FINAL

Incidental Harassment Authorization Application

Alameda Main Street Ferry Terminal Refurbishment Project Alameda County, California

JUNE 2023

Prepared for:

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AMS	Alameda Main Street
NMFS	National Marine Fisheries Service
project	AMS Ferry Terminal Refurbishment Project
WETA	San Francisco Bay Area Water Emergency Transportation Authority

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1 Description of the Activity

1.1 Location and Setting

The Alameda Main Street (AMS) Ferry Terminal Refurbishment Project (project) is in the City of Alameda in Alameda County, California. Alameda occupies approximately 10.6 square miles of land area immediately south of the City of Oakland and the Oakland–Alameda Estuary, east of San Francisco, and north and east of the San Francisco Bay. Alameda Island makes up approximately 80% of the Alameda's land area, with the remainder on Bay Farm Island across the San Leandro Channel (see Figure 1, Project Location). The project site is located at 2990 Main Street (Assessor's Parcel Numbers 74-890-1-17, 74-1368-13-1, 74-1368 1, and 999-9999-999).

Two species protected by the Marine Mammal Protection Act could occur within the project area, harbor seal (*Phoca vitulina richardii*) and California sea lion (*Zalophus californianus*). Both species are residents of the San Francisco Bay Estuary and are known to occur within the Oakland Inner Harbor. The closest known haul-out for either species is a harbor seal haul-out at the breakwater island at Alameda Point (approximately 5 miles from the project area, 37.770127, -120.296819). Both harbor seals and California sea lions may occasionally forage in the Oakland Inner Harbor.

1.2 Project Overview and Purpose

The San Francisco Bay Area Water Emergency Transportation Authority (WETA) is proposing the project to support WETA ferry operations within the Oakland Inner Harbor. The project purpose is to address structure aging, deterioration, and stabilization issues (i.e., compliance with current seismic safety requirements) associated with existing AMS Ferry Terminal components.

1.3 Project Description

The proposed action would update and replace aging ferry terminal components and structural support. The project is composed of the following primary components:

Terminal Bridge and Foundation Replacement. Project activities would involve demolishment of existing bridge/walkway and bridge foundation and replacement with a new aluminum truss bridge. Nearshore and landside support would be installed and would consist of a 48-inch monopile (located in-water) and two 24-inch pipe piles with cap beams, respectively.

Gangway Replacement. The project would include removal of the existing 60-foot gangway and replacement with an 80-foot covered aluminum gangway.

Float Demolition/Replacement. The existing terminal float would be removed and replaced-in-kind with a new steel float. Ramps that had been previously installed on the float would be removed, protected in place, and reused once the new float is installed. Float ramps would be shifted to the west to provide additional room for a longer gangway. The four existing 30-inch guide piles would be removed and replaced with four new 36-inch guide piles. To achieve a safer, more efficient berthing capacity and enable ingress and egress in a timely manner, float demolition/ replacement activities would also involve installation of two new 36-inch donut fender piles.

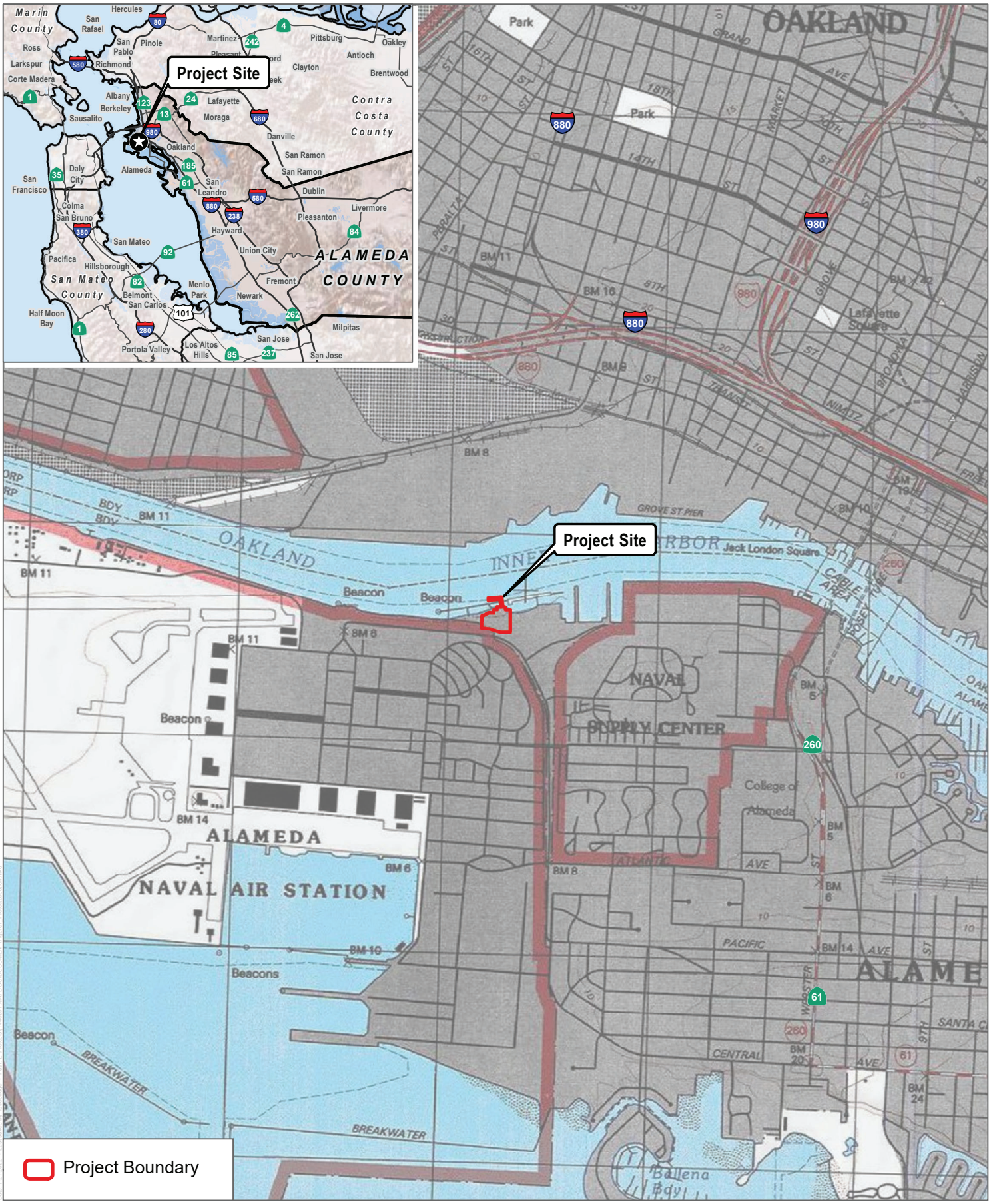
Utility Upgrades. Utility upgrades associated with the project would involve replacement of existing razor equipment and installation of electrical service for new lighting, ramp controls, outlets, a new potable water line, and conduit for future upgrades on bridge, gangway, and float structures. The new potable water line will connect to an existing line at the ferry terminal restroom facility. The new line will be used for intermittent terminal cleaning activities, as needed. No other utility improvements are planned.

Overall, the footprint of the project site is expected to increase the AMS Ferry Terminal shade area by approximately 830 square feet. No changes in operational demand (i.e., an increase in ferry users) are anticipated, and no physical impacts beyond the project boundaries (see Figure 2, Project Site) are anticipated as part of the project. Vehicular and pedestrian access to the AMS Ferry Terminal is not anticipated to change. A summary of the bridge pile types and numbers to be installed is provided in Table 1.

The water depth at the project site varies between 14 feet to 28 feet mean lower low water. Most construction activities will occur above or at the waterline. The only elements that will extend below the mudline are the new piles that will have a maximum tip elevation of approximately 110 inches mean lower low water.

Table 1. Summary of Bridge Pile Types and Numbers

	Location	Number	Pile Type
In Water			
Float Replacement (guide piles and donut fender piles)	Terminal Float	6	36-inch steel pipe
Terminal Bridge and Foundation Replacement	Truss Bridge	1	48-inch steel pipe
Total In-Water Bridge Pile Installations		**7**	
On Land			
Terminal Bridge and Foundation Replacement	Truss Bridge	2	24-inch pipe pile w/cap beams
Total On-Land Bridge Pile Installations		**2**	



SOURCE: USGS 7.5-minute Series Oakland West Quadrangle

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0 1,000 2,000 Feet

FIGURE 1

Project Location

Alameda Main Street Terminal Refurbishment Project

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SOURCE: Bing Maps 2021

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0 75 150 Feet

FIGURE 2

Project Site

Alameda Main Street Terminal Refurbishment Project

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1.4 Description of Construction Activity

In-water and on-land construction activities that result in noise and vibration may result in incidental take (harassment) of marine mammals present in the area at the time of construction. Construction will occur within the Oakland Inner Harbor and on lands adjacent to the harbor.

