter. This analysis conservatively assumes that larger 18-inch size for the noise projections. Impact pile driving produces pulsed-type sounds, while vibratory pile driving produce continuous-type sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing.

Pulsed sounds, such as impact pile driving, explosions, or seismic air guns are brief, distinct acoustic events that occur either as an isolated event (e.g., explosion) or repeated in some succession (e.g., impact pile driving). Pulsed sounds are all characterized by discrete acoustic events that include a relatively rapid rise in pressure from ambient conditions to a maximum pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures. Pulsed sounds are typically high amplitude events that have the potential to cause hearing injury. Continuous or non-pulsed sounds can be tonal or broadband. These sounds include vessels, aircraft, machinery operations such as vibratory pile driving or drilling, and active sonar systems. This project may involve both pulsed and continuous type sounds from pile installation.

Given the dense substrate at the project, it is possible that much of the pile installation would involve impact pile driving. However, this analysis assumes two methods:

1. Vibratory installation and proofing of piles with an impact hammer
2. Impact pile driving only

Preliminary indications are that MGF RBH 200 vibration hammer and/or Delmag D30/32 diesel impact hammer or equivalent hammer would be required to vibrate and impact-drive these relatively small diameter piles. The driving periods are not likely to be continuous. The piles require a minimum of 35 feet of embedment into the ground.

<sup>10</sup> Based on NOAA 77 FR 43049, July 23, 2012. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Pile Replacement Project.

For vibratory pile installation, it is estimated that it would take approximately 20 minutes (1200 seconds) to vibrate in each pile and between one to two minutes of impact driving of each pile with the impact hammer to proof them. It is also estimated that the pile driving crew could vibrate several piles in one day and complete the impact driving the following day. Approximately 100 blows were assumed for proofing of piles with an impact hammer. In terms of underwater sound effects on fish, the highest cumulative sound levels would occur under a scenario where numerous piles are impact driven in one day.

For the scenario that requires mostly impact pile driving, pile installation are estimated to require up to 20 minutes of pile driving. However, there is no reliable estimate of the pile driving time. Assuming a hammer is used that moves the pile at about 30 to 40 blows per minute, up to 20 minutes of impact pile driving would be required for each pile. A full pile driving event was assumed to require 685 pile strikes. The project would install up to 3 piles in one day. In terms of underwater sound effects on fish, the highest cumulative sound levels would occur under a scenario where three piles are impact driven in one day.

### **Discussion of Underwater Sound Generation from Pile Driving**

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory and impact pile driving. Sounds from similar-sized steel shell piles have been measured in water for several projects.

#### *Vibratory Pile Installation Sound Generation*

A review of available acoustic data for pile driving indicates that recent Test Pile Program at Naval Base Kitsap at Bangor, Washington provides the most extensive set of data. The project involved the installation of test piles of 24-, 36- and 48-inches in diameter using a vibratory driver. Most of the installed piles were 36 inches in diameter and only one pile was 24-inch diameter. This Test Pile Program provided the average sound level based on the RMS levels using a 10-second time constant. Most other data reported are based on maximum RMS values using a 1- to 10-second time constant (e.g., Caltrans Fish Guidance Manual 2009).

For 36-inch diameter piles driven by the Navy, the average RMS level for all pile driving events was 159 dB RMS at 33 feet or 10 meters. There was a considerable range in the RMS levels measured across a pile driving event, where the highest average RMS level was 169 dB RMS.

The range of vibratory sound levels at 33 feet or 10 meters reported by Caltrans is 155 dB for 12-inch diameter piles to 175 dB RMS for 36-inch diameter piles (based on maximum 1-second RMS levels). All of these piles were driven in relatively shallow water.

Noting that the piles to be used for this project will be smaller than those driven by the Navy for their Test Pile Program at Bangor, Washington, a near-source level of 168 dB RMS at 33 feet (10 meters) level was used to characterize the sound that would be produced from vibratory pile installation.

#### *Impact Pile Driving Sound Generation*

A review of existing data indicates that measurements conducted for the USCG Tongue Point Pier Repairs in the Columbia River are most representative. This project was located on the Columbia

River near Astoria, Oregon. The purpose of the project was to repair the existing Tongue Point pier. The project included installation of 24-inch-diameter steel pipe piles to replace existing wood-piles, along with reconstruction of a concrete deck. Figures 2a and 2b show the installation of these piles.



**Figure 2a.** Pile layout on Pier. Piles have been vibrated in and are ready to be driven with the impact hammer

**Figure 2b.** Preparing to impact drive a 24- inch steel trestle pile with bubble rings to attenuate under water noise.

Data measured at the Tongue Point Pier Repair included similar types of pile driving on an existing pier in deep water. Although the length of the installed piles are similar to those proposed for this project, the diameters were larger than proposed for this project. The difference in pile size should not result in much, if any, difference in the expected noise levels from pile driving.

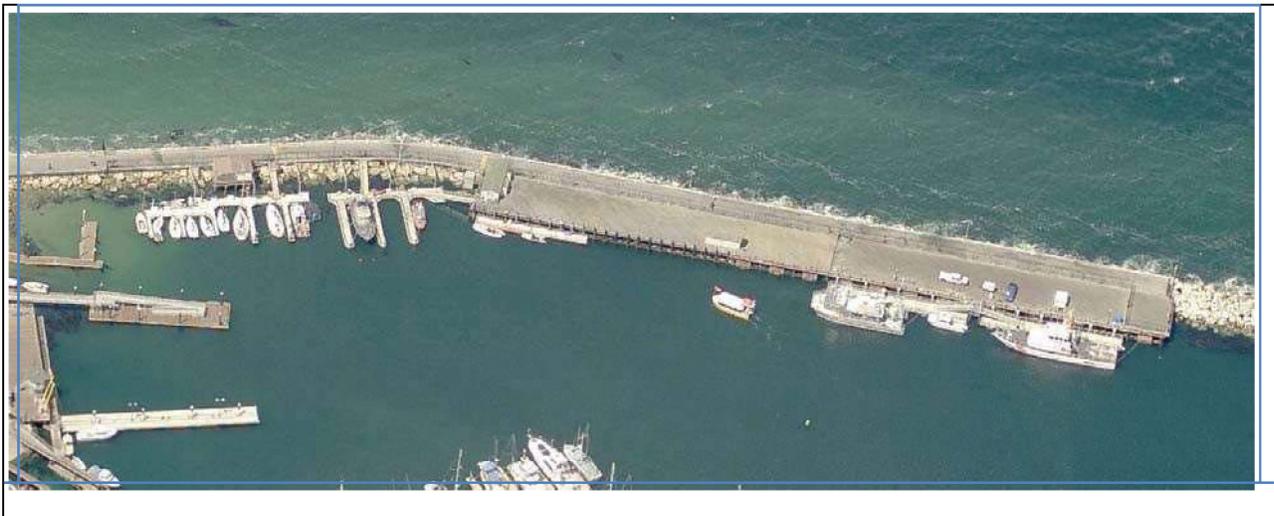
Average sound levels measured at Tongue Point include peak pressures of 189 to 207 dB, RMS sound pressure levels of 178 to 189 dB, and SEL levels of 160 to 175 dB per strike at 33 feet (10 meters). Sound levels associated with vibratory installation of the piles were not measured on this project. The ambient levels measured in between pile driving ranged from a RMS level of 115 to 125 dB. Due to the difference in pile sizes, use of the Tongue Point data would likely overestimate sound levels expected at the proposed USCG Station Monterey project. Based on the Tongue Point sound measurements, unattenuated near-source impact pile driving levels applicable to this project are 208 dB peak, 195 RMS and 175 dB SEL. Note, a substantially higher RMS level of 195 dB was assumed rather than 189 dB that was measured for Tongue Point. Typically, there is an approximately 10 to 15 dB difference in peak and RMS sound pressure levels. Assuming the higher peak pressure of 208 dB, an RMS level of 195 dB would typically occur. To provide a conservative estimate, the higher RMS sound pressure level was assumed for this assessment.

## PREDICTION OF UNDERWATER SOUND FROM PROJECT PILE DRIVING

Estimated noise impacts are discussed specifically for each type of pile driving. For vibratory driving, which would provide a continuous sound, a source level of 168 dB RMS was applied. Impact driving, which produces higher amplitude pulse-type sounds would have a near-source level of 208 dB peak, 195 dB RMS and a single strike SEL of 175 dB. These levels represent unattenuated conditions (i.e., no air bubble curtain or other means of reducing underwater sounds).

Sound from pile installation (i.e., impact or vibratory pile driving) would transmit or propagate from the construction area. Transmission loss (TL) is the decrease in acoustic pressure as the sound pressure wave propagates away from the source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. NMFS has developed an underwater acoustic calculator that uses practical spreading (a  $15 \log_{10}$  function) to predict sound levels at various distances from the source. This equates to a 4.5 dB decrease in sound level for every doubling of distance away from the source. The formula for transmission loss is  $TL = 15 \log_{10}(R)$ , where R is the distance from the source divided by the distance to where a near-source level was measured (i.e., 33 feet or 10 meters for this application). This TL model, based on the default practical spreading loss assumption, was used to predict underwater sound levels generated by pile installation from this project. Measurements conducted during project pile driving could further refine the rate of sound propagation or TL.

Pile installation would be adjacent to a rock jetty that would provide substantial underwater shielding of sound transmission to areas north (or through the jetty). Figure 3 depicts this rock jetty.



**Figure 3.** Aerial view of the project site showing the rock jetty that extends along the north side of the project piers

### *Vibratory Pile Installation*

The peak noise level threshold will not be exceeded with the vibratory installation of the piles. The peak levels are expected to be less than 190 dB at 10 meters. There are no cumulative SEL criteria for vibratory pile installation; therefore, an analysis was not conducted to determine SEL levels for

the vibratory driving. The criteria for harassment of marine mammals from vibratory pile driving are based on the average RMS levels. Table 4 shows the distance to the different harassment criteria. Note that these distances are based on a standard 15 log<sub>10</sub> propagation rate. The actual distances would be less than the projected distances as a result of shielding from the rock jetty and the topography of the bottom of the bay.

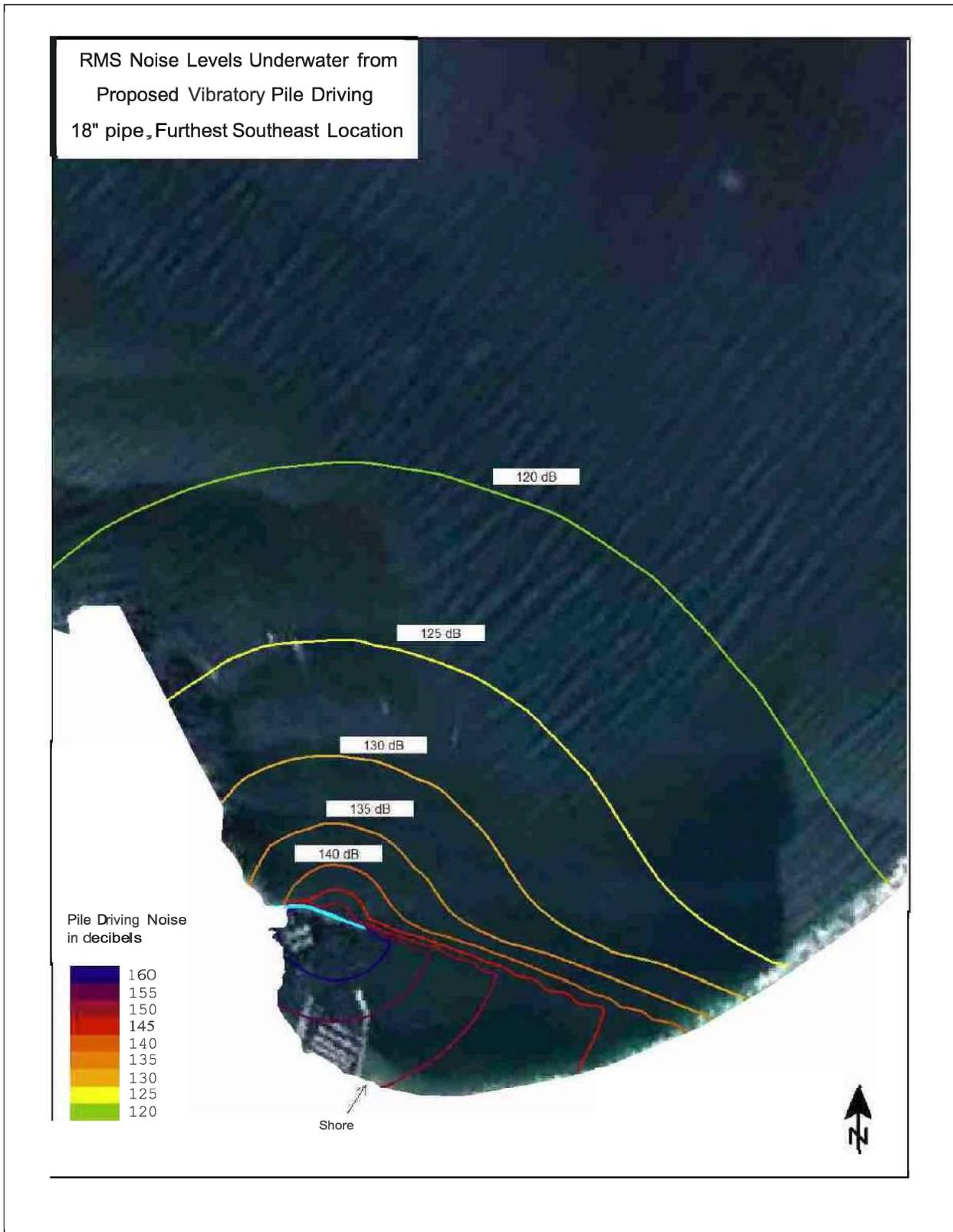
Vibratory sound from pile driving was modeled using SoundPlan to simulate the effect of the rock jetty in reducing sound. Unlike impact pile driving, vibratory sound is radiated only from the pile and tends to have a higher frequency sound content. Therefore, there is little or no ground borne sound that could transmit through underwater barriers such as the rock jetty. SoundPlan was used to develop the pattern of sound transmission; however, NMFS practical spreading loss assumptions of 15 log<sub>10</sub> sound propagation (as described above) were assumed. Figure 4 shows the pattern of sound expected from vibratory pile installation, taking into account shielding from the rock jetty. The distances to the 120 dB RMS contour are limited by interaction with the rock jetty and shoreline. Table 4 reports the theoretical and modeled distances to where 120 dB RMS sound levels would extend. It is likely that the rock jetty would reduce sound considerably more than predicted, so that the distance north from the jetty to the extent of the 120 dB RMS sound level would be less than reported in Table 4.