The following construction equipment is anticipated to be used during construction of the project:

- One derrick crane barge
- One skiff
- One support tug
- One support barge
- One vibratory hammer
- One impact hammer
- One delivery truck
- One concrete truck
- One pump truck
- Construction personnel trucks (approximately 3–6)
- Generator/compressors (one generator/one compressor at any given time). Where feasible and available, diesel construction equipment would be powered by Tier 3 or Tier 4 engines as designated by the California Air Resources Board and U.S. Environmental Protection Agency. In addition, if available for on-site delivery, diesel construction equipment would be powered with renewable diesel fuel that is compliant with California's Low Carbon Fuel Standards and certified as renewable by the California Air Resources Board executive officer.

The project would require removal of existing piles and material placement for installation of steel pipe piles for the new float, donut fenders, and bridge support. It is estimated the approximate 162 square feet of existing piles would be removed, and approximately 240 square feet of steel pipe piles, fender piles, and bridge support piles would be installed. A net total of 78 square feet of pilings (total piling installed minus pilings removed) would be installed.

Most project components would be fabricated off site and transferred to the project site via barge. Debris generated during construction and site clearing activities would consist of the existing steel float, steel guide piles, gangway, bridge structure, bridge structure steel support system (H-Pile and steel beams), concrete approach slab, and miscellaneous electrical/mechanical conduit attached to the existing elements to be removed. In accordance with Section 5.408 of the California Green Building Standards Code, the project would implement a construction waste management plan for recycling and/or salvaging for reuse of a minimum of 65% of nonhazardous construction/ demolition debris. Solid waste collected throughout the Alameda is hauled to the Davis Street Transfer Station in the City of San Leandro, where it is loaded into higher-capacity trailer trucks and hauled to Altamont Landfill in eastern Alameda County. Recyclable materials, which are collected from residential and commercial customers in separate bins, are hauled to ACI's Aladdin Materials Recovery Facility and Transfer Facility in the City of San Leandro, which sorts, separates, and bundles the recyclables for sale to secondary markets. Materials removed from the project site would be removed via a support barge in the Oakland Inner Harbor.

Project construction staging would occur within the AMS Ferry Terminal parking lot. Before construction activities begin on any project component, signage would be posted surrounding the project site notifying the public of temporary parking lot closure. No street closures are anticipated. Because the project would be limited to the project site and construction/staging activities would not impede into the local roadways, a traffic control plan would not be implemented. The San Francisco Bay Trail, which traverses east–west through the AMS Ferry Terminal and project site, would remain open for pedestrian access with the potential for brief interruptions with minor rerouting during certain construction activities, such as concrete installation for the new bridge structure landside cap beam. Access and use of the San Francisco Bay Trail would return to its original condition upon project completion.

Project construction activities would include importing materials (i.e., concrete, steel reinforcement, steel pipe, valves, and asphalt), grading to develop the "construction platform" at the toe of the dam, improving dam access routes, dredging to rock and drilling from a barge, in-water work, tunneling with mechanical excavators, hauling spoils from the site, fabricating and assembling infrastructure, and decommissioning existing infrastructure.

2 Dates, Duration, and Geographic Region

Construction of the project is expected to occur over a period of approximately 4–6 weeks, beginning in summer 2023 with an anticipated completion date of late summer 2023. It is estimated that project construction would require 4–8 daily construction crew members, with the possibility for up to 15 on-site construction workers during major operations (e.g., concrete pours). Consistent with Section 4-10.7 of the Alameda Municipal Code, noise-generating construction activities would be limited to occur between 7:00 a.m. and 7:00 p.m. Monday through Friday and 8:00 a.m. and 5:00 p.m. on Saturdays. It is anticipated that project construction would occur Monday through Friday, 7:00 a.m. to 3:30 p.m., with the potential for Saturday work.

The project area is in the Oakland Inner Harbor, in a developed portion of Alameda Island. Residential neighborhoods are to the south of the project area, and developed industrial sites are situated to the east. The Oakland Inner Harbor shipping channel and terminal are located north of the project area, and a dog park and some undeveloped (but highly disturbed) shoreline occur west of the project area, running out to the former Alameda naval air station, now known as Alameda Point.

The project area is located within the North Alameda watershed, which composes the majority of Alameda Island. Because the topography of Alameda Island is flat and has a lot of filled baylands, no creeks or streams occur, but surface water is transported to the San Francisco Bay through a series of storm drains.

Due to in-water work timing restrictions to protect federally listed fish species, all in-water construction activities including pile removal/installation would occur during the period from June 1 to November 30 unless otherwise permitted by the National Marine Fisheries Service. Pile removal is anticipated to take between 1-3 days, pile installation is scheduled for 3 days with 2 days of in-water pile installation. Pile removal and installation are planned for consecutive days.

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3 Species and Numbers of Marine Mammals

Two marine mammals, Harbor Seal and California Sea Lion, known to frequent the San Francisco Bay and that have been observed in the Oakland Inner Harbor are the species most likely to occur near the project area. Table 2 summarizes the status of these marine mammal stocks present in San Francisco Bay, and additional details on these species is provided below. Other marine mammal species are that are observed within the San Francisco Bay but are not expected to occur within the Oakland Inner Harbor include: the gray whale (*Eschrichtius robustus*), individual humpback whales (*Megaptera novaeangliae*), harbor porpoises (*Phocoena phocoena*), the bottlenose dolphin (*Tursiops truncates*), the northern elephant seal (*Mirounga angustirostris*), the Guadalupe fur seal *(Arctocephalus townsendi*), and the northern fur seal (*Callorhinus ursinus*). These species tend to occur in the Central Bay; this includes the area bound by the Golden Gate Bridge, the San Francisco – Oakland Bay Bridge (SFOBB), and Richmond Bridge.

3.1 Pacific Harbor Seal

The Pacific harbor seal is a subspecies of the common harbor seal *Phoca vitulina* and belongs to the family Phocidae. Harbor seals area a true seal, distinct from the eared seals such as California sea lion, and have a rounded head and visible ear canal. Males and females are similar in size and can exceed 6 feet and 300 pounds. Harbor seals. They display year-round site fidelity and generally do not make annual migrations although they have been known to swim several hundred miles to find food or suitable breeding habitat. In the San Francisco Bay, Harbor seals forage in shallow water on a variety of fish and crustaceans and could occasionally be found foraging in the Oakland Inner Harbor. They are opportunistic, generalist foragers (Gibble, 2011) and are expected to forage in shallow, intertidal waters on a variety of fish, crustaceans, and other species like octopus in the San Francisco Bay. The most numerous prey items identified in harbor seal fecal samples from haul-out sites in San Francisco Bay include yellowfin goby (*Acanthogobius flavimanus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea harengus pallasi*), staghorn sculpin (*Leptocottus armatus*), plainfin midshipman (*Porichthys notatus*), and white croaker (*Genyonemus lineatas*) (Harvey and Torok, 1994).

Harbor seals are generally solitary; however, they group up at out of the water at haul-outs. These shoreline areas are locations such as tidal rocks, bayflats, sandbars, and sandy beaches (Zeiner et al., 1990) where harbor seals or other pinnipeds congregate to rest, socialize, breed, and molt. Haul-outs are also used for thermoregulation, birthing, and nursing pups. Haul-out locations are relatively consistent from year-to-year (Kopec and Harvey, 1995), and females have been recorded returning to their own natal haul-out when breeding (Cunningham et al., 2009). Harbor seals haul-out at approximately 20 locations in San Francisco Bay with three main locations: Mowry Slough in the south Bay, Corte Madera Marsh and Castro Rocks in the north Bay, and Yerba Buena Island in the central Bay (Grigg, 2008; Gibble, 2011).

The California Department of Transportation (Caltrans) conducted marine mammal monitoring at multiple locations inside San Francisco Bay from May 1998 to February 2002 and determined that at least 500 harbor seals populate San Francisco Bay (Green et al., 2002). This estimate is similar to previous seal counts in San Francisco Bay, which ranged from 524 to 641 seals from 1987 to 1999 (Goals Project, 2000). The main pupping areas in San Francisco Bay are at Mowry Slough and Castro Rocks (Caltrans, 2012). Pupping season for harbor seals in San Francisco Bay spans from approximately March 15 through May 31, with pup numbers generally peaking in late April or May (NMFS, 2015a).