**Table 4 - Modeled Extent of 120 dB RMS Sound Pressure Levels from Vibratory Pile Installation**

<b>Modeling Scenario</b>	<b>Distance to 120 dB RMS</b>
Theoretical	10 miles or 16 kilometers
Modeled North	6,650 feet or 2,000 meters
Modeled Northeast Shoreline	8,000 feet or 2,400 meters
Modeled East to Shoreline	6,000 feet or 1,800 meters
Modeled South to Shoreline	1,800 feet or 550 meters

*Impact Pile Driving*

Peak sound pressure, average RMS sound pressure levels, and SELs from impact driving were predicted using the near source levels for impact pile driving and the practical loss sound propagation assumptions described above. As with vibratory driving, the rock jetty was considered in the modeling. Table 5 shows the extent of sound levels for the NMFS marine mammal and fish criteria. Figure 5 shows the extent of unattenuated RMS sound pressure levels for impact pile driving out to the NMFS behavioral criterion of 160 dB RMS.



**Figure 4.** Extent of RMS Sound Pressures from Vibratory Pile Installation

Reducing sounds from impact pile driving using air bubble curtains is common. Caltrans reports a large range in sound reduction from almost no reduction to 30 dB as a result of use of these curtains. During the Tongue Point project (i.e., the source of impact pile driving levels for this assessment) the reduction from an air bubble curtain was between 8 and 14 dB. Therefore, this assessment assumes that underwater sounds could be reduced at least 10 dB with the use of a properly designed and deployed air bubble curtain attenuation system. Based on the topography (on a slope with large rocks- rip rap) it will be difficult to obtain a good seal between the bottom surface of the causeway and the bubble ring. Special care will be required to obtain the minimum sound reduction of 10 dB.

**Table 5 - Modeled Extent of Sound Pressure Levels from Unattenuated and Attenuated Impact Pile Driving**

Modeling Scenario	Distance to Marine Mammal Criteria			Distance to Fish Criteria		
	RMS (dB re: 1µPa)			Peak (dB re: 1µPa)	Cumulative SEL* (dB re: 1µPa-sec <sup>2</sup> )	
	160	180	190	206 dB	187	183
Modeled Unattenuated	7,050 ft. 2,150 m	330 ft 100 m	75 ft 22 m	<70 ft <20 m	400ft 123 m	750 ft 228 m
Modeled North and Northeast (through jetty)	250 ft 76 m	--	--	<33 ft <10 m	<33 ft <10 m	<33 ft <10 m
Modeled East to Shoreline	6,070 ft 1,850m	330 ft 100 m	75 ft 22 m	<70 ft <20 m	400ft 123 m	750 ft 228 m
Modeled South to Shoreline	1,800 ft 550 m	330 ft 100 m	75 ft 22 m	<70 ft <20 m	400ft 123 m	750 ft 228 m
Modeled Attenuated in all directions (except North)	1,525 ft 465 m	75 ft 22 m	<33 ft <10 m	<33 ft <10 m	90 ft 27 m	160 ft 49 m

\* Based on the driving of one pile. SEL criteria apply to impact pile driving events that occur during one day. See Tables 6 through 8 for predicted accumulated SEL for various daily pile driving scenarios.

Accumulated SEL levels associated with impact pile driving will vary daily, depending on the amount of pile driving. Two impact pile driving scenarios were considered:

- Full Drive: Assumes the pile would be driven 35 feet into the ground and require 685 pile strikes
- Proofing: Assumes about 2 to 3 minutes of pile driving, requiring up to 100 pile strikes.

Tables 6 and 7 predict the accumulated SEL for the driving or proofing of up to 10 piles. Table 6 reports the accumulated SEL levels based on unattenuated pile driving, while Table 7 assumes a 10-dB reduction in the SEL level when using a properly deployed air bubble curtain system. Table 8 reports the estimated distances to the accumulated 183 and 187 dB SEL level, depending on the number of piles driven or proofed in one day. Note that the calculated distances for the cumulative SEL shown in Table 8 reflect that there is no increase in the cumulative SEL when the single strike SEL is below 150 dB. For example the distance to the 150 dB single strike SEL is 100 meters for impact driving; therefore the cumulative SEL does not change for distances beyond 100 meters.

**Figure 5. Extent of RMS Sound Pressures from Impact Pile Driving**



**Table 6 -Cumulative SEL levels for Unattenuated Pile Driving at 33 ft (10 m)**

Pile Type	Pile size	Blows	Single Strike SEL	Number of Piles Driven in a Day		
				1	2	3
Full Drive	18- inch	685	175	203	206	208
Proofing	18-inch	100	170	190	193	195

**Table 7 - Cumulative SEL for Attenuated Pile Driving at 33 ft (10 m)**

Pile Type	Pile size	Blows	Single Strike SEL	Number of Piles Driven in a Day		
				1	2	3
Full Drive	18- inch	685	165	193	196	198
Proofing	18-inch	100	160	185	188	190

**Table 8 - Distances to the Cumulative SEL Criteria for Attenuated Pile Driving in Meters**

Location	Pile size	Blows	Hammer type	RMS	Peak Sound Pressure	Single Strike SEL	Distance to the 187 dB Cumulative SEL - Meters									
							1	2	3	4	5	6	7	8	9	10
Full Drive	18-inch	685	D30/36	185	198	165	27	42	55	67	78	88	97	100	100	100
Proofing	18-inch	100	D30/36	185	198	165	<10	12	15	19	22	24	27	29	32	34

Location	Pile size	Blows	Hammer type	RMS	Peak Sound Pressure	Single Strike SEL	Distance to the 183 dB Cumulative SEL - Meters									
							1	2	3	4	5	6	7	8	9	10
Full Drive	18-inch	685	D30/36	185	198	165	49	78	100	100	100	100	100	100	100	100
Proofing	18-inch	100	D30/36	185	198	165	14	22	28	34	40	45	50	54	59	63

## AIRBORNE SOUNDS FROM PILE DRIVING

Pile driving generates airborne sound that could potentially result in disturbance to marine mammals (i.e., pinnipeds) which are hauled out or at the water’s surface. The NMFS has adopted thresholds for harassment and injury to marine mammals, as shown in Table 9. The appropriate airborne noise thresholds for behavioral disturbance for all pinnipeds, except harbor seals, is 100 dB re 20  $\mu$ Pa RMS and for harbor seals is 90 dB re 20  $\mu$ Pa RMS. Similar to underwater sounds, these sounds are considered over the frequency range of 75Hz to 20,000 Hz and are assumed to be similar to C-weighted sound levels, which are broadband sound levels that are weighted at very low frequencies below 100 Hz.<sup>11</sup> The thresholds are interpreted to apply to average RMS sound levels during a driving event.

<sup>11</sup> C-weighting is based on a curve defined by IEC 61672:2003 relating to the measurement of sound pressure level. The weighting is employed by arithmetically adding a table of values for one third-octave bands, to the measured levels. There is generally no weighting applied to sounds between about 80 and 8,000 Hz.

**Table 9 - Adopted Airborne Criteria for Marine Mammals<sup>12</sup>**

Species	Disturbance Airborne Noise Thresholds for Impact & Vibratory Pile Driving (dB re: 20 µPa)
Cetaceans	None
Pinnipeds	90 dB RMS (un-weighted) for harbor seals 100 dB RMS (un-weighted) for sea lions and all other pinnipeds

**Fundamentals of Airborne Noise**

Sound from a single source (i.e., a “point” source) radiates uniformly outward in a spherical pattern as it travels away from the source. The sound level attenuates (or drops off) at a rate of 6 dBA for each doubling of distance. Usually the noise path between the source and the observer is very close to the ground. Noise attenuation from ground absorption and reflective wave canceling adds to the rate of attenuation. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is done for simplification only; for distances of less than 300 feet, prediction results based on this scheme are sufficiently accurate. For acoustically “hard” sites (i.e., sites with a reflective surface, such as a smooth body of water, between the source and the receiver), no excess ground attenuation is assumed.

Sounds generated from construction activities are considered point sources, rather than a line source such as a freeway or roadway. The marine environment around the project site is mostly water and would be considered a “hard” site. The TL drop off rate of sound is based on spherical spreading loss (a  $20 \log_{10}$  function). This equates to a 6-dB reduction in sound per doubling distance. The formula for calculating the drop off is the source level plus  $20 \cdot \log_{10}(D_1/D_2)$ , where  $D_1$  is the reference position and  $D_2$  is the receiver position. For example, if an impact pile driver has a reference level of 110 dB at 50 feet the noise level at 500 feet would be calculated as follows for conditions where excess attenuation is not anticipated:

$$\text{Received level} = 110\text{dBA} + 20\text{Log}_{10}(50/500) \text{ dBA}$$

$$\text{Received level} = 110 + (-20) \text{ dBA}$$

$$\text{Received level} = 90 \text{ dBA}$$

There are relatively few data regarding the un-weighted sound levels for impact or vibratory pile driving. Table 10 shows the  $L_{\max}$  and  $L_{\text{eq}}$  levels<sup>13</sup> measured while driving relatively small diameter steel shell piles (24- to 36-inch diameter) at the Navy Test Pile Program project in Bangor, Washington.

<sup>12</sup> Based on NOAA 77 FR 43049, July 23, 2012. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Pile Replacement Project.

<sup>13</sup>  $L_{\max}$  level is the typical maximum RMS sound level measured with a Sound Level Meter set to the “fast” response (or 1/8<sup>th</sup> second response time). The  $L_{\text{eq}}$  is the energy average sound level measured over a driving event.

**Table 10 – Underwater Sound Levels from Driving of Steel Piles Measured at 50 ft (15m)**

Sound Descriptor	Sound Level in dB	
	Vibratory Hammer	Impact Hammer
Lmax	102	112
Leq	97	103

**Airborne Impacts from Vibratory Pile Driving**

Measured sound levels from vibratory pile driving used in this analysis are based on measurements made during the Navy Test Pile Project, as shown in Table 10. The maximum measured unweighted Lmax was 102 dB and the average Lmax was 97 dB at 50 feet or 15 meters. The  $20\log_{10}$  attenuation rate was used to calculate the distances to the various NMFS thresholds that are presented in Table 11. The distances shown are based on the Lmax levels. We believe that as NMFS criterion are based on average levels, these distances likely overestimates impacts. Figure 6 shows the extent of these sound levels.

**Table 11 – Distance to Thresholds with Vibratory driving**

Threshold	Distance (meters)	
	100 dB	90 dB
Lmax	65 ft 20 m	200 ft 60 m
Leq	35 ft 10 m	110 ft 35 m