3.2 California Sea Lion

The California sea lion is a member of the Otariidae or "eared seals" family and has external ear flaps not shared by other pinniped families. California sea lions are sexually dimorphic: males can reach up to 8 feet long and weigh 700 pounds; whereas females are smaller, at approximately 6 feet long and 200 pounds. Sexual maturity occurs within 4 to 5 years. Like harbor seals described above, California sea lions forage and conduct most of their activities in the water, as well as using haul-outs for portions of their life history. During spring months California sea lions breed in Southern California and along the Channel Islands. Although most females remain in southern California waters year-round, males and some subadult females range widely and can occupy larger inland waters and estuaries like the San Francisco Bay throughout the year (Caltrans, 2012). No pupping has been recorded in the San Francisco Bay. California sea lion are extremely intelligent and social and can spend much of their time aggregated at communal haul-outs. Group hunting is common, and they may cooperate with other species, such as dolphins, when hunting large schools of fish. The California sea lion feeds on a mixture of fish species and squid (NMFS, 2015b).

In the San Francisco Bay, the primary California sea lion haul out is located at Pier 39 in the Fisherman's Wharf area of the San Francisco Marina. The Marine Mammal Center (TMMC) in Sausalito, California has performed monitoring surveys at this location since 1991. A maximum of 1,706 sea lions was seen hauled out during one survey effort in 2009 (TMMC, 2015). Winter numbers are generally more than 500 animals (Goals Project, 2000). In August to September, counts average from 350 to 850 (NMFS, 2004). Of the California sea lions observed, approximately 85 percent were male. No pupping activity has been observed at this site or at other locations in San Francisco Bay (Caltrans, 2012). The California sea lions usually frequent Pier 39 in August after returning from the Channel Islands (Caltrans, 2013). In addition to the Pier 39 haul-out, California sea lions haul out on buoys and similar structures throughout San Francisco Bay. They mainly are seen swimming off the San Francisco and Marin shorelines within San Francisco Bay but may occasionally enter the project area to forage.

WETA ferry boat captains have reported frequently seeing both harbor seals and California sea lions in the estuary channel and near Bay Ship and Yacht within the inner harbor (in-water sightings, not hauled-out) but did not report seeing either species or other marine mammals near the ferry dock/platform. Whales (no species reported but likely gray whales, *Eschrichtius robustus*) were reported to have been seen occasionally in the San Francisco Bay (outside of the Oakland Inner Harbor) during winter and spring (WETA, pers. comm. 2022). Due to regular and frequent ferry service and associated human activities on the AMS ferry terminal, marine mammals have not been observed using the ferry dock/platform and are not expected to haul out on the ferry dock/platform.

Table 2. Marine Mammal Populations

Common Name	Scientific Name	Federal Status	Occurrence in Oakland Inner Harbor		Total Range and Population	
			Numbers	Seasonality	Range	Abundance
California Sea Lion	*Zalophus californianus*	Not Listed[1]	Unknown	Incidental Visitor	California to Canada	257,606
Harbor Seal (eastern Pacific subspecies)	*Phoca vitulina richardii*	Not Listed[1]	Unknown	Incidental Visitor	Mexico to Alaska	30,968 in California

Source: NMFS 2015, 2021.
Note: Not listed as "endangered" or "threatened" under the Endangered Species Act nor as "depleted" under the Marine Mammal Protection Act.

4 Affected Species and Distribution

Both California sea lion and harbor seal are only expected to be incidental visitors in the Oakland Inner Harbor, and there are no known haul-out locations for either species in the Oakland Inner Harbor. One reconnaissance-level marine mammal survey was conducted on September 20, 2022. During the survey, biologists used a boat to survey the Oakland Inner Harbor from Grand Street into the San Francisco Bay and south to the known seal haul-out at Alameda Point. Binoculars were used to scan the open water, docks, and other potential haul-out locations within the San Francisco Bay and the Oakland Inner Harbor. The survey was conducted during the construction window, and the goal of the survey was to observe any marine mammals within the Oakland Inner Harbor and record the distance from the project and Oakland Inner Harbor to areas used more frequently by California sea lions or harbor seals in the San Francisco Bay. No California sea lions or harbor seals were observed within the Oakland Inner Harbor during the survey; both species were observed in the San Francisco Bay outside of the Oakland Inner Harbor. One California sea lion was observed hauled out on a buoy near the Bay Bridge, two harbor seals were observed in open water between the Bay Bridge and Alameda Point, and two harbor seals were observed on the artificial haul-out at Alameda point.

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5 Type of Incidental Take Authorization Requested

The incidental harassment authorization request is for Level A and Level B harassment of the marine mammals (California sea lions, harbor seals) that might enter the Level A or B Zone of Influence during active pile driving activity (see Appendix A, AMS Ferry Terminal Hydroacoustic Assessment). Noise, vibrations, and other physical disturbances can harass marine mammals. The range of effects potentially includes behavioral changes, physiological stress, physical injury (including hearing loss), and mortality.

The method of take is incidental harassment from disturbance associated with construction activities, personnel and equipment, and noise, possibly deterring foraging behavior in the Oakland Inner Harbor. Construction activities that may impact marine mammals primarily include pile removal and installation. The construction activities will be limited to the area around the existing ferry terminal. Both in-water and in-air noise is expected during the course of construction, and potential impacts are discussed below in Section 7. Take estimates provided are attributed to in-water noise; in-water activities principally consist of pile driving. No haul-outs are present in the Oakland Inner Channel thus no Level A or B Harassment of hauled-out pinnipeds would occur from in-air noise. No additional project activities are anticipated to result in take of marine mammals, and the serious injury or mortality of marine mammals is not anticipated to occur.

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6 Take Estimates of Marine Mammals

Incidental harassment of marine mammals during the project may occur to two marine mammal species (California sea lion and harbor seal) that could be present in the Oakland Inner Harbor during proposed pile-driving activities. Avoidance and minimization measures will be implemented to reduce the potential for harassment to the maximum extent possible, as detailed in the Section 11 below. No pile driving activities will occur if marine mammals are observed within the Level A harassment zone, however, because is possible that a marine mammal could entire or surface in the Level A harassment zone, some Level A take is requested. In addition, because pile driving and removal could take between 4-6 days with a maximum of 5 days of in-water pile driving and removal, and be accomplished with a variety of methods (impact vs vibratory), minimum and maximum takes estimates are provided.

Incidental take is estimated for each species by estimating the maximum number of marine mammals potentially present within a harassment zone during active pile driving based on density estimates, numbers of animals typically observed within the Oakland Inner Harbor and identified during the marine mammal survey. No resident harbor seals occur within the Oakland Inner Harbor. Densities for harbor seal of 3.957 animal per square kilometer and for California sea lion of 0.161 were used to calculate potential take. These densities are based on the Caltrans 2016 as-sea values (81 FR 67313). Daily take was increased by a factor of 10 for California Sea Lion to account for potential El Nino Conditions (82 FR 29521, 82 FR 41215). Using these density estimates and the Level A and B harassment areas, the take estimates were calculated for a range of construction options. Activities and potential animal exposure to Level A harassment levels are presented in Table 3 for phocid species (harbor seal), and Table 4, for otariid species (California sea lion). Take estimates based on exposure and activity duration are provided in Table 5, for Level A harassment and Table 6 for Level B harassment.

Table 3. Construction Activities and Potential Exposure for Phocid Species (harbor seal)

Construction Activity	Density Estimate (animals/KM2)	Level A Harassment Area (KM2)	Level B Harassment Area (KM2)	# animals exposed per day
Impact driving 36” steel pile in water (attenuated)	3.957	0.65	0.59	Level A: 2.57
				Level B: 2.33
Impact driving 48” monopile in water (attenuated)	3.957	0.04	0.49	Level A: 0.15
				Level B: 1.94
Vibratory driving 36”-steel pile in water (unattenuated)	3.957	0.01	1.93	Level A: 0.04
				Level B: 7.64
Vibratory driving 48” monopile in water (unattenuated)	3.957	0.0003	1.93	Level A: 0.001
				Level B: 7.64

Table 4. Construction Activities and Potential Exposure for Otariid Species (California sea lion)

Construction Activity	Density Estimate (animals/KM2)	Level A Harassment Area (KM2)	Level B Harassment Area (KM2)	# animals exposed per day
Impact driving 36" steel pile in water (attenuated)	0.161	0.01	0.59	Level A: 0.00161
				Level B: 0.09
Impact driving 48" monopile in water (attenuated)	0.161	0.0003	0.49	Level A: 0.0000483
				Level B: 0.08
Vibratory driving 36"-steel pile in water (unattenuated)	0.161	n/a	1.93	Level A: n/a
				Level B: 0.31
Vibratory driving 48" monopile in water (unattenuated)	0.161	n/a	1.93	Level A: n/a
				Level B: 0.31

Pile-driving (in-water) estimates are based on the number of days that pile driving could potentially occur for the project described in Section 2.