**Airborne Impacts from Impact Pile Driving**

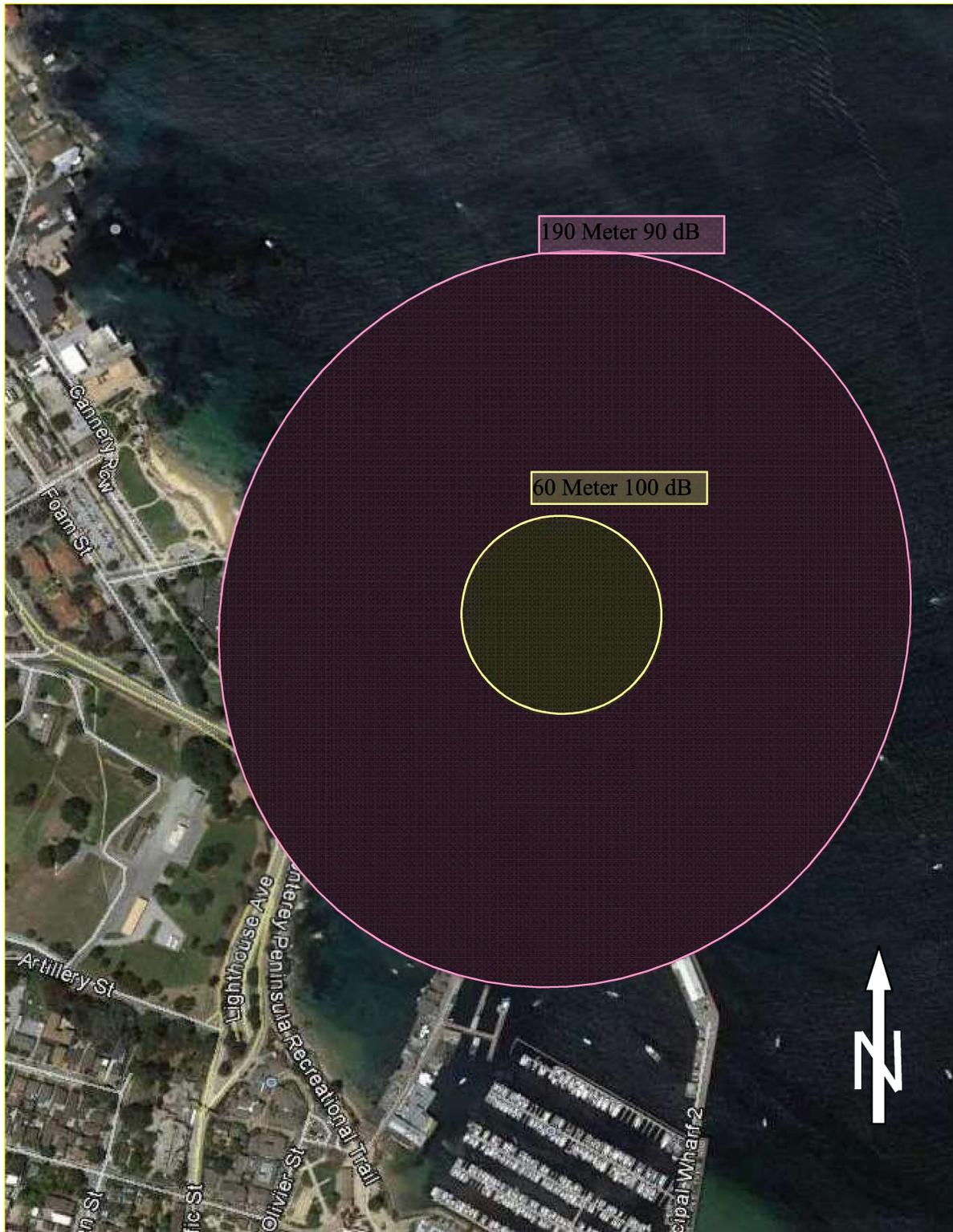
Measured sound levels from impact pile driving used in this analysis are also based on measurements made during the Navy Test Pile Project. The maximum measured unweighted Lmax was 112 dB and the average Lmax was 103 dB at 50 feet (15 meters). The  $20\log_{10}$  attenuation rate was used to calculate the distances to the various NMFS thresholds that are presented in Table 12. The levels shown are the Lmax levels. Again, these distances likely overestimate impact areas, since they are based on the maximum levels. Figure 7 shows the extent of these sound levels.

**Table 12 – Distance to Thresholds for Impact Driving**

Threshold	Distance	
	100 dB	90 dB
Based on Lmax	200 ft 60 m	630 ft 190 m
Based on Leq	70 ft 20 m	225 ft 70 m



**Figure 6.** Extent of Airborne  $L_{max}$  Sound Levels from Vibratory Pile Driving



**Figure 7.** Extent of Airborne  $L_{max}$  Sound Levels from Impact Pile Driving

## **AMBIENT SURVEY**

Baseline sound levels, both underwater and in air, were measured in the project area during August 12 through 14, 2012. The results of the baseline acoustic field program are presented in this section and are used to assess potential for adverse noise impacts on marine mammals and fish habitat during the proposed improvements at USCG Station Monterey. Measurements included a continuous two-day measurement at the project site and spot measurements both inside and outside the harbor.

### **Equipment**

Underwater sound measurements were made using Reson TC4033 hydrophones with PCB in-line charge amplifiers (Model 422E13) and PCB Multi Gain Signal Conditioners (Model 80M122). The signals were fed into Larson Davis Model 831 Integrating Sound Level Meter (SLM) (Type 1) and digital recorders. The multi gain signal conditioner provides the ability to lower or raise the signal strength so that measurements are made within the dynamic range of the instruments used to analyze the signals.

Continuous airborne measurements were conducted using a Larson Davis Model 820 Integrating Sound Level Meter (SLM) (Type 1) fitted with precision microphones and windscreens. The sound level measuring assemblies were calibrated before and after the noise monitoring survey, and the response of the systems were always found to be within 0.5 dB of the calibrated level. No calibration adjustments were made to the measured noise levels. In addition, digital recordings with calibration tones were made for backup purposes.

### **Field Activities**

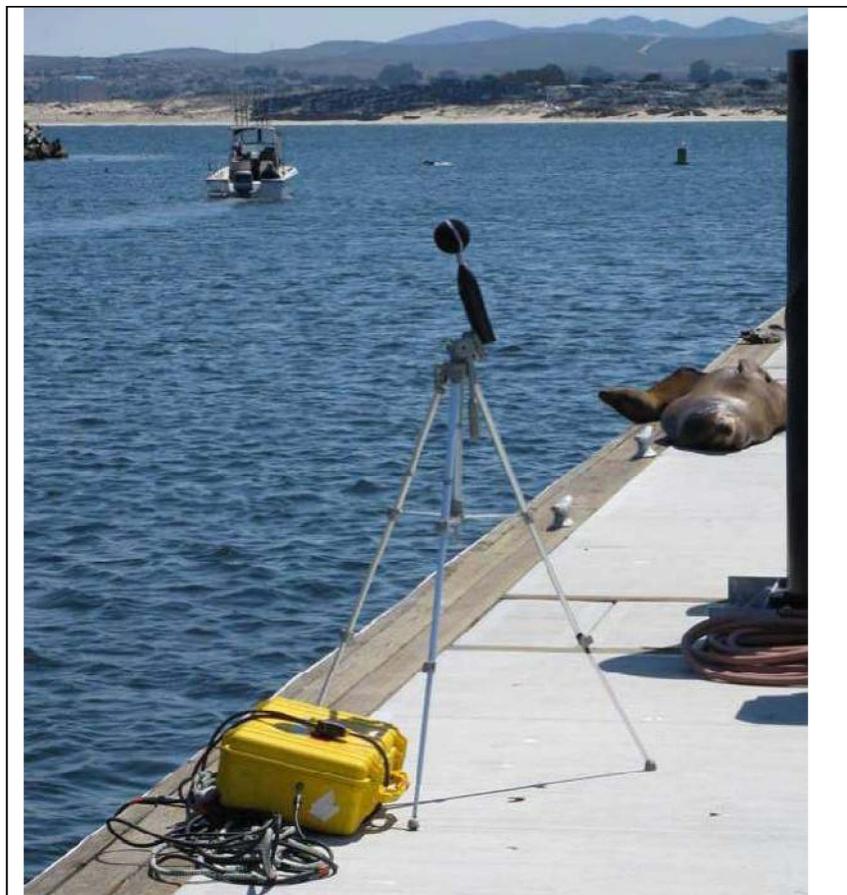
Ambient sound levels were measured at two fixed positions and one vessel based position. All underwater sound measurements were made in decibels referenced to 1  $\mu$ Pa and airborne measurements were in decibels referenced to 20  $\mu$ Pa. At the two fixed positions the hydrophones were placed at mid depth of the water column. The first position was based on the existing USCG Station Monterey Pier and was set up to measure a 24-hour period; this allowed an analysis of the day night differences in the noise levels. The second fixed position was placed on the dock across from the USCG Station Monterey pier. Due to security concerns this system was placed in the morning and picked up at the end of the day. The hydrophone was set at mid water depth. Figures 8 through 11 are photographs of the monitoring positions. Time and date stamped time histories for all relevant datasets were compiled in 1-second Leq intervals. These data are presented in Appendix A.



**Figure 8.** Photo of project site taken at dock monitoring position looking at the monitoring position at the USCG pier.



**Figure 9.** Photo of airborne and underwater monitoring location at the USCG wharf.



**Figure 10.** Airborne and underwater acoustic monitoring at new dock across from USCG pier.



**Figure 11.** Airborne and underwater sound measurement position from floating boat about 1 km east of the project site.

Table 13 summarizes the data collected at the project site and the nearby dock. These data are summarized by day and night periods. The data are presented statistically, where the L<sub>10</sub> level is the level exceeded 10 percent of the time, the L<sub>50</sub> is the median level and the L<sub>90</sub> is the level exceeded 90 percent of the time. Measurements at nighttime were only conducted from the pier.

**Table 13 - Summary Results: Underwater Broadband Sound Pressure Levels (80 to 20,000 Hz), in dB reference 1 µPa**

Sound Descriptor	USCG Pier			Dock
	Overall	Day	Night	Day
Maximum	143	143	134	142
L <sub>10</sub>	123	124	117	--
L <sub>50</sub>	114	116	113	112
L <sub>90</sub>	112	112	112	--

Table 14 summarizes the median and range of underwater sound levels measured at the pier site and Table 15 provides similar data for the dock site. In the vicinity of the project site, the median broadband ambient underwater sound levels (between 80 Hz and 20 kHz ) were measured at 114 dB. Maximum levels were typically around 125 dB, as indicated by the L<sub>10</sub> level. The maximum sounds were likely from boats. There were a considerable number of harbor seals and California sea lions near the hydrophones that may have resulted in elevated localized sounds. While ambient sounds are in the 110 to 120 dB range, acoustic events, such as boat traffic, typically result in sound levels that exceed 120 dB.

**Table 14 - Summary of Underwater Measurement Levels at the USCG Pier in dB reference 1 µPa**

Partial day 8/12		Night 8/13 - 8/14	
Max	136	Max	132
Min	112	Min	110
Median	113	Median	113
<b>Night 8/12 - 8/13</b>		<b>Day 8/14</b>	
Max	136	Max	135
Min	110	Min	111
Median	113	Median	116
<b>Day 8/13</b>		<b>For all data</b>	
Max	143	Max	143
Min	110	Min	110
Median	116	Median	114

The ambient sound levels were similar at all locations and were found to be marginally affected by sea state conditions and tidal currents. Light winds and relatively calm seas occurred during the measurement survey. Sources of anthropogenic noise included early morning fishing boats leaving the boat launch and boat traffic throughout the day. There was also a constant cracking or popping sound present at all locations measured. This was attributed to the presence of what is commonly called the Snapping Shrimp. These species have an oversized claw that is used to communicate

and hunt, and for defense. The resulting sounds from these shrimp sound like static.

Sound pressure levels recorded at the two measurement locations were consistent; however, periodic deviations on the order of 20 dB were seen for brief periods.

**Table 15 - Summary of Underwater Measurement Levels at the Dock Across from USCG Pier in dB reference 1  $\mu$ Pa**

Day 8/13		Summary All data	
Max	142	Max	142
Min	105	Min	105
Median	112	Median	112

Day 8/14	
Max	139
Min	106
Median	114

Airborne sound levels were measured in decibels referenced to 20  $\mu$ Pa. Airborne noise levels at the project site vary. The median daytime sound level ranged 62 to 68 dB (C weighted). Ambient sounds included barking seals, boat traffic, birds, distant traffic, and occasional aircraft. Barking seals and seagulls were observed to produce the highest noise levels.

**Table 16 - Summary of Airborne Measurement Levels at the USCG Pier in dB reference 20  $\mu$ Pa**

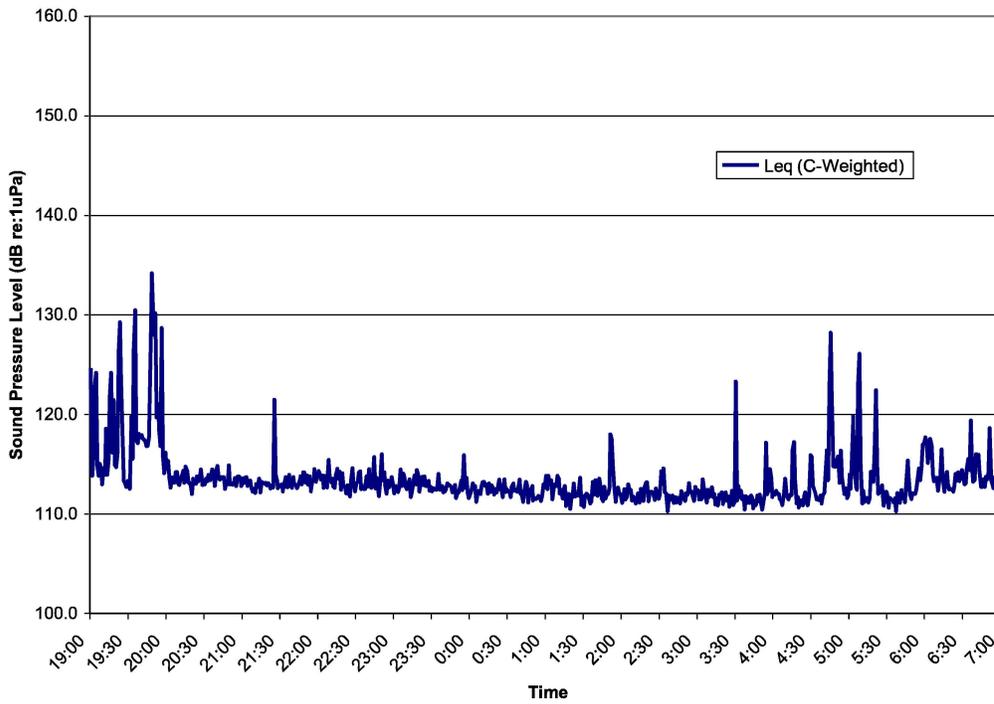
Sound Descriptor	Total		8/12 Night		8/13 Day		8/13 Night		8/14 Day	
	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax
L <sub>10</sub>	77	85	81	88	74	86	70	79	66	76
L <sub>50</sub>	65	72	74	81	68	78	60	67	62	67
L <sub>90</sub>	57	62	65	71	63	71	53	56	60	63

Airborne sounds were measured from a boat floating approximately 1 kilometer east of the project site in Monterey Bay. However, wind waves interacting with the boat caused elevated low frequency noise that raised the overall unweighted sound pressure levels. These were measured at 65 to 75 dB during the daytime (about 0900 to 0930). These levels were typical of sounds measured in the project area (i.e., inside the harbor).