In total, approximately 4-6 consecutive days of pile driving and extraction are anticipated for the terminal bridge and foundation replacement and for the float replacement. This includes 1 day for the 48-inch steel pipe, 1 day for the 24-inch on-land pipes for the terminal bridge and foundation replacement, 1 day for the six 36-inch pipe piles for the float replacement, and 1-3 days for existing pile removal using vibratory methods. The Level B Harassment area for installation of the 36" piles was used as a proxy to estimate take for the vibratory removal of the 30" piles (this provides a conservative estimate, the installation of the 36" pile will produce a greater sound impact than the vibratory removal of the 30" piles).

Because extensive surveys were not completed, but small numbers of both sea lions and harbor seals are known to incidentally use the Oakland Inner Harbor, a conservative estimate of how many marine mammals might be present was used. Because the density estimates don't account for the potential occurrence of additional animals or a small group of animals entering the Oakland Inner Harbor, additional take is being requested to ensure that take estimates will not be exceeded (see Tables 5-6).

Table 5. Level A Incidental Take Estimates

Construction Activity	Species	Potential Take/Day	Duration of Activities	Estimated Incidental Take	Additional Level A Take Requested (# animals/ day)	Total Level A Incidental Take during Construction per activity
Impact driving 36" steel pile in water (attenuated)	Harbor Seal	2.57	1 day	3	1	4
	CA Sea Lion	0.0161*		<1	1	1
	Harbor Seal	0.15	1 day	<1	1	1

Table 5. Level A Incidental Take Estimates

Construction Activity	Species	Potential Take/Day	Duration of Activities	Estimated Incidental Take	Additional Level A Take Requested (# animals/ day)	Total Level A Incidental Take during Construction per activity
Impact driving 48" monopile in water (attenuated)	CA Sea Lion	0.000483*		<1	1	1
Vibratory driving 36"-steel pile in water (unattenuated)	Harbor Seal	0.04	1 day	<1	1	1
	CA Sea Lion	n/a		n/a	n/a	n/a
Vibratory driving 48" monopile in water (unattenuated)	Harbor Seal	0.001	1 day	<1	1	1
	CA Sea Lion	n/a		n/a	n/a	n/a
Vibratory removal of existing 30" piles (using 36" install as proxy)	Harbor Seal	0.04	1-3 days	<1	1	1-3
	CA Sea Lion	n/a		n/a	n/a	n/a

* Potential take/day for CA Sea Lion multiplied by factor of 10 to account for potential El Nino Conditions (82 FR 29521, 82 FR 41215).

For harbor seal, based on the Level A take estimates shown in Table 5 above, the range of requested Level A take would be between 3-8 harbor seals; minimum take would include 1 during 30" pile removal, 1 during 36" pile installation and 1 during 48" pile installation, maximum take would include 3 during 30" pile removal, 4 during 36" pile installation, and 1 during 48" pile installation.

For California sea lion, based on the Level A take estimates shown in Table 5 above, the requested Level A take would be 2 California sea lions including 1 during 36" pile installation and 1 during 48" pile installation.

Table 6. Level B Incidental Take Estimates

Construction Activity	Species	Potential Take/Day	Duration of Activities	Estimated Incidental Take	Additional Level B Take Requested (# animals/ day)	Total Level B Incidental Take during Construction per activity
Impact driving 36" steel pile in water (attenuated)	Harbor Seal	2.33	1 day	3	2	5
	CA Sea Lion	0.9*		1	2	3
Impact driving 48" monopile in water (attenuated)	Harbor Seal	1.94	1 day	2	2	4
	CA Sea Lion	0.8*		1	2	3

Table 6. Level B Incidental Take Estimates

Construction Activity	Species	Potential Take/Day	Duration of Activities	Estimated Incidental Take	Additional Level B Take Requested (# animals/ day)	Total Level B Incidental Take during Construction per activity
Vibratory driving 36"-steel pile in water (unattenuated)	Harbor Seal	7.64	1 day	8	2	10
	CA Sea Lion	3.1*		3	2	5
Vibratory driving 48" monopile in water (unattenuated)	Harbor Seal	7.64	1 day	8	2	10
	CA Sea Lion	3.1*		3	2	5
Vibratory removal of existing 30" piles (using 36" install as proxy)	Harbor Seal	7.64	1-3 days	8-24	2	10-30
	CA Sea Lion	3.1*		3-9	2	5-15

* Potential take/day for CA Sea Lion multiplied by factor of 10 to account for potential El Nino Conditions (82 FR 29521, 82 FR 41215).

For harbor seal, based on the Level B take estimates shown in Table 6 above, the range of requested Level B take would be between 19-50 harbor seals; minimum take would include 10 during 30" pile removal, 5 during 36" pile installation and 4 during 48" pile installation, maximum take would include 30 during 30" pile removal, 10 during 36" pile installation, and 10 during 48" pile installation.

For California sea lion, based on the Level B take estimates shown in Table 6 above, the range of requested Level B take would be between 11-25 California sea lion; minimum take would include 5 during 30" pile removal, 3 during 36" pile installation and 3 during 48" pile installation, maximum take would include 15 during 30" pile removal, 5 during 36" pile installation, and 5 during 48" pile installation.

In summary, WETA is requesting authorization for Level A acoustical harassment of up to 2 California sea lions and 8 harbor seals and Level B acoustical harassment of up to 25 California sea lions and 50 harbor seals due to pile driving and extraction. These requested take numbers represent the maximum potential take based on the calculated estimates, including additional take requested due to uncertainty; all other potential scenarios would result in less take.

7 Anticipated Impact of the Activity

The waters within the Oakland Inner Harbor do not provide haul-out, rookery, mating, breeding, molting, or other habitat of a similar ecological significance for California sea lions or harbor seals. However, construction activities may impact marine mammals using the Oakland Inner Harbor for foraging activities. Construction activities that may impact marine mammals include pile removal and installation. These activities will be limited to the area around the existing ferry terminal. Both in-water and in-air noise is expected throughout the duration of construction, with the most noise generated during pile installation operations, as pile removal and installation radiates sound into the water, the substrate, and the air. Other noise events would include trucks delivering materials, ferry terminal removal equipment, concrete pumps, etc., none of which should generate as much noise as pile installation.

7.1 Construction Impacts

7.1.1 Pile-Driving Construction Impacts

The results of the hydroacoustic analysis are presented in Appendix A. The distance to the adopted marine mammal thresholds varies depending on the type of pile being driven (the 48-inch pile has the greatest potential for underwater noise impacts), the method of pile driving (vibratory or impact), and if the pile-driving activity is attenuated or not. As described in Section 11, Mitigation Measures, various precautionary measures will be taken depending on the conditions found by the construction contractor and the required method for pile installation. If possible, all piles will be installed using a vibratory hammer, but there is a possibility that the vibratory hammer will not suffice, and an impact hammer will need to be used and could be attenuated with a bubble curtain. The various scenarios are analyzed in detail in the hydroacoustic assessment, and maps showing the extent of the Level A and B Harassment Zones are provided (Appendix A).

Pile-driving activities within the Oakland Inner Harbor may deter sea lions or harbor seals from foraging in the project area. No alterations to sea lion or harbor seal habitat are anticipated as a result of the project. No other direct or indirect impacts are anticipated.

7.1.2 Other On-Land Construction Activities

In-air noise will be generated primarily during pile installation operations; other noise sources include trucks delivering materials, concrete pumps, and other typical construction equipment, none of which should generate as much noise as the pile installation. Construction-related noise levels would vary throughout the day, depending on the type of equipment in use at any one time and the distance to the receptors. Anticipated equipment is described in Section 1.4.

Because marine mammals are inquisitive by nature, they may approach the work area and become subject to airborne or underwater noise levels that may cause harassment or injury.

7.2 Species Impacts

The harbor seal population in California is approximately 30,968 individuals (Table 2). This application requests incidental taking by Level A acoustical harassment of up to 8 harbor seals and Level B acoustical harassment of up to 50 harbor seals, combined approximately 0.187% of the California stock.

The Pacific stock of California sea lion population is approximately 257,606 individuals (Table 2). This application requests incidental taking by Level A acoustical harassment of up to 2 California sea lion, and Level B acoustical harassment of up to 25 California sea lions, combined approximately 0.0111% of the Pacific stock.

If incidental take occurs, it is only expected to result in short-term changes in behavior and potential temporary hearing threshold shift. These takes would be unlikely to have any impact on stock recruitment or survival and, therefore, would have a negligible impact on the U.S. stock. No cetacean species occur within the Oakland Inner Harbor.