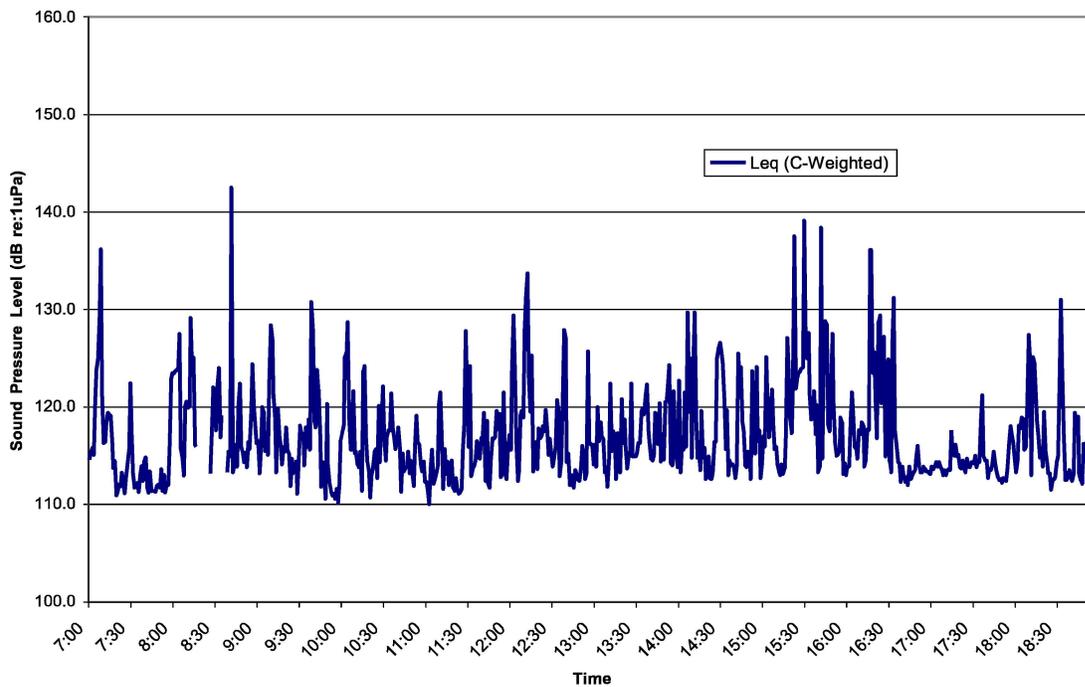
## **Appendix A Acoustic Data**

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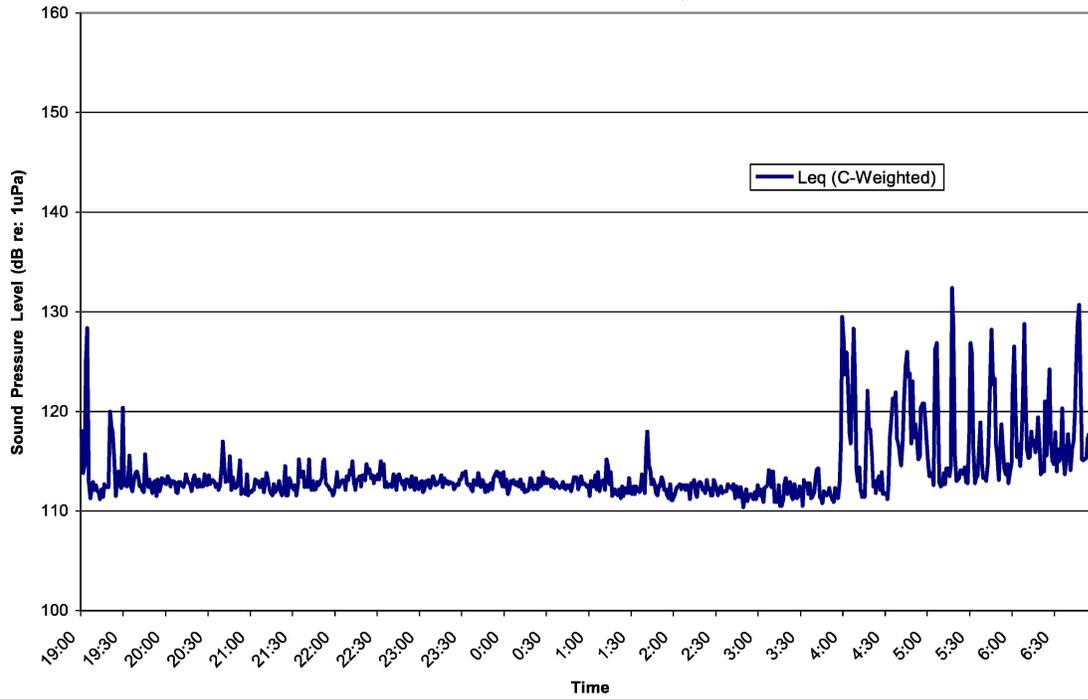
USCG Pier  
August 12, 2012 to August 13, 2012  
1900 to 0700  
One Minute Time History



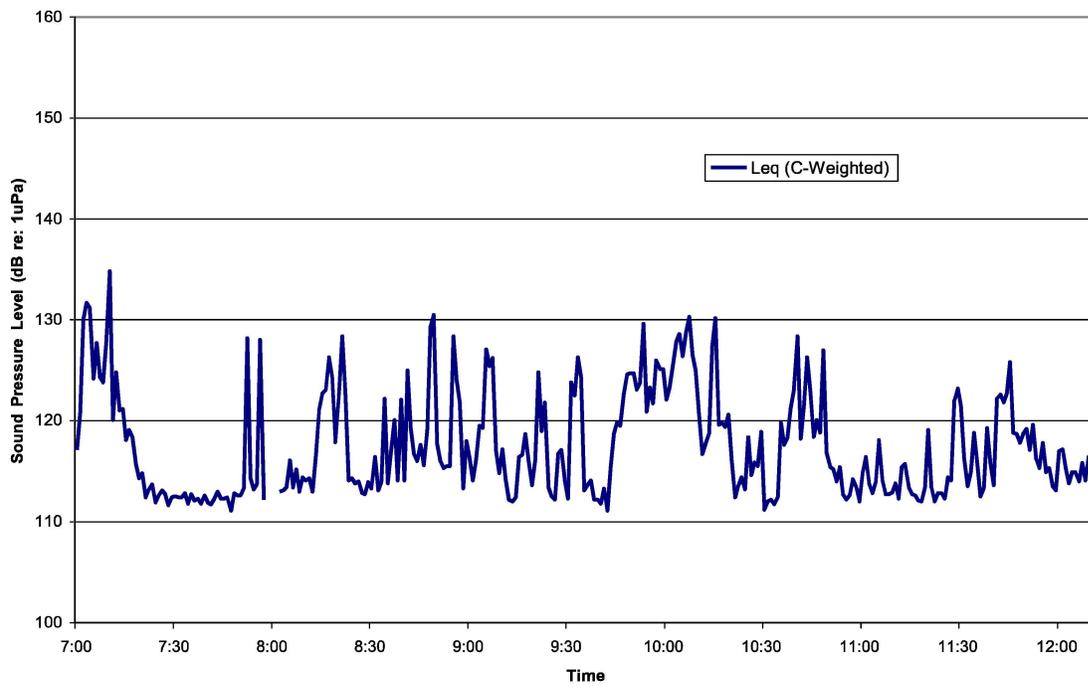
USCG Pier  
August 13, 2012  
0700 to 1900  
One Minute Time History

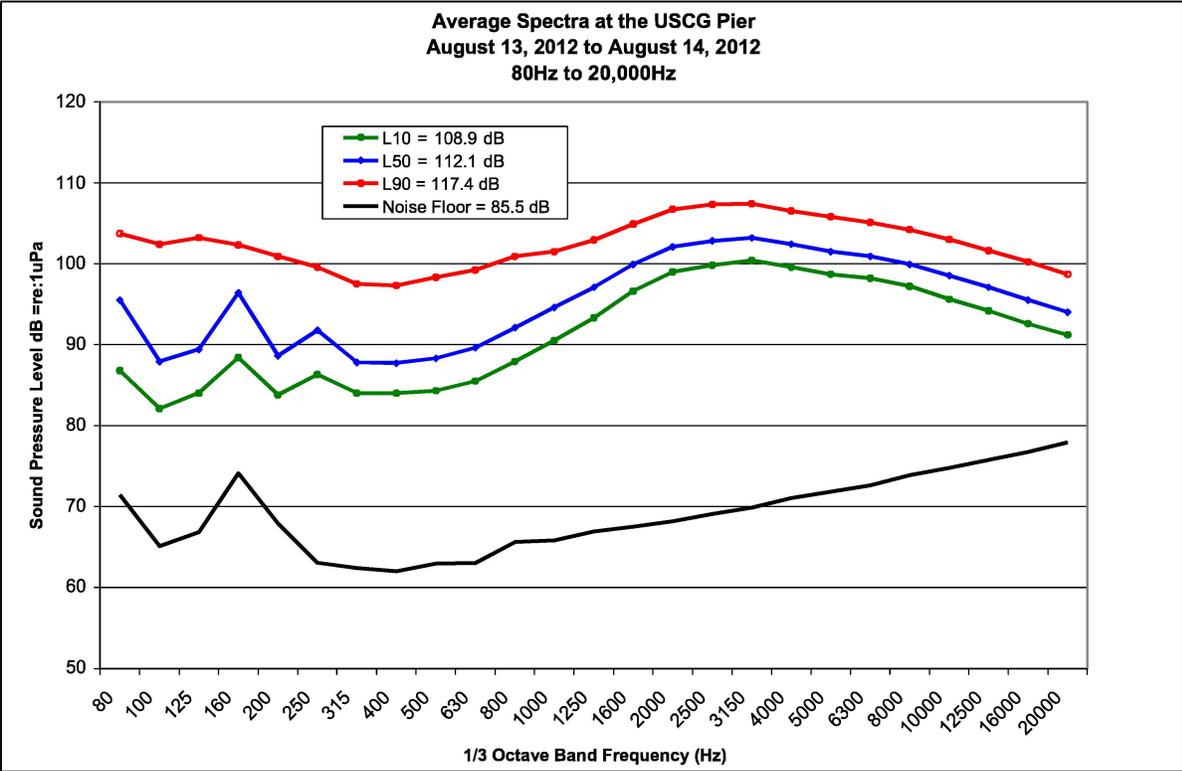
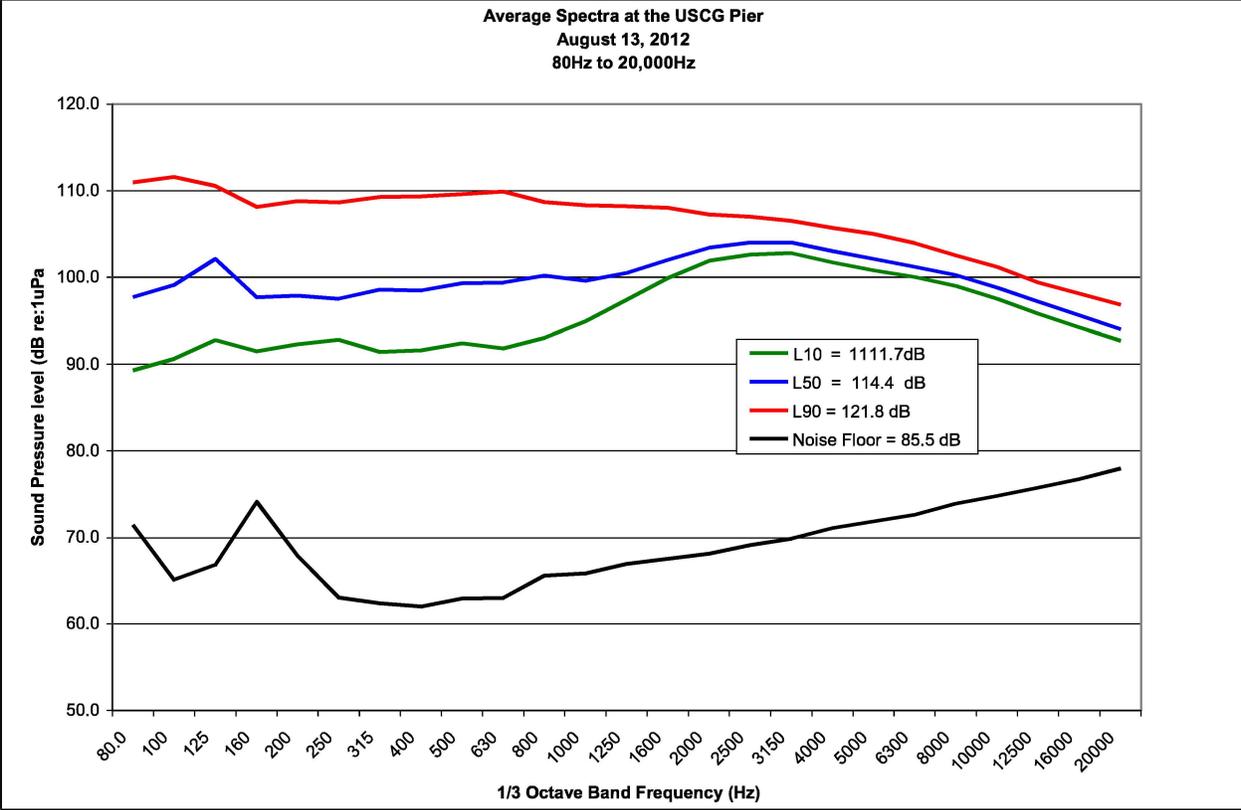