With implementation of avoidance and minimization efforts, potential effects will be minimized; however, temporary harassment may occur. With implementation of the proposed work restrictions, monitoring, and other mitigation measures specified in the Section 11, disturbance from project-related construction activities is expected to have only a localized, short-term impact.

8 Anticipated Impacts on Subsistence Uses

There are no known subsistence uses of sea otters, sea lions, or harbor seals in the project area, and, therefore, there are no anticipated impacts on subsistence uses.

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9 Anticipated Impacts on Habitat

The proposed activities are not expected to have any long-term detrimental impact on the habitat of harbor seals or California sea lions. Construction-related effects will be temporary and minimized with implementation of the proposed avoidance/minimization and mitigation measures. No permanent habitat removal will occur.

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10 Anticipated Effects of Habitat Impacts on Marine Mammals

There is no anticipated impact of habitat loss or habitat modification on harbor seal or California sea lion populations as a result of the project.

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11 Mitigation Measures

WETA and their construction contractor shall implement the following noise minimization and avoidance measures during project construction activities:

- All piling installation shall be conducted between June 1 and November 30, when the likelihood of sensitive fish species being present in the work area is minimal.
- Vibratory pile driving shall be conducted following USACE's Proposed Additional Procedures and Criteria for Permitting Projects under a Programmatic Determination of Not Likely to Adversely Affect Select Listed Species in California (the 2018 NLAA Program).
- To the extent feasible, all pilings shall be installed and removed with vibratory pile-driver hammer only.
- An impact pile driver may only be used where necessary to complete installation of larger steel pilings in accordance with seismic safety or other engineering criteria.
    - If an impact pile driver is used, it will be cushioned using a 12-inch-thick wood cushion block.
    - A hydroacoustic monitoring plan (including sound source verification) shall be prepared to be implemented in the event that an impact hammer is used. The acoustic monitoring plan will be prepared and submitted to the National Marine Fisheries Service (NMFS) at least 30 days prior to the contruction start date. The sound monitoring results will be made available to the California Department of Fish and Wildlife and the NMFS.
        - The hydroacoustic monitoring plan shall provide details on the sound attenuation system and the methods used to monitor and verify sound levels during impact pile-driving activities.
        - The hydroacoustic monitoring plan shall include the use of a bubble curtain during any impact pile driving of piles in the water. The bubble curtain will be operated in a manner consistent with the following performance standards:
    - The bubble curtain will distribute air bubbles around 100% of the piling perimeter for the full depth of the water column.
    - The lowest bubble ring will be in contact with the mudline for the full circumference of the ring, and the weights attached to the bottom ring shall ensure 100% mudline contact. No parts of the ring or other objects shall prevent full mudline contact.
    - Air flow to the bubblers must be balanced around the circumference of the pile.
- A "soft start" technique shall be employed in all pile driving to give marine mammals an opportunity to vacate the area. When initiating pile driving, or when there has been downtime of 30 minutes or more without pile driving, the contractor will initiate the driving with ramp-up procedures described below.
    - For vibratory hammers, the contractor will initiate the driving for 15 seconds at reduced energy, followed by a 30-second waiting period. This procedure will be repeated two additional times before continuous driving is started.
    - For impact driving, an initial set of three strikes would be made by the hammer at 40% energy, followed by a 30-second waiting period, then two subsequent three-strike sets at 40% energy, with 30-second waiting periods, before initiating continuous driving.

- A Protected Species Observer (PSO) will be present during all pile driving and extraction to observe the work area before, during, and after pile driving and extraction. The monitor will be present as specified by NMFS during the impact pile-driving and extraction phases of construction. Monitoring and reporting will include:
  - **Pre-Construction Monitoring.** Prior to initiation of in-water construction, a qualified Protected Species Observer, approved by the U.S. Fish and Wildlife Service (USFWS) and/or NOAA Fisheries, will conduct monitoring of marine mammals to update existing information on the animals' occurrence in and near the project area, their movement patterns, and their use of any haul-out sites. This preconstruction monitoring will take place at least five days prior to the start of in-water construction and will cover a period of at least one week (with at least 5 days of actual observation over a period of 4 hours each day), 2 hours in the morning at the time that construction activities would begin and 2 hours at midday, when construction activities would resume after a lunch break.
  - **Pre-Construction Workers Training.** Prior to in-water construction, the approved monitor will conduct a worker's training to instruct construction crews regarding the status and sensitivity of the target species in the area and the actions to be taken to avoid or minimize impacts in the event of a target species entering the in-water work area.
  - **In-Water Construction Biological Monitoring.** The qualified Protected Species Observer will be present during in-water construction activities to search for target marine mammal species and halt project activities that could result in injury or mortality to these species [an estimated 8 hour/day (or for the duration of in-water construction activities each day). Each day, before pile driving (or other loud in-water construction activity) begins, the monitor will survey the buffer zone for marine mammals. The monitor will also scan for target species throughout the project vicinity, i.e., the areas adjacent to the project site and buffer zone.
  - **Construction Monitoring Records.** The approved Protected Species Observers will keep a record of all observations of the target species. The information on each observation will include: a) species identification and approximate number of animals observed; b) age and sex class of each animal (if possible); c) activity and direction of movement; d) ongoing project activities at the time of observation; e) responses of target species to project activities; f) any unusual behavior or circumstances observed (project- or non-project related); and g) location, date and time of each observation. Summary monitoring reports will be submitted to NOAA Fisheries and USFWS by December 31.
  - Protected Species Observers (PSO) will be on site at all times during pile removal and driving. It is expected that 1 to 3 PSOs may be needed.
    - The vibratory Level B acoustical harassment ZOIs will be monitored for the presence of marine mammals 30 minutes before, during, and 30 minutes after any pile driving activity.
    - The PSO shall record marine mammal behavior, overall numbers of individuals observed, frequency of observation, and the time corresponding to the daily tidal cycle.
    - Marine mammal visual monitoring shall be conducted from the best vantage point available, including the adjacent docks within the harbor, to maintain an excellent view of the exclusion zone and adjacent areas during the survey period.
    - If marine mammals are observed, their location within the ZOIs, and their reaction (if any) to pile-driving activities will be documented.
    - Monitors would be equipped with radios or cell phones for maintaining contact with work crews.
    - Monitoring will be continuous unless the contractor takes a significant break; then the 30 minutes before, during, and 30 minutes monitoring sequence will begin again.

- PSOs will meet the following minimum qualifications:
  - Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance. Use of high-quality binoculars (e.g., Zeiss, 10 x 42 power) will be necessary to correctly identify the target.
  - Advanced education in biological science, wildlife management, mammalogy or related fields (Bachelor's degree or higher) is preferred, but not required.
  - Experience or training in the field identification of marine mammals (cetaceans and pinnipeds).
  - Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations.
  - 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 necessary.
  - Experience and ability to conduct field observations and collect data according to assigned protocols (this may include academic experience).
  - Writing skills to prepare a report that includes number/type of marine mammals observed; marine mammal behavior in the area during construction, dates/times of observations; dates/ times when in-water construction was conducted; dates/times when marine mammals were present near or within the ZOIs; dates/times when in-water construction was suspended to avoid take of marine mammals.

- Post-construction Compliance Report. WETA will submit a post-construction compliance report prepared by the on-site biologist within 90 calendar days after the IHA expires (See Section 13).
- A shutdown and harassment zone (Table 7, below), based on the results of the hydroacoustic assessment (Appendix A) will be established based on the type of pile driving required for the protection of marine mammals. Pile driving will be halted if a marine mammal is observed within the shutdown zone and will not restart until 15 minutes after the animal has left the shutdown zone.

Table 7. Shutdown and Level B Harassment Zones for the AMS Ferry Terminal Refurbishment Project

Method	Pile Type	Pile Size (in)	Shutdown Zone for Phocids (m)	Shutdown Zone for Otariids (m)	Level B Harassment Zone (m)
Impact, installation	Steel	36	830	60	736
Impact, installation	Steel	48	140	10	631
Vibratory, extraction	Steel	30	40	10	4,200 (1,700)
Vibratory, installation	Steel	36	40	10	4,200 (1,700)
Vibratory, installation	Steel	48	10	10	4,200 (1,700)

Note: Vibratory driving of 36" piles used as proxy for vibratory extraction of 30" piles.
Constrained by bends in the Oakland Estuary and relatively shallow bathymetry near the shipping channel: 4,200 m (13,780 ft) west, 1,700 m (5,577 ft) east

- All necessary permits, including a biological opinion from the U.S. Fish and Wildlife Service and NMFS, an Incidental Harassment Authorization from NMFS, and an Incidental Take Permit, will be obtained and adhered to during construction for in-water work that requires impact pile driving and is not covered under one of the existing programmatic consultations for federally listed species.