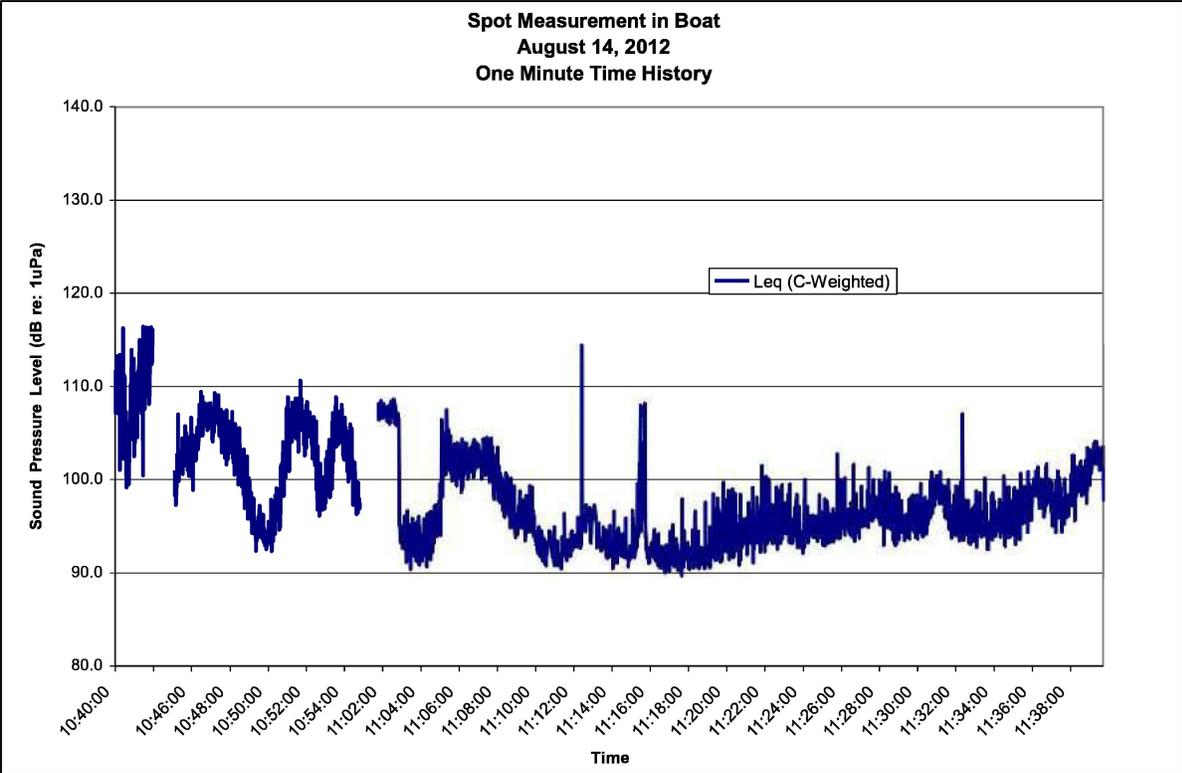
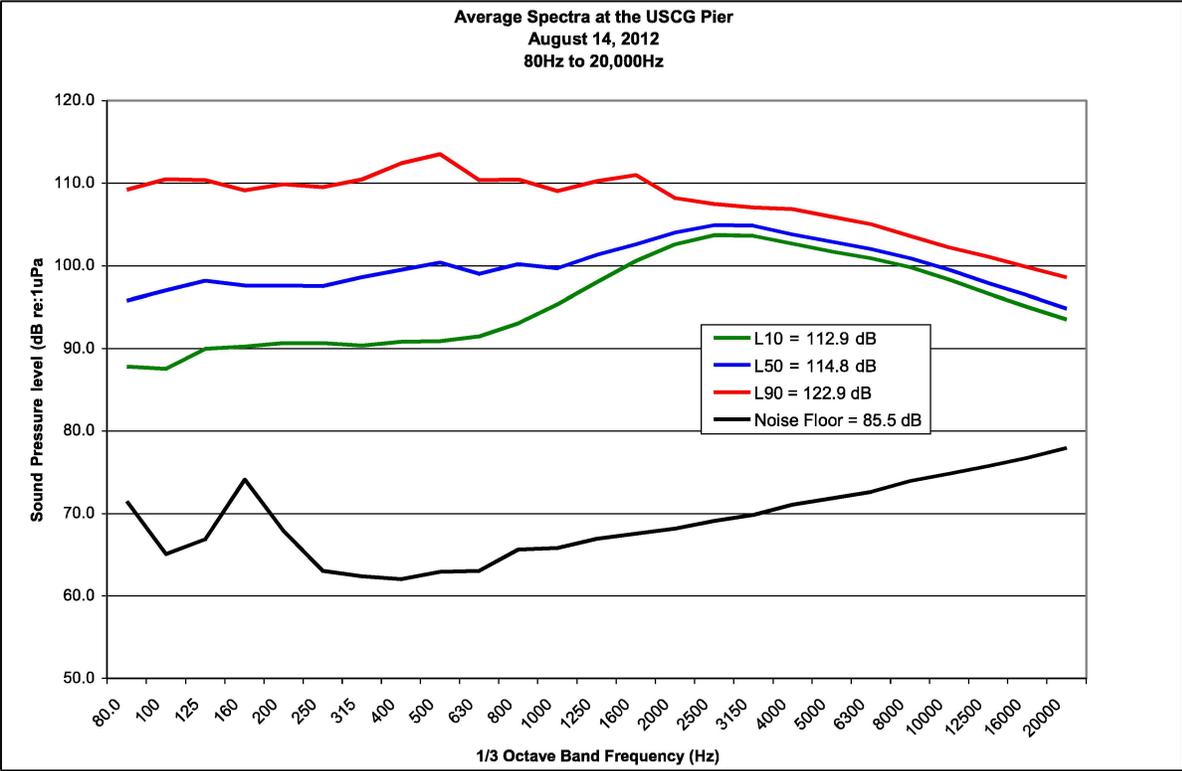
USCG Pier  
August 13, 2012 to August 14, 2012  
1900 to 0700  
One Minute Time History



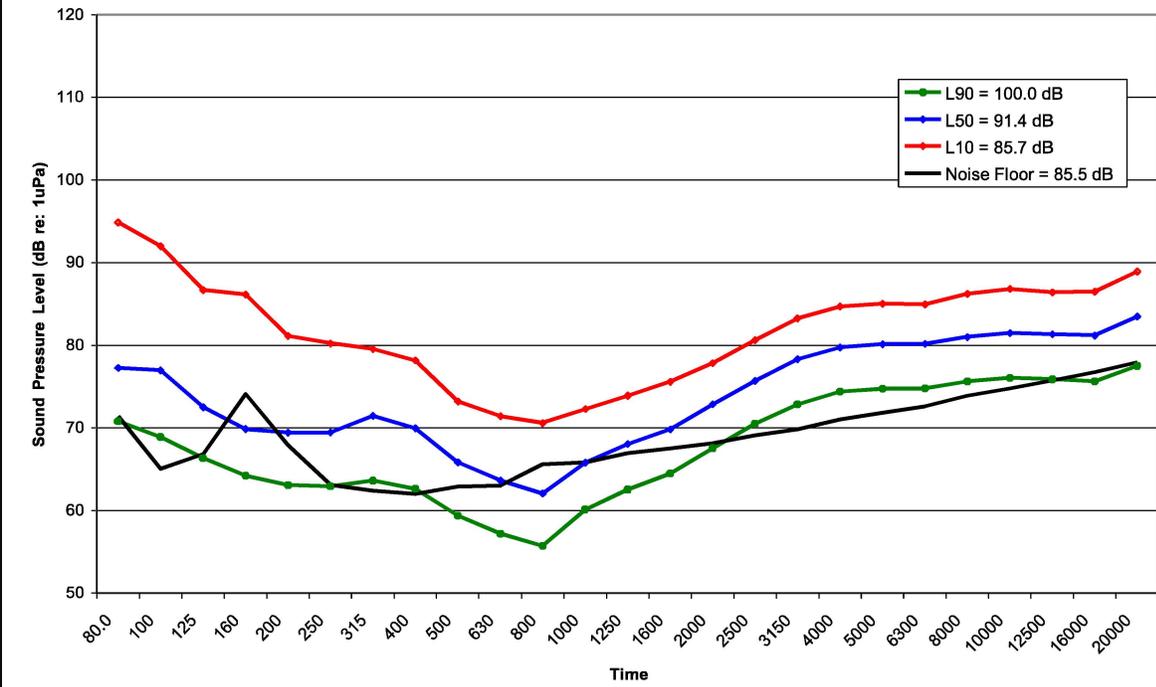
USCG Pier  
August 14, 2012  
0700 to 1200  
One Minute Time History