12 Arctic Plan of Cooperation

The project location is not within the Arctic region; therefore, no Arctic Plan of Cooperation is required.

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13 Monitoring and Reporting

A compliance closeout report will also be submitted to NMFS and the U.S. Fish and Wildlife Services within 90 calendar days of Incidental Harassment Authorization expiration. These reports shall detail the following:

1. Dates that construction occurred
2. Pertinent information concerning the success of the project in meeting the avoidance and minimization measures
3. An explanation of failure to meet such measures, if any
4. Known project effects on marine mammals, if any
5. Marine mammal sightings
6. Number of animals sighted within exclusion and harassment zones and actions taken
7. Animal behavior and behavior change
8. Animals' age (pup, juvenile, adult)
9. Environmental condition such as weather, visibility, sea state, etc.
10. Occurrences of incidental harassment, if any
11. Documentation of employee environmental education
12. Any other pertinent information

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14 Suggested Means of Coordination

All marine mammal monitoring data collected during the pre-construction and in-construction phases of the project will be submitted to NMFS as per permit requirements.

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Appendix A

AMS Ferry Terminal Hydroacoustic Assessment

ALAMEDA MAIN STREET FERRY TERMINAL REFURBISHMENT PROJECT HYDROACOUSTIC ASSESSMENT

Alameda, California

August 5, 2022
Updated May 18, 2023

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EXECUTIVE SUMMARY

This report summarizes the results of an acoustic assessment performed to evaluate the effects of construction activity noise on aquatic species. The construction activities for the refurbishment of the Alameda Main Street (AMS) Ferry Terminal includes replacement of the terminal bridge and foundation, gangway replacement, float demolition and replacement, and utility upgrades. The purpose of this assessment is to predict construction noise levels that may occur during the project so that permitting regulatory agencies can address concerns and answer questions raised about the potential project effects on sensitive habitat and aquatic species. The assessment focuses on predicting underwater noise levels from pile-driving activities. Because the design and construction details are preliminary at this time, an analysis that predicts conditions that are expected to cause reasonably worst-case acoustic conditions were analyzed. Under this worst-case scenario, piles would be driven using both vibratory and impact hammers. Note that impact pile driving would only occur if vibratory driving were not able to install piles to their tip elevation. Results of this assessment are summarized as follows:

- **48-inch-diameter steel pipe pile (Monopile)**: Impact pile driving of these piles in water could cause acoustic impacts at distances extending out to 4,200 meters (m) and 296 m for the root-mean-square (RMS) (150 decibel [dB] re 1 micropascal [µPa]) and Cumulative sound exposure level (SEL) (187 dB re 1µPa^2-sec) respectively for the adopted fish thresholds. Note that sounds would travel further to the west. Distances where sound levels exceed the marine mammal thresholds could extend out to about 292 m for the Level A Injury Zone for Pinnipeds while extending out to about 1,359 m for the Level B Harassment Zones. Vibratory driving of these piles would result in impact distances extending out to 158 m for the RMS (150 dB re 1µPa) adopted fish threshold, while resulting in Level B Harassment Zones of extending out to the mouth of the Middle Harbor at 4,200 m for the marine mammal thresholds. Use of attenuation methods (e.g., air bubble curtains), would reduce these distances.

- **36-inch steel pipe pile (guide piles & donut fender piles)**: Impact driving of these piles in water could result in sounds above thresholds extending out to the mouth of the Middle harbor at 4,200 m and 1,585 m for the RMS (150 dB re 1µPa) and Cumulative SEL (187 dB re 1µPa^2-sec) respectively for the adopted fish thresholds. Distances where sound levels exceed the marine mammal thresholds could extend out to about 1,782 m for the Level A Injury Zone for Pinnipeds while extending out to about 1,585 m for the Level B Harassment Zones. Vibratory driving of these piles would result in impact distances extending out to 158 m for the RMS (150 dB re 1µPa) adopted fish threshold, while resulting in Level B Harassment Zones of extending out to 4,200 m for the marine mammal thresholds. Use of attenuation methods (e.g., air bubble curtains), would reduce these distances.

- **24-inch steel pipe pile:** These piles would be driven on land, which could result in impact distances extending out to 736 m and 64 m for the RMS (150 dB re 1µPa) and Cumulative

SEL (187 dB re 1µPa^2-sec) respectively for the adopted fish thresholds. Distances where sound levels exceed the marine mammal thresholds could extend out to about 63 m for the Level A Injury Zone for Pinnipeds while extending out to about 158 m for the Level B Harassment Zones. Vibratory driving of these piles would result in impact distances extending out to 5 m for the RMS (150 dB re 1µPa) adopted fish threshold, while resulting in Level B Harassment Zones of extending out to 541 m for the marine mammal thresholds.

Note, the maximum anticipated distances to various fish and marine mammal thresholds calculated for each type of pile using NMFS guidelines, are constrained by bends in the Oakland Estuary and relatively shallow water bathymetry near the edge of the shipping channel ~ 4,200 m to the west of the ferry terminal site and ~1,700 m to the east. Substantial noise from piling activity is not anticipated to propagate past these bends. The computed distances for vibratory driving using the standard attenuation rate (15 Log of the distance) are 11.6 to 15.8 km, which extend beyond the harbor mouth. However, measurements in the Bay have shown greater attenuation rates of 18 Log of the distance that reduce this distance to 3.6 to 4.6 km. Given this higher attenuation rate and the narrow channel that sound would propagate, sounds above the threshold would not extend beyond the Middle Harbor.

Attachment A depicts the areas where sound effects above thresholds are predicted. Attachment B shows the screenshots of the NMFS Optional Multi Species Pile Driving Calculator (Version 1.2 2022)

INTRODUCTION

The San Francisco Bay Area Water Emergency Transportation Authority (WETA) is proposing the Alameda Main Street (AMS) Ferry Terminal Refurbishment Project (project) to support WETA ferry operations within the Oakland Inner Harbor.

The project site is located at 2990 Main Street in Alameda (City), California and includes the existing AMS Ferry Terminal, which consists of a trestle, steel float structure, aluminum gangway, and bridge structure. The site is designated under the General and Maritime Industry land use and zoned as General Industrial (M-2). Much of the project site is within the Oakland Inner Harbor, with a portion of the bridge structure extending onto the landside of the City. The landside of the project site consists of various bay rocks, rip-rap, and dirt/sand. The project site is accessible by vehicle via Main Street and by ferry within the Oakland Inner Harbor. The project is within a developed area of the City and is bounded by the Oakland Inner Harbor to the north, industrial uses to the east, the San Francisco Bay Trail, AMS Ferry Terminal parking lot, and residential uses to the south, as well as the Main Street Dog Park and undeveloped land uses to the east.

Specific project elements include the following:

- **Terminal Bridge and Foundation Replacement**. Project activities would involve demolishment of existing bridge/walkway and bridge foundation and replacement with a new aluminum truss bridge. Onshore and landside support would be installed and would consist of driving a 48-inch monopile and two 24-inch pipe piles with cap beams, respectively (in water).

- **Gangway Replacement.** The project would include removal of the existing 60-foot gangway and replacement with an 80 foot covered aluminum gangway.

- **Float Demolition/Replacement.** The existing terminal float would be removed and replaced-in-kind with a new steel float. Ramps that had been previously installed on the float would be removed, protected in place, and reused once the new float is installed. Float ramps would be shifted to the west to provide additional room for a longer gangway. The four existing 30-foot guide piles would be removed and replaced with four (4) new 36-inch guide piles. To achieve a more safe, efficient berthing capacity and enable ingress and egress in a timely manner, float demolition/replacement activities would also involve installation of two (2) new 36-inch donut fender piles and two (2) 36-inch donut fender piles (in water).

- **Utility Upgrades**. Utility upgrades associated with the project would involve replacement of existing razor equipment, installation of electrical service for new lighting, ramp controls, and outlets, provision of new potable water as well as conduit for future upgrades on bridge, gangway, and float structures. No other utility improvements are planned.

This study is an assessment of potential underwater noise levels generated by planned construction activities involved with the refurbishment of the AMS Ferry Terminal. The study was requested in order to aid regulatory biologists in assessing underwater sound impacts on fish and marine species that may be present in the area when construction occurs. This assessment is based on information provided by project designers consisting of a location map, draft layout sheets,

estimated pile-driving data, a review of potential construction activities to be conducted at the site, a review of related studies, the modeling, and a semi-quantitative analysis of underwater noise levels. This study assesses the sound levels associated with potential pile-driving activities that could affect aquatic species. This study does not address environmental impacts associated with the project.