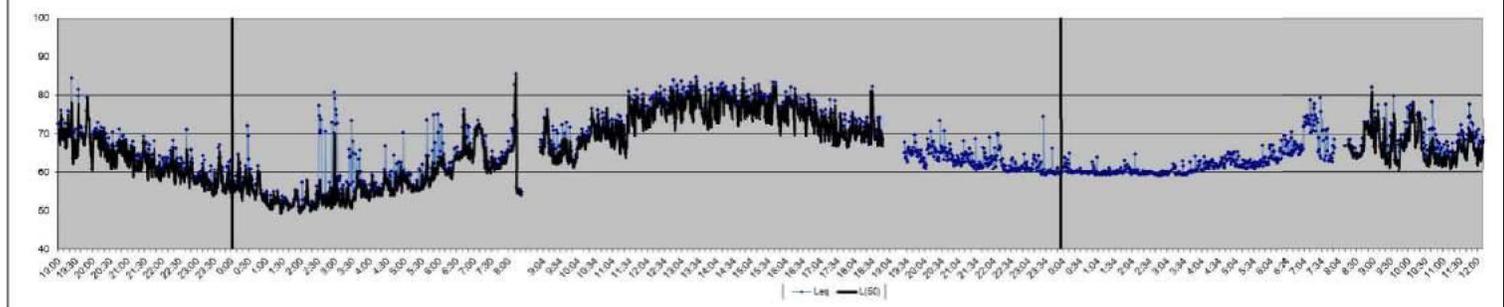




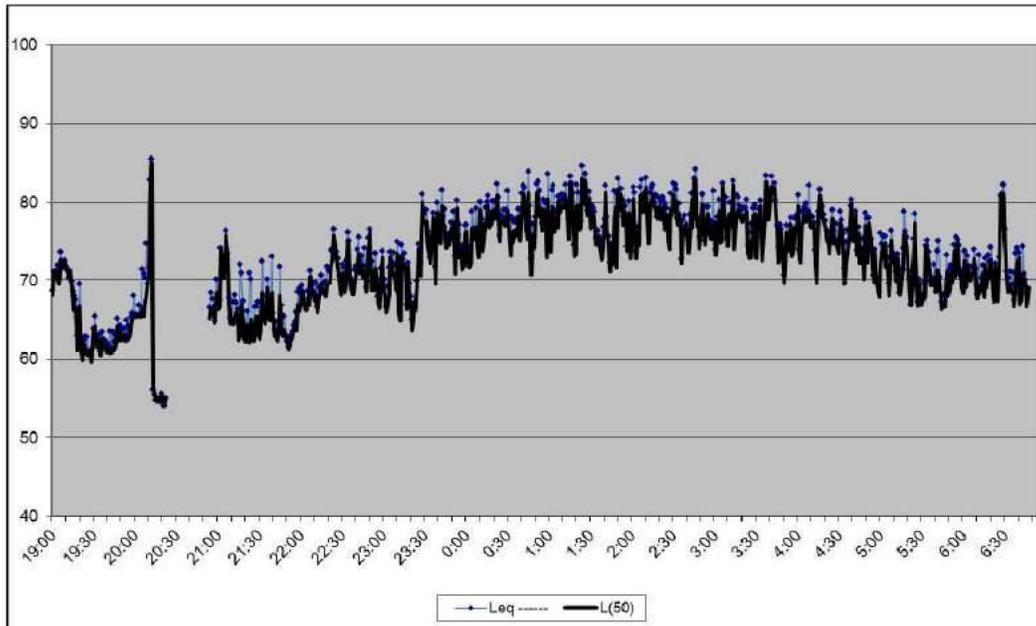


**Spot Measurement in Boat out in Bay  
One Kilometer from USCG Pier August  
14, 2012  
One Minute Time History**

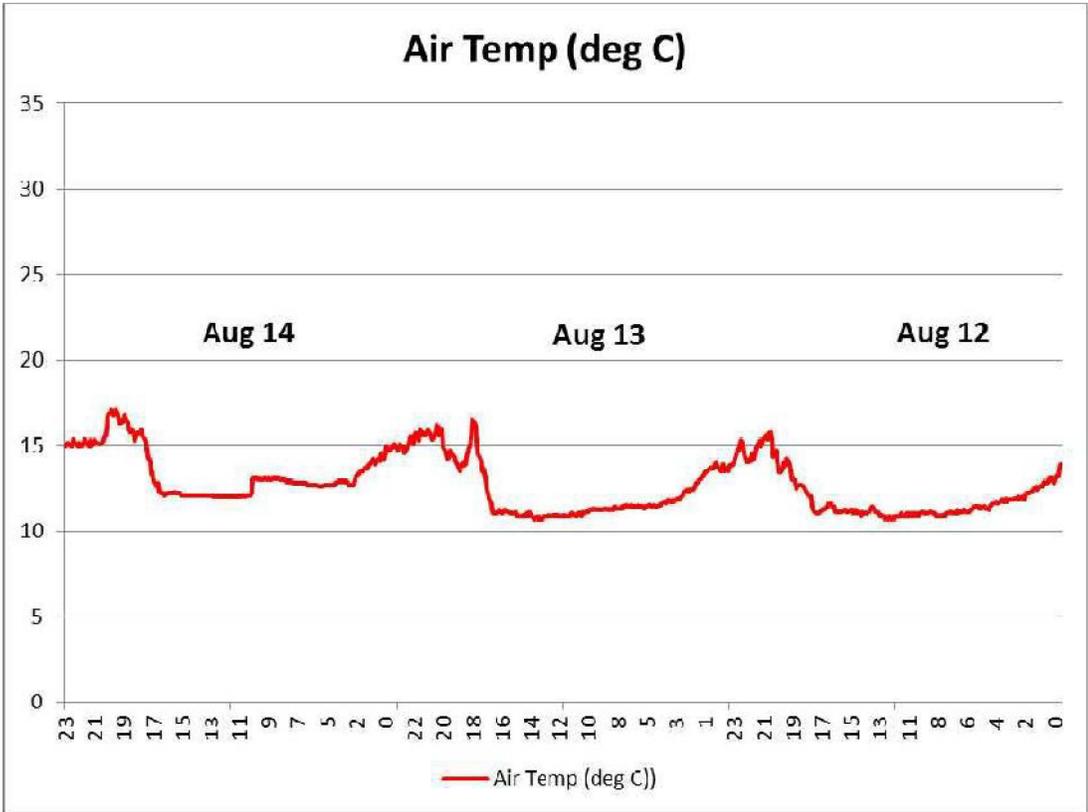
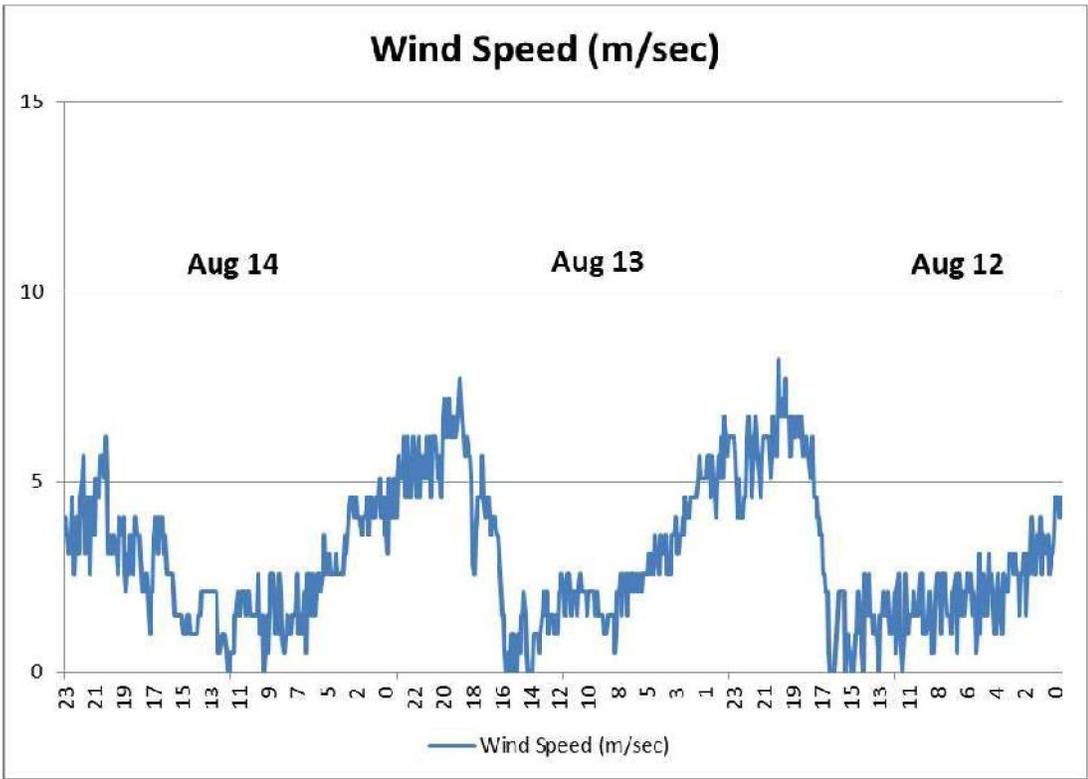




**Airborne Sound Levels Measured at the USCG Pier dB re 20  $\mu$ Pa, C-Weighted - Aug 12-14, 2012**



**Airborne Sound Levels Measured Daytime Only for August 13 (0700 through 1900)**



Meteorological Data Measured by NOAA in Monterey Bay

**Station MTYC1 - 9413450 - Monterey, CA**

[Owned and maintained by NOAA's National Ocean Service](#)

**Water Level Observation Network**

**36.605 N 121.888 W (36°36'18" N 121°53'18" W)**

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## **Appendix B**

### NOAA NMFS User Spreadsheets for Calculating Level A Noise Isopleths

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**E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)**

VERSION 1.1: Aug-16

KEY	
	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isoleth

**STEP 1: GENERAL PROJECT INFORMATION**

PROJECT TITLE	USCG Monterey Bay revised
PROJECT/SOURCE INFORMATION	caltrans data
Please include any assumptions	
PROJECT CONTACT	

**STEP 2: WEIGHTING FACTOR ADJUSTMENT**

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz) <sup>†</sup>	2	
--	---	--

<sup>†</sup> Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

**\* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

**STEP 3: SOURCE-SPECIFIC INFORMATION**

**NOTE:** Choose either E1-1 OR E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

**E1-1: METHOD TO CALCULATE PK AND SEL<sub>cum</sub> (USING RMS SPL SOURCE LEVEL)**

SEL <sub>cum</sub>		PK	
Source Level (RMS SPL)		Source Level (PK SPL)	
a) Activity Duration (h) within 24-h period OR b) Number of piles per day <sup>†</sup>		Distance of source level measurement (meters) <sup>†</sup>	
Pulse Duration <sup>‡</sup> (seconds)		Source level at 1 meter	#NUM!
a) Number of strikes in 1 h OR b) Number of strikes per pile <sup>†</sup>		Unless otherwise specified, source levels are referenced 1 m from the source.	
Activity Duration (seconds)		<b>Metric-Matched Hearing Group</b> Low-Frequency (LF) cetaceans: baleen whales Mid-Frequency (MF) cetaceans: dolphins, beaked whales, bottlenose whales High-Frequency (HF) cetaceans: true porpoises, Negundo dolphins, cephalopod squid, <i>Lagenorhynchus rostratus</i> , <i>S. L. australis</i> Phocid pinnipeds (PW): sea seals Otariid pinnipeds (OW): sea lions and the seals	
10 Log (duration)	#NUM!		
Propagation (xLogR)			
Distance of source level measurement (meters) <sup>†</sup>			
*Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005			
† For cells B27 & B29 users should supply information for both cells as either a) OR b); Don't mix-n-match. Unless otherwise specified, source levels are referenced 1 m from the source.			

**RESULTANT ISOPLETHS\***

\*Impulsive sounds have dual metric thresholds (SEL<sub>cum</sub> & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL <sub>cum</sub> Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
PK Threshold	219	230	202	218	232
PTS PK Isoleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

**E1-2: ALTERNATIVE METHOD TO CALCULATE PK AND SEL<sub>cum</sub> (SINGLE STRIKE EQUIVALENT)**

Unweighted SEL <sub>cum</sub> (at measured distance) = SEL <sub>cum</sub> + 10 Log (# strikes)	197.0		
--	-------	--	--

SEL <sub>cum</sub>		PK	
Source Level (Single Strike/shot SEL)	177	Source Level (PK SPL)	
a) Number of strikes in 1 h OR b) Number of strikes per pile <sup>†</sup>	20	Distance of source level measurement (meters) <sup>†</sup>	
a) Activity Duration (h) within 24-h period OR b) Number of piles per day <sup>†</sup>	5	Source level at 1 meter	#NUM!
Propagation (xLogR)	15	Unless otherwise specified, source levels are referenced 1 m from the source.	
Distance of single strike SEL measurement (meters) <sup>†</sup>	10		
† For cells B50 & B51 users should supply information for both cells as either a) OR b); Don't mix-n-match. Unless otherwise specified, source levels are referenced 1 m from the source.			

**RESULTANT ISOPLETHS\***

\*Impulsive sounds have dual metric thresholds (SEL<sub>cum</sub> & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL <sub>cum</sub> Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	85.7	3.0	102.0	45.8	3.3
PK Threshold	219	230	202	218	232
PTS PK Isoleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

**WEIGHTING FUNCTION CALCULATIONS**

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f <sub>1</sub>	0.2	8.8	12	1.9	0.94
f <sub>2</sub>	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB) <sup>†</sup>	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10 \ln_{10} \left\{ \frac{(f/f_1)^{2a}}{[1 + (f/f_1)^2]^{a+b}} \cdot \frac{(f_2/f)^{2a}}{[1 + (f_2/f)^2]^{a+b}} \right\}$$

100	0.008728738	0.001579994	1.108033241	20.49314289
101	1.083916614	1.050554538	2.108033241	30.54701342
1.022283439	1.000661266	1.000480205	1.008908642	1.01284096
0.968517118	0.008047639	0.001503348	0.520982928	0.6623668

# A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION 1.1: Aug-16

KEY	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isopleth

### STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	USCG Monterey (Revised)
PROJECT/SOURCE INFORMATION	WSDOT Friday Harbor data (2010) vibratory 14' steel piles
Please include any assumptions	
PROJECT CONTACT	

### STEP 2: WEIGHTING FACTOR ADJUSTMENT Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz) <sup>‡</sup>	2.5	
<sup>‡</sup> Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab		

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

\* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

### STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	162
Activity Duration (hours) within 24-h period	4
Activity Duration (seconds)	14400
10 Log (duration)	41.58
Propagation (xLogR)	15
Distance from source level measurement (meters)*	10

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: balcen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruegeri</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

\*Unless otherwise specified, source levels are referenced 1 m from the source.

### RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL <sub>cum</sub> Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	20.1	1.8	29.7	12.2	0.9

### WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f <sub>1</sub>	0.2	8.8	12	1.9	0.94
f <sub>2</sub>	19	110	140	30	25
c	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60
$W(f) = c + 10 \log_{10} \left\{ \frac{(f/f_1)^{2a}}{[1 + (f/f_1)^2]^b} [1 + (f/f_2)^2]^b \right\}$	156.25	0.017826393	0.003528024	1.731301939	50.03208714
	157.25	1.132226089	1.079477462	2.731301939	65.17875984
	1.034925779	1.001033325	1.000637857	1.013937114	1.0201
	0.960108173	0.0157283	0.003266187	0.625161295	0.752488349

## **Appendix B**

### **Hydroacoustic Monitoring Plan**

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*Waterfront Repairs at*  
*US Coast Guard Station Monterey*  
**UNDERWATER NOISE MONITORING PLAN**

*Prepared for:*  
United States Coast Guard  
U.S. Coast Guard Civil Engineering Unit Oakland  
1301 Clay Street, Suite 700N  
Oakland, California 94612

*Prepared by:*  
Amec Foster Wheeler Environment & Infrastructure, Inc.  
104 West Anapamu Street, Suite 204A  
Santa Barbara, CA 93101  
(805) 962-0992

*December 2017*

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## **INTRODUCTION**

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The U.S. Coast Guard (USCG) proposes to conduct maintenance on an existing wharf which is used to berth vessels that are critical to support Station Monterey's mission. USCG Station Monterey is located at 100 Lighthouse Avenue at the southern end of Monterey Bay in Monterey, California). Station Monterey occupies an upland site and adjacent waterside structures including a 1,700-foot breakwater, a wharf constructed over the breakwater, and floating docks to the east of the wharf.

The wharf is constructed of timber and steel material and is supported by 64 piles. In 1995, 47 of the original timber piles were replaced with 14-inch steel pipe piles and the remaining 17 timber piles had polyvinyl chloride (PVC) pile wraps installed. The 17 remaining timber piles in need of replacement are bearing piles that have exceeded their service life primarily due to marine bores and the harsh marine environment to which they are exposed. A detailed description of pile installation and removal is provided in sections below.

This underwater noise monitoring plan describes the methodology and reporting to be implemented during pile-driving and extraction activities for the duration of the project. The plan has been prepared using guidance documentation issued by National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) including *Sound Propagation Modeling to Characterize Pile Driving Sounds Relevant to Marine Mammals* issued January 31, 2012 and *Data Collection Methods to Characterize Underwater Background Sound Relevant to Marine Mammals in Coastal Nearshore Waters and Rivers of Washington and Oregon*, issued January 31, 2012. This plan follows the underwater noise monitoring plan template developed by the Washington Department of Transportation (WSDOT 2013).

## **PERMIT/ENDANGERED SPECIES ACT (ESA) CONDITIONS**

---

Mitigation measures to avoid Level A (injury) harassment and reduce the potential effects from Level B (disturbance) harassment to marine mammals during pile-extraction and pile-driving activities have been established in coordination with NOAA NMFS and U.S. Fish and Wildlife Service (USFWS) during preparation of the application for incidental harassment authorization (IHA). Measures include:

1. Noise Attenuation During Impact Pile Driving

Noise attenuation systems (i.e., bubble curtains and cushion pads) will be used during all impact pile driving to interrupt the acoustic pressure and reduce the impact on marine mammals. By reducing underwater sound pressure levels at the source, bubble curtains would reduce the area over which both Level A and B harassment would occur, thereby potentially reducing the numbers of marine mammals affected.

Pre-drilling would be performed and would be discontinued when the pile tip is approximately 5 feet above the required pile tip elevation. Pre-drilling is a method that starts the "hole" for the new pile; the pile is inserted after the hole has been pre-drilled which creates less friction and overall noise and turbidity during installation. Pre-drilling also is beneficial for overall pile stability as it reduces the stress and, therefore, chance of breakage or damage to the pile during installation.

Because the existing conditions include sloped topography and riprap, care would be taken when placing the bubble curtain to ensure a good seal is formed.

2. Exclusion Zone

- a. As discussed in Section 6 of the IHAA, various areas of concern (AOIs) were identified that would experience noise levels in excess of the Level A criteria for marine mammals. Because of this, the establishment of exclusion zones around each pile will be implemented to prevent Level A harassment to individual species. The exclusion zone includes all areas where underwater sound pressure levels are expected to reach or exceed the Level A harassment criteria for marine mammals. To be conservative, we have used the isopleths for impact pile driving which extend the farthest out. These correspond to the distances shown in Table 1

**Table 1. Exclusion Zone Distance by Species**

	<b>Species of Concern within the Action Area</b>	<b>Distance to Exclusion Zone</b>	<b>Frequency to be Measured</b>
Otariid Pinnipeds	California sea lion	0.9 meters	75 Hz (low) 20 kHz (high)
Mid-Frequency Cetaceans	Risso’s dolphin	1.9 meters	150 Hz (low) 20 kHz (high)
	Bottlenose dolphin		
	Killer whale		
Mustelids	Southern sea otter	10 meters	75 Hz (low) 20 kHz (high)
Phocid Pinnipeds	Harbor seal	27.9 meters	75 Hz (low) 20 kHz (high)
Low Frequency Cetaceans	Gray whale	52.1 meters	7 Hz (low) 20 kHz (high)
	Humpback whale		
High Frequency Cetaceans	Harbor Porpoise	62.1 meters	200 Hz (low) 20 kHz (high)

To provide a margin of safety, a provisional, conservative exclusion zone will be established during initial pile extraction and driving efforts, while hydroacoustic measurements are made to establish actual field conditions. These exclusion zones will be adjusted once field conditions have been established through hydroacoustic monitoring.

3. Visual Monitoring for Marine Mammals

The exclusion zone will be monitored for 30 minutes prior to any pile extraction and driving activities to ensure that the area is clear of any marine mammals. If an individual is observed, pile extraction or driving will not commence until the individual has left the exclusion zone for a minimum of a 15-minute period (pinnipeds and small cetaceans) or a 30-minute period (large cetaceans).

If a marine mammal enters the exclusion zone during pile replacement work, activity will stop until the individual leaves the exclusion zone. Work would not commence for a period of 15 minutes (for pinnipeds and small cetaceans) or 30 minutes period (for large cetaceans) after they have left the exclusion zone.

Monitoring will be conducted by qualified observers familiar with marine mammal species and their behavior. The observer will monitor the exclusion zone from the most practicable vantage point possible (i.e., the pier itself, the breakwater, adjacent boat docks in the harbor, or a boat) to determine whether marine mammals enter the exclusion zone. Monitors would be equipped with radios or cell phones for maintaining contact with work crews.

Vessel-based visual monitoring within the 120-dB and 160-dB AOI shall be conducted during 10 percent of the vibratory pile driving and removal and impact pile driving activities, respectively.

If a species is observed within the Level A or B zones that has not been included in this IHA request, work would immediately cease and delay procedures including a 30-minute wait period would be implemented.

If a humpback whale is observed within the Level A or Level B zones, work will cease until they leave these zones. Work would not commence until 30-minutes after the last sighting within these zones.

#### 4. Acoustic Monitoring

Hydroacoustic monitoring will be conducted during pile driving.

#### 5. Daylight Construction Period

Work would occur only during daylight hours.

#### 6. Soft Start (for impact pile driving only)

A “soft-start” technique is intended to allow marine mammals to vacate the area before the pile driver reaches full power. An initial set of three strikes would be made by the hammer at 40-percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets before initiating continuous driving.

#### 7. Safe Access to Work Zone

Should any serious injury or mortality to marine mammals result during the course of the proposed activity, the USCG will suspend operations and will immediately contact NMFS. If sea otters are injured during implementation of the project, the USCG will suspend operations and immediately contact the Monterey Bay Aquarium’s sea otter 24-hour emergency line.

## **PILE INSTALLATION LOCATION**

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The figures below show the location of the existing dock in need of pile driving and the locations of the piles proposed for replacement. There will be a total of 17 piles driven as part of the project.



Figure 1: Location of USCG Station Monterey Existing Pier

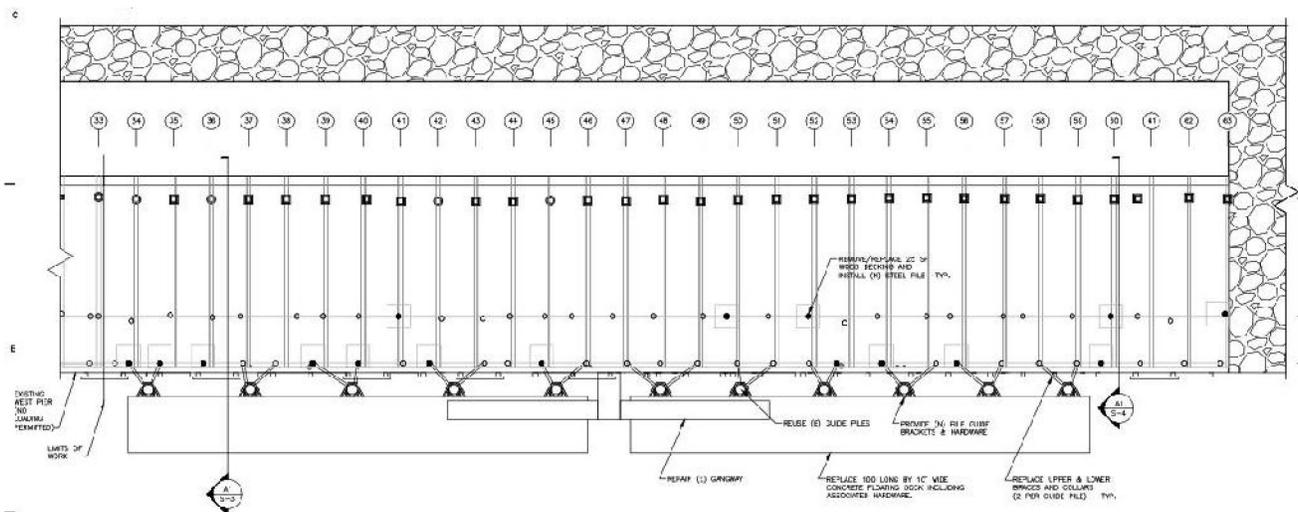


Figure 2: Piles to be Replaced

## **PILE INSTALLATION**

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The existing timber piles, approximately 16 to 18 inches in diameter, will be removed using a vibratory extractor. Each timber pile will be replaced with a 14-inch steel pipe pile installed using a vibratory hammer (the preferred method) and each pipe pile will be positioned and installed in the footprint of the extracted timber pile. Pile proofing will be conducted via impact hammer. If, due to substrate or breakwater armor, a pipe pile is unable to be driven to 30 feet below the mud line using a vibratory hammer, then an impact hammer will be used; and if the pile cannot be driven with an impact hammer, the pipe pile would be posted onto the armor stone.

Pile-driving activities are expected to occur for an estimated minimum of three (3) days and a maximum of eight (8) days of the total construction time. It is assumed that driving time would be approximately 20 minutes per pile for vibratory or impact pile driving. It is assumed that vibratory extraction of the existing piles would take approximately 10 minutes per pile. Pile driving and extraction would therefore result in an estimated of 240 minutes per day; 510 minutes for the total project or approximately 8.5 hours of underwater and airborne noise generation from pile driving/extraction activities over the course of the project construction.

Hydroacoustic monitoring objectives include:

1. Verify the disturbance zones for marine mammals (see exclusion zones established above under mitigation measures).
2. Confirm sound attenuation system effectiveness.

Hydroacoustic monitoring of steel pile with impact driving will be conducted for a minimum of five pile extractions and five pile installations. Hydroacoustic monitoring of steel pile with vibratory pile driving will not be conducted. Piles chosen to be monitored will be representative of mid-channel or typical water depths where piles are driven.

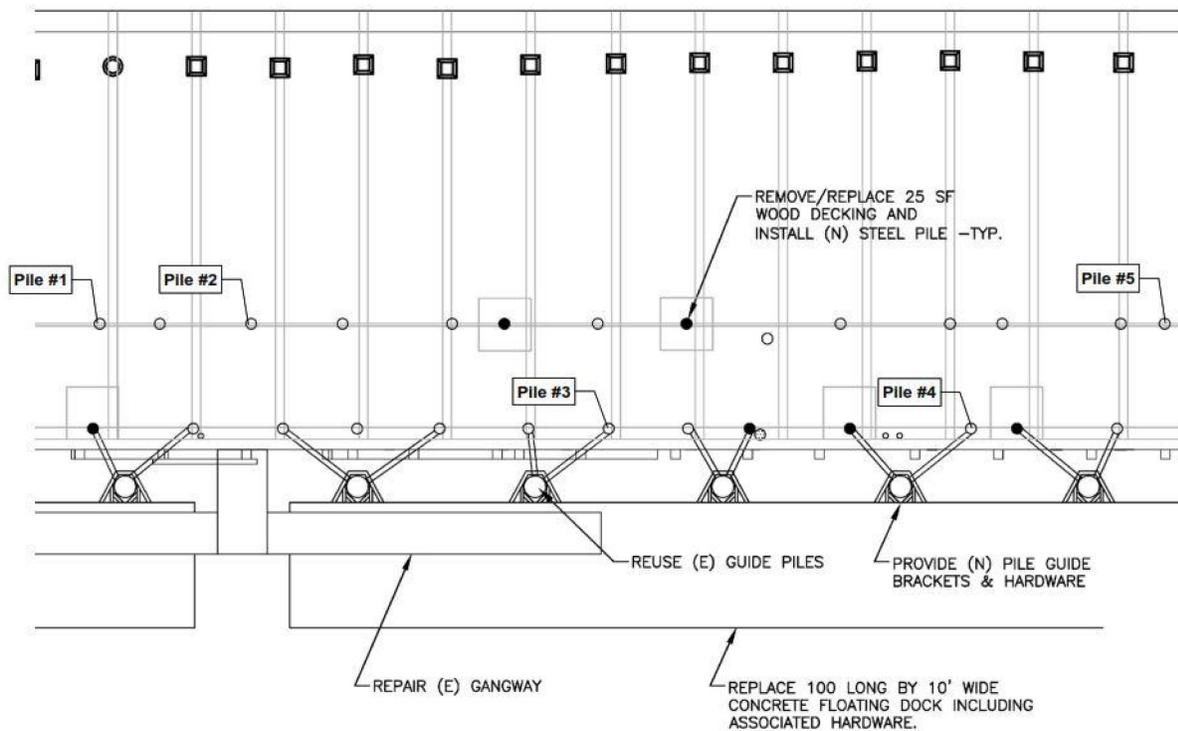
### **Piles Struck with an Impact Hammer**

Piles chosen to be monitored are driven in water depths that are representative of mid-channel or typical water depths at the project location where piles will be driven.

Figure 3 indicates the location of the piles to be monitored; however, the specific piles to be monitoring may be adjusted in the field with the approval of the Project Engineer. Regardless of pile location to be monitored, three hydrophones will be positioned, all with a clear line-of-sight between the pile and the hydrophone, one at each of the following distances:

1. 10 meters
2. Between 20 meters and 50 meters (depending on water depth at the pile; distance from the pile will be approximately three times the water depth)
3. Between 200 meters and 1,000 meters at mid-water column depth measured concurrently with the close-in measurements (i.e. 10-meter, and 20- to 50-meter) to estimate the site-specific transmission loss.

All hydrophones will be placed at least 1 meter (3.3 feet) below the surface.



*Figure 3: Piles to be Monitored*

Airborne measurements will also be collected, at height of 1.5 to 3 meters above the wharf. At 15 meters from the pile, a second microphone may be placed at a location on the haul-out jetty in a fixed position approximately 80-150 meters from the piles.

### **Vibratory Pile Driving for Marine Mammal Consultations**

Currently, hydroacoustic monitoring of vibratory pile installation is not required for fish, marbled murrelet, or marine mammal consultations. Monitoring of vibratory pile installation is voluntary and is designed to evaluate site specific conditions so that the biological monitoring area for marine mammals may be reduced. Because of the short duration of the project and the anticipated need for impact pile driving, we are not proposing to perform hydroacoustic monitoring during pile driving.

## **CONTRACTOR REQUIREMENTS**

The contractor will submit a detailed description of their qualifications, which must include a minimum of a bachelor's degree in a related field<sup>1</sup> and 3 years' experience in noise monitoring and analysis, and monitoring plan based on this template for approval by the USCG. A list of the contractors' proposed sound level monitoring equipment shall be included along with specifications and a description of the purpose. The measurement range in terms of amplitude (in decibels [dB] referenced to one micropascal [re: 1 uPa]), sensitivity and frequency shall be

<sup>1</sup> This can include Institute of Noise Control Engineering of the USA (INCE/USA) certification or related fields such as acoustics, physics, oceanography, geology or other physical sciences that have required coursework in physics.

stated. A minimum frequency range of 7 Hertz (Hz) to 20 kilohertz (kHz) and a minimum sampling rate of 48,000 Hz will be used when monitoring. Sampling rates higher than 48 kHz are preferred. Table 2 describes the minimum requirements of the equipment to be used. In addition to the equipment selection, quality control/quality assurance procedures should be described (e.g., how will system responses be verified and how will data be managed).