UNDERWATER SOUNDS FROM PILE-DRIVING ACTIVITIES

Fundamentals of Underwater Noise

Impact pile driving can produce high underwater sound levels. 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, 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 (RMS) pressure, 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 comprises that portion of the waveform containing the sound energy (Richardson et al. 1995; ISO 18406:2017(E).). 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, most commonly as the "total energy flux" (Finerran 2002). 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. The unit used is decibels (dB) re 1 micropascal $(\mu Pa)^2$-second (sec). In this report, peak pressure levels are expressed as the absolute maximum pressure of a pulse in dB re 1 µPa; however, in other literature, peak pressure levels can take varying forms, such as pascals or pounds per square inch. The total sound energy in an impulse accumulates over the duration of that pulse and the duration of a pile driving event. Figure 1 illustrates 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. The waveform can provide an indication of rise time or the rapidity with which pressure fluctuates with time; however, rise time differences are not clearly apparent for pile-driving sounds because of the numerous rapid fluctuations that are characteristic of this impulse type. A plot showing the accumulation of sound energy over the duration of the pulse (or at least the portion of time during which much of the energy accumulates) illustrates the differences in source strength and rise time. An example of the underwater acoustical characteristics of a typical pile-driving pulse is shown on Figure 1.

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 pile driving. 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:

$$SEL_{cumulative} = SEL_{single-strike} + 10log(\#of\ pile\ strikes)$$

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 * $Log_{10}(1000) = 30$.

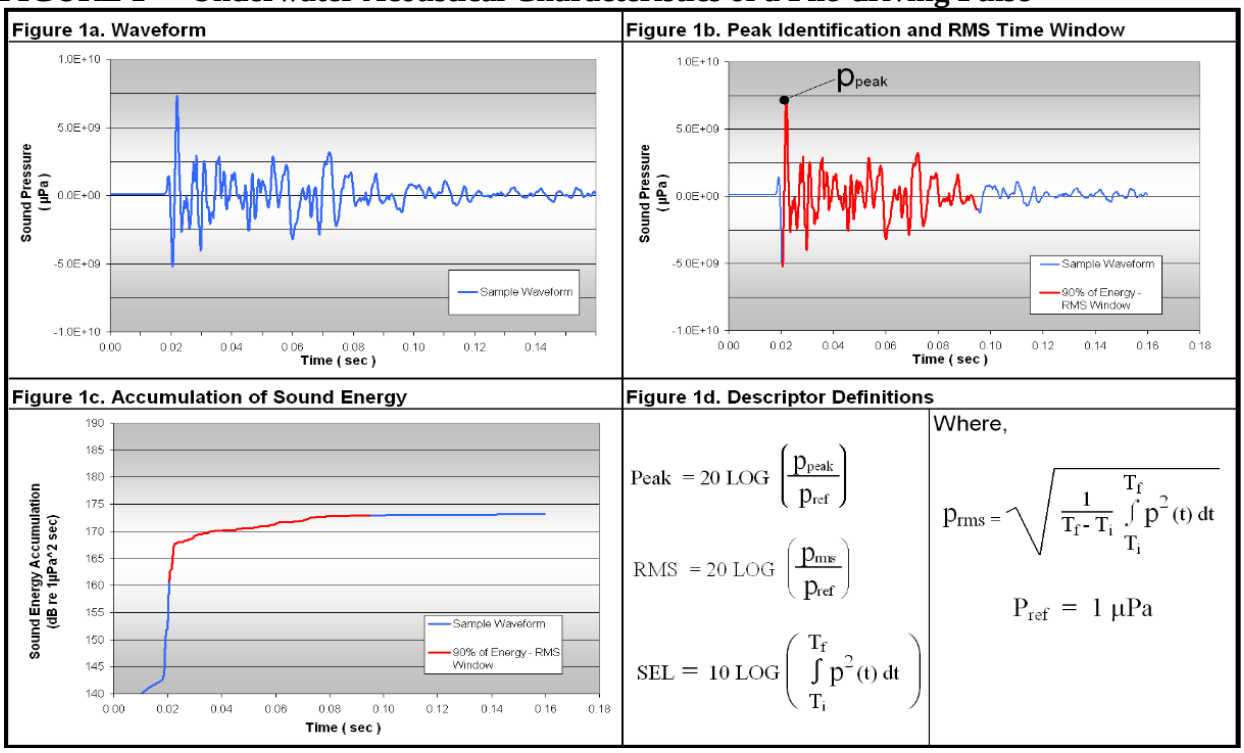
TABLE 1 Definition of Underwater Acoustical Terms

Term	Definition
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 dB (referenced to a pressure of 1 µPa) but can also be expressed in units of pressure, such as µPa or pounds per square inch.
RMS Sound Pressure Level, (NMFS Criterion) dB re 1 µPa	The squared root of the average of the squared pressures over the time that comprises that portion of the waveform containing 90 percent of the sound energy for one pile-driving impulse.[1] This measure is typically used to assess acoustical impacts on marine mammals.
SEL, dB re 1 μPa^2-sec	Proportionally equivalent to the time integral of the squared pressure and is described in this report in terms of dB re 1 μPa^2-sec over the duration of the impulse. Similar to the unweighted SEL standardized in airborne acoustics to study noise from single events.
Cumulative SEL	Measure of the total energy received through a pile-driving event (here defined as pile driving that occurs within a day).
Waveforms, µPa over time	A graphical plot illustrating the time history of positive and negative sound pressures 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.

[1] The underwater sound measurement results obtained during a Pile Installation Demonstration Project indicated that most pile-driving impulses occurred over a 50- to 100-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) used by NMFS.

Notes: msec = millisecond(s)
NMFS = National Marine Fisheries Service

FIGURE 1 Underwater Acoustical Characteristics of a Pile-driving Pulse



Underwater Sound Thresholds

Fish

In 2008, NOAA's 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 agreed in principle to interim criteria to protect fish from pile-driving activities. The agreed-upon criteria are presented in Table 2.

TABLE 2 Adopted Fish Criteria

Interim Criteria for Injury	Sound Levels Agreed-upon in Principle
Peak	206 dB re 1 µPa (for all sizes of fish)
Cumulative SEL	187 dB re 1 µPa²-sec – for fish size of 2 grams or greater[a] 183 dB re 1 µPa²-sec – for fish size of less than 2 grams[a]

[a] Applies to pile strikes of 150 dB SEL (single strike) or greater.

The adopted criteria listed in Table 2 are for pulse-type sounds (e.g., impact pile driving) and do not address sound from vibratory driving. The SEL criteria are not applied to vibratory driving sounds. The in-water areas with project sound levels above 150 dB RMS are considered by NMFS to be acoustically affected given possible behavioral changes in fish; however, these levels are not anticipated to trigger any mitigation requirements (Caltrans 2020).

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" (NMFS 2018). 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" (NMFS 2018).

Table 3 outlines the current adopted Level A and Level B (behavioral harassment) criteria. The application of the 120-dB RMS threshold for vibratory pile driving 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 levels for all pulses.

NMFS has provided marine mammal acoustic technical guidance for predicting the onset of permanent threshold shift (PTS) and temporary threshold shifts in marine mammal hearing from sound sources (NMFS 2018). For this project location, the functional hearing groups are expected to be limited to phocid pinnipeds (harbor seals), and otariid pinnipeds (California sea lions). For impact pile driving, the majority of the acoustic energy is confined to frequencies below 2 kilohertz (kHz), and there is very little energy above 20 kHz. Similarly, much of the acoustic energy for vibratory driving is in the frequency range below 2.5 kHz. The underwater acoustic criteria for phocid and otariid pinnipeds are provided in Table 3. Table 4 lists the functional hearing groups and their hearing ranges as defined by the NMFS guidance (NMFS 2018).

TABLE 3 Underwater Acoustic Criteria for Pinnipeds

Species	Underwater Noise Thresholds (dB re 1 µPa)				
	Vibratory Pile-driving Disturbance Threshold (*Level B Harassment*)	**Impact Pile-driving Disturbance Threshold (*Level B Harassment*)**	**Marine Mammal Hearing Group (see Table 4)**	**PTS SEL_{cum} Threshold Peak – dB re 1 µPa SEL_{cum} – dB re 1 μPa^2-sec**	
				Impulsive (*Impact Pile Driving*)	**Non-Impulsive (*Vibratory Pile Driving*)**
Pinnipeds	120 dB RMS	160 dB RMS	Phocid	218 dB Peak 185 dB SEL_{cum}	201 dB SEL_{cum}
			Otariid	232 dB Peak 203 dB SEL_{cum}	219 dB SEL_{cum}

TABLE 4 Definition of Marine Mammal Hearing Group for Pinnipeds

Marine Mammal Hearing Groups	
Functional Hearing Group	**Functional Hearing Range**
Phocid Pinnipeds – true seals, including harbor seals	50 Hz to 86 kHz
Otariid Pinnipeds – sea lions and fur seals	60 Hz to 39 kHz

Note: Hz = hertz

PROJECT UNDERWATER SOUND-GENERATING ACTIVITIES

The primary type of activity that has the potential to elevate underwater noise levels is the installation of piles using an impact pile driver. For this project however, vibratory driving is expected to be used for majority of the pile installation with the possibility of using an impact hammer if piles hit refusal prior to the required tip elevation. Pile installation activities for the project include installation of a single (1) 48-inch steel pipe monopile in water for the terminal bridge along with two (2) 24-inch steel pipe piles with concrete cap beams on land. The project also involves removal of four (4) existing 30-inch guide piles, installation of four (4) 36-inch guide piles and two (2) 36-inch donut fender piles in water for the terminal float.