**Table 2.**

**Equipment for underwater sound monitoring (hydrophone, signal amplifier, and calibrator). All have current National Institute of Standards and Technology (NIST) traceable calibration. This table is intended as a guideline and exact specifications can be adjusted to meet the needs of the individual project or contractors' equipment.**

Item	Specifications	Minimum Quantity	Usage
Hydrophone	Receiving Sensitivity- -211dB re 1V/ $\mu$ Pa	3	Capture underwater sound pressures near the source and convert to voltages that can be recorded/analyzed by other equipment.
Signal Conditioning Amplifier	Amplifier Gain- 0.1 mV/pC to 10 V/pC Transducer Sensitivity Range- 10-12 to 103 C/MU	3	Adjust signals from hydrophone to levels compatible with recording equipment.
Calibrator (pistonphone-type)	Accuracy- IEC 942 (1988) Class 1	1	Calibration check of hydrophone and microphones in the field.
Digital Signal Analyzer	Sampling Rate- 48kHz or greater	1	Analyzes and transfers digital data to laptop hard drive.
Microphone (free field type)	Range- 30 – 120 dBA Sensitivity- -29 dB $\pm$ 3 dB (0 dB = 1 V/Pa) Wind Screen	2	Monitoring airborne sounds from pile driving activities (if not raining).
Laptop computer or Digital Audio Recorder	Compatible with digital signal analyzer	1	Record digital data on hard drive or digital tape.
Real Time and Post-analysis software	-	1	Monitor real-time signal and post-analysis of sound signals.

The inspector/construction contractor will inform the acoustic specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Sound levels will be continuously monitored during the entire duration of each pile drive. Peak levels of each strike will be monitored in real time.

The Project Engineer will provide the acoustic specialist with a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, initial hammer energy settings and any changes to those settings during the pile driving monitoring,

depth the pile was driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

To facilitate further analysis of data full bandwidth, time-series underwater signal shall be recorded as a text file (.txt) or wave file (.wav) or similar format. Recorded data shall not use data compression algorithms or technologies (e.g., MP3, compressed .wav, etc.).

## **METHODOLOGY**

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As mentioned above, three hydrophones will be positioned with a clear line-of site between the pile and the hydrophone. All hydrophones will be placed at least 1 meter (3.3 feet) below the surface. One will be placed at each of the following distances:

1. 10 meters
2. Between 20 meters and 50 meters (depending on water depth at the pile; distance from the pile will be approximately three times the water depth)
3. Between 200 meters and 1,000 meters at mid-water column depth measured concurrently with the close-in measurements (i.e. 10-meter, and 20- to 50-meter) to estimate the site-specific transmission loss.

A weighted tape measure will be used to determine the depth of the water. The hydrophone(s) will be attached to a nylon cord, a steel chain, or other proven anti-strum features if the current is swift enough to cause strumming of the line. The nylon cord or chain will be attached to an anchor that will keep the line the appropriate distance from each pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface. The distances will be measured by a tape measure, where possible, or a range-finder. The acoustic path (line of sight) between the pile and the hydrophone(s) should be unobstructed in all cases.

When collecting sound data, appropriate measures will be taken, when necessary, to ensure that the flow-induced noise at the hydrophone will not interfere with the recording and analysis of the relevant sounds (NMFS 2012a). As a general rule, current speeds of 1.5 meters/second or greater are expected to generate significant flow-induced noise, which may interfere with the detection and analysis of low-level sounds such as the sounds from a distant pile driver or background sounds.

The hydrophone calibration(s) will be checked at the beginning of each day of monitoring activity. An acoustical piston phone and microphone or hydrophone coupler would be used along with manufacturer calibration certificates. An acoustically certified piston phone and coupler that fits the hydrophone or microphone would directly calibrate the measurement system. The volume correction of the coupler for each hydrophone or microphone would be known so that the piston phone would produce a known signal that would be compared against the measurement system response. The response of the measurement system would then be noted in the field book and applied to all subsequent measurements.

For underwater acoustic readings, the Sound Level Meters (SLMs) are calibrated to the calibration tone prior to use in the field. The tone is then measured by the SLM and is recorded on to the beginning of the digital audio recordings that will be used. The system calibration status would be checked by measuring the calibration tone and recording the tones. The recorded tones are used for subsequent detailed analysis of recorded pile strike sounds. NIST

traceable calibration forms shall be provided for all relevant monitoring equipment. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth as described above.

The onsite inspector/contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each pile being driven with a minimum one-third octave band frequency resolution. The wideband instantaneous absolute peak pressure and Sound Exposure Level (SEL) values of each strike, and daily cumulative SEL should be monitored in real time during construction to ensure that the project does not exceed its authorized take level. Peak and RMS pressures will be reported in dB (re:1  $\mu\text{Pa}$ ). SEL will be reported in dB (re: 1  $\mu\text{Pa}^2\cdot\text{sec}$ ). Wideband time series recording is strongly recommended during all impact pile driving.

Prior to and during pile driving activity, environmental data – such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (e.g., aircraft, boats, etc.) – will be gathered. Start and stop time of each pile driving event and the time at which the bubble curtain or functional equivalent<sup>2</sup> is turned on and off will be logged.

The contractor or agency will provide the following information, in writing, to the contractor conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, pile cap or cushion type, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

### **Sound Attenuation Monitoring**

All monitored piles may be tested with the sound attenuation system on and off (or presence and absence) to test its effectiveness<sup>3</sup>. To account for varying resistance as the pile is driven; the sound attenuation device will be turned off for periods during the beginning, the middle third, and near the end of the drive. After turning off the attenuation system, pile driving should not resume for at least 2 minutes to allow time for air bubbles to completely disperse.

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<sup>2</sup> A functional equivalent must function as well as or better than the attenuation device that was proposed during consultation or required by the ESA consultation or applicable permits. It must achieve the same or better sound level reductions that were used in the calculations during ESA consultation or the permitting process.

<sup>3</sup> Note: There may be circumstances where the USFWS determines that unattenuated pile driving (striking the pile with the bubble curtain turned off) would pose a significant risk of injury to marbled murrelets. In those situations, the Service may request that unattenuated pile driving does not occur and that hydroacoustic monitoring be conducted to determine the extent at which certain thresholds are met instead. This will need to be determined on a case by case basis for projects that may affect marbled murrelets.

## **SIGNAL PROCESSING**

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Post-signal analysis should only be required for impact pile driving. SLMs are anticipated to provide direct measurements of  $L_{\max}$  and  $L_{\text{eq}}$  sound pressure levels for underwater vibratory pile driving and airborne impact and vibratory pile driving. Post-signal analysis of the underwater impact sound level signals will include measurement of the maximum absolute value of the instantaneous pressure within each strike, RMS value for each pile strike, mean and standard deviation of the RMS for all pile strikes of each pile, the SEL per strike, mean and standard deviation of the SEL for all pile strikes of each pile, and the  $SEL_{\text{cumulative}}$  for each pile. A frequency spectrum between 20 and 10,000 Hz for up to eight successive strikes with similar sound levels would be prepared and reported.

## **ANALYSIS**

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### **Impact Pile Driving for Fish and Murrelet Consultations**

Analysis of the data from the San Francisco-Oakland Bay Bridge Pile Installation Demonstration project (PIDP) indicated that 90 percent of the acoustic energy for most pile-driving impulses occurred over a 50 to 100 millisecond period with most of the energy concentrated in the first 30 to 50 milliseconds (Illingworth and Rodkin, 2001). The RMS values computed for this project will be computed over the duration between where 5 percent and 95 percent of the energy of the pulse occurs. The SEL energy plot will assist in interpretation of the single strike waveform. The single strike SEL associated with the highest absolute peak strike along with the total number of strikes per pile and per day will be used to calculate the cumulative SEL for each pile and each 24-hour period.

In addition a waveform analysis of the individual absolute peak pile strikes will be performed to determine any changes to the waveform with the use of bubble curtains. A comparison of the frequency content with and without noise attenuation will be conducted. Units of underwater sound pressure levels will be dB (re:1  $\mu\text{Pa}$ ) and units of SEL will be re:1  $\mu\text{Pa}^2 \cdot \text{sec}$ .

## **REPORTING**

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An analysis of the change in the waveform and sound levels with and without the use of a bubble curtain for impact driving operations will be conducted.

Preliminary results for daily monitoring activities, if required, will be submitted/reported to the primary point of contact<sup>4</sup> at each of the Services within 60 days after monitoring concludes. In addition a final draft report including data collected and summarized from all monitoring locations will be submitted to the Services within 90 days of the completion of hydroacoustic monitoring. The results will be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted

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<sup>4</sup> The primary point of contact is the biologist that conducted the Section 7 consultation for the Service(s). In the event that the consulting biologist is not available, communication regarding monitoring results and reports should be addressed to the manager of the consultation branch or division with a reference to the consultation title.

to the Services within 30 days following receipt of comments on the draft report from the Services. The report shall include:

- Size and type of piles.
- A detailed description of the type(s) of noise attenuation device(s), including design specifications.
- The make, model and energy rating of the impact hammer used to drive the piles.
- A description of the sound monitoring equipment.
- The distance between hydrophone(s), microphone(s) and pile.
- Hydrophone(s) depth(s) and water depth at hydrophone locations.
- The distance from the pile to the water's edge.
- The depth of water in which the pile was driven.
- The depth into the substrate that the pile was driven.
- The physical characteristics of the bottom substrate into which the piles were driven.
- The total number of strikes to drive each pile and for all piles driven during a 24-hour period.
- The underwater wideband background sound pressure level reported as the 50 percent Cumulative Distribution Function (CDF) (already reported and measured).
- The results of the hydroacoustic monitoring, as described under Signal Processing.
- The distance at which peak, SEL, and RMS values exceed the respective threshold values.
- A description of any observable fish, marine mammal, or bird behavior in the immediate area and, if possible, correlation to underwater sound levels occurring at that time.

For airborne noise monitoring: broadband A-weighted and unweighted maximum, minimum, and average  $L_{\max}$  and  $L_{\text{eq}}$  levels shall be tabulated for every pile. For each pile size and substrate type frequency spectra (one-third octave minimum frequency resolution) charts will be included to show the frequency content of  $L_{\max}$  and  $L_{\text{eq}}$  signatures. The frequency content of airborne noise background levels shall also be shown. Background sound levels or  $L_{95}$  surrogate for background sound shall be reported.

## REFERENCES

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- Illingworth and Rodkin, Inc. 2001. Noise and Vibration Measurements Associated with the Pile Installation Demonstration Project for the San Francisco-Oakland Bay Bridge East Span, Final Data Report, Task Order 2, Contract No. 43A0063.
- NMFS. 2012a. Guidance Document: Data Collection Methods to Characterize Underwater Background Sound Relevant to Marine Mammals in Coastal Nearshore Waters and Rivers of Washington and Oregon. Memorandum: NMFS Northwest Fisheries Science Center – Conservation Biology Division and Northwest Regional Office – Protected Resources Division, January 31, 2012.
- NMFS. 2012b. Guidance Document: Data Collection Methods to Characterize Impact and Vibratory Pile Driving Source Levels Relevant to Marine Mammals. Memorandum: NMFS Northwest Fisheries Science Center – Conservation Biology Division and Northwest Regional Office – Protected Resources Division, January 31, 2012.
- NMFS. 2012c. Guidance Document: Sound Propagation Modeling to Characterize Pile Driving Sounds Relevant to Marine Mammals. Memorandum: NMFS Northwest Fisheries Science Center – Conservation Biology Division and Northwest Regional Office – Protected Resources Division, January 31, 2012.
- Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521.

## APPENDIX A

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### Calculation of Cumulative SEL

An estimation of individual SEL values can be calculated for each pile strike by calculating the following integral, where T is T<sub>90</sub>, the period containing 90 percent of the cumulative energy of the pulse (eq. 1).

$$SEL = 10 \log \left( \int_0^T \frac{p^2(t)}{p_0^2} dt \right) \text{ dB} \quad (\text{eq. 1})$$

Calculating a cumulative SEL from individual SEL values cannot be accomplished simply by adding each SEL decibel level arithmetically. Because these values are logarithms they must first be converted to antilogs and then accumulated. Note, first, that if the single strike SEL is very close to a constant value (within 1 dB), then cumulative SEL = single strike SEL + 10 times log base 10 of the number of strikes N, i.e., 10Log<sub>10</sub>(N). However if the single strike SEL varies over the sequence of strikes, then a linear sum of the energies for all the different strikes needs to be computed. This is done as follows: divide each SEL decibel level by 10 and then take the antilog. This will convert the decibels to linear units (or uPa<sup>2</sup>•s). Next compute the sum of the linear units and convert this sum back into dB by taking 10Log<sub>10</sub> of the value. This will be the cumulative SEL for all of the pile strikes.

## APPENDIX B

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### Calculation of a Cumulative Distribution Function and Plot for Background Sound Level Analysis

Data from three full 24-hour underwater measurement cycles (minimum) are used to calculate a 30-second Root Mean Square (RMS) value for each 30-second period for the entire dataset. The RMS should be calculated for both the full frequency range recorded as well as a separate dataset which has been passed through a high pass filter thus eliminating those frequencies below 1000 Hz. These datasets are then grouped into 24-hour periods. To determine if the data is approximately log-normal in distribution, each 24-hour period is plotted as a Probability Density Function (PDF). Each 24-hour period can be plotted on the same PDF plot. The plots should be approximately log normal in distribution and thus can be used in the further analysis. Each day of data should have an approximately Gaussian sigmoid shape, the differences between them and the ideal might be hard to spot, but the sigmoid from day to day will show noticeable variation. Data which does not approximate a log normal distribution should be excluded from further analysis.

The Cumulative Distribution Function (CDF) plot is obtained by plotting the normalized cumulative sum vs. the bin location. You can also get the PDF from plotting the normalized bin count vs. the bin location. The normalized bin count is obtained by dividing the count column by (number of data points multiplied by the space between 2 consecutive bins). This provides the integral of the PDF equal to 1. For instructions on creating a histogram in Microsoft Excel, see: <http://www.vertex42.com/ExcelArticles/mc/Histogram.html>