Pile driving in the water causes sound energy to radiate directly into the water by vibrating the pile between the surface of the water and the riverbed, and indirectly as a result of ground-borne vibration at the riverbed. Airborne sound does not make a substantial contribution to underwater sound levels because of the attenuation of sound at the air/water interface. Pile driving on land would generate low-frequency ground-borne vibration that could cause localized sound pressures in the water that are radiated from the streambed. A minimum water depth is required to allow sound to propagate. For pile-driving sounds, the minimum depth is 1 m (3 feet). Pile-driving activities conducted on land near water bodies have been found to transmit low-frequency sound into the water. The mechanisms for transmitting this sound into the water are complex and difficult, if not impossible, to predict.

Table 5 summarizes the proposed pile-driving activities, the number of piles anticipated per day, and the duration of the pile driving activity for vibratory driving.

TABLE 5 Pile-driving Activities for the Proposed Project

New Structure	Pile Type	Pile Location	Duration/Estimated Blows per Pile[1]	Piles per Day
Terminal Bridge and Foundation Replacement	48-inch steel pipe	In Water	45 mins vibrate 1,015 strikes impact	1
Terminal Bridge and Foundation Replacement	24-inch steel pipe	On Land	45 mins vibrate 1,015 strikes impact	2
Float Replacement (Guide piles & Donut Fender piles)	36-inch steel pipe	In Water	45 mins vibrate 1,015 strikes impact	6
Structure Removal	Pile Type	Pile Location	Duration	Piles per Day
Guide piles	30-inch steel pipe	In Water	45 mins vibrate	4

[1] Impact driving if needed, assumes about 20 to 30 minutes of driving with a total of about 1,015 strikes per pile.

Predicted Underwater Sound Levels from Construction

This assessment predicts underwater sound levels associated with the different piling activities that are anticipated. Piling activities include the impact and/or vibratory installation and removal of steel piles. The prediction of sound levels associated with this activity are based on measurements from similar activities.

The prediction of sound levels from pile-driving activities proposed for this project relies on data collected from other sites with similar conditions. The following studies were identified and used to aid in predicting underwater noise levels and calculating the distances to thresholds for fishes and marine mammals discussed in this report.

Underwater Sound Levels from Project Pile Driving

Data in the following studies were reviewed for the various pile-driving activities summarized in Table 6. The values in Table 6 are for sound levels measured at 10 m (33 feet) from the piles for conditions similar to those that would occur at this project. Detailed information on the measurements that make up these levels below are provided in the references.

TABLE 6 Measured Levels for Pile-driving Activities

Driving Method	Pile Type	Size	Sound Pressure Level in dB re 1 µPa at 10 Meters			Notes
			Peak	RMS	SEL	
Impact	Steel pipe pile on land	24-inch	195	178	166	Assumed 15 dB lower than levels in water using data from Naval Base Kitsap, Bangor, WA
Impact	Steel pipe pile in water	36-inch	211	193	183	Caltrans 2020 as recommended by NMFS
Impact	Steel pipe pile in water	48-inch	213	192	179	Caltrans 2020 as recommended by NMFS
Vibrate	Steel pipe pile on land	24-inch	185	146	146	Assumed 15 dB lower than levels in water using data from Naval Base Kitsap, Bangor, WA
Vibrate	Steel pipe pile in water	36-inch	200	168	168	Anchorage Port Modernization Program – Test Pile Program (POA 2016)
Vibrate	Steel pipe pile in water	48-inch	200	168	168	Anchorage Port Modernization Program – Test Pile Program (POA 2016)

Levels from vibratory installation of 36-inch steel piles in water would represent a conservative estimate for levels expected from vibratory removal of 30-inch steel guide piles. Impacts from vibratory removal of 30-inch piles are represented by the impacts resulting from 36-inch steel piles for the rest of the report (worst-case scenario).

Table 7 shows the predicted sound levels expected at 10-m (33-foot) distances from different pile-driving activities expected from the project. Included are the unattenuated sound levels (peak, RMS, SEL) expected, also at 10 m (33 feet) from the piles.. Table 7 also shows expected attenuated levels that correspond to a 5-dB reduction because of different attenuation mechanisms like bubble curtains or isolation casing that may be used during the in-water pile-driving activities. These levels, which have been taken from past projects, provide an estimate of the levels to be expected from the pile-driving activities proposed for the project. Impacts on fishes and marine mammals are then calculated using these levels (both unattenuated and attenuated). No methods are available to further attenuate land-based pile-driving sounds.

TABLE 7 Sound Levels Used for Predicting Underwater Sound Impacts

Driving Method	Pile Type	Size	Sound Pressure Level Measured in dB re 1 µPa at 10 Meters					
			Unattenuated			Attenuated[a]		
			Peak	RMS	SEL	Peak	RMS	SEL
Impact	Steel pipe pile on land	24-inch	195	178	166	Sounds from piles driven on land cannot be further attenuated		
Impact	Steel pipe pile in water	36-inch	211	193	183	206	188	178
Impact	Steel pipe pile in water	48-inch	213	192	179	208	187	174
Vibrate	Steel pipe pile on land	24-inch	185	146	146	Sounds from piles driven on land cannot be further attenuated		
Vibrate	Steel pipe pile in water	36-inch	200	168	168	<5 dB attenuation expected from vibrated piles		
Vibrate	Steel pipe pile in water	48-inch	200	168	168	<5 dB attenuation expected from vibrated piles		

[a] Attenuated condition assumes minimum 5-dB lower sounds.

Predicted Impacts on Fishes

Table 8 shows the anticipated distances (in meters and in feet) to the various adopted interim fish thresholds[2]. Distances are shown for both unattenuated and attenuated piles (5-dB attenuation). Also, when the piles are installed with a vibratory hammer, the cumulative SEL thresholds for fish do not apply, and the 150-dB RMS level provides an estimated zone of possible acoustic effects. The distance to each threshold was computed using the transmission loss coefficient of 15 times the Log_{10} of the distance, as recommended by NMFS when there is no site-specific information for the area. This attenuation rate was used in the computations; however, it should be noted that attenuation rates of 18 times the Log_{10} of the distance were measured during pile driving for the San Francisco-Oakland Bay Bridge East Span project (Caltrans 2020)[3]. Cumulative SEL was further computed by adding 10 times the Log_{10} of the number of impact pile strikes. Impact strikes used in these computations are the sum of the anticipated strikes per pile times the number of piles per day.

Note that sound propagation in the Oakland Inner Harbor is limited by bends in the Oakland Estuary and relatively shallow water bathymetry near the shipping channel boundaries. Substantial sound is not anticipated to travel beyond 4,200 m to the west (out the shipping channel) and 1,700 m east of the project site (where the channel bends). Therefore, the distance for noise impacts from this project is limed to 4,200 m west and 1,700 m east under the worst-case conditions.

[2] Distances to Adopted Interim fish thresholds calculated using Optional Multi Species Pile Driving Calculator Version 1.2 (2022) - https://www.fisheries.noaa.gov/s3/2023-05/BlankMultiSpecies-August2022b-Public-OPR1.xlsx . Screenshots of calculated results shown in Attachment B

[3] Technical Guidance for Assessment of the Hydroacoustic Effects of Pile Driving on Fish, Chapter I.9 San Francisco-Oakland Bay Bridge East Span Replacement Project page I-229

TABLE 8 Distance to Adopted Fish Thresholds for All Piles

Driving Method	Pile Type	Size	Piles per Day	Estimated No. of Strikes per Pile	Condition[a]	Distance to Adopted Fish Thresholds			
						Peak 206 dB[b]	RMS 150 dB[b]	Cumulative SEL	
								187 dB[c]	183 dB[c]
Impact	Steel pile on land	24-in	2	1,015[e]	Unattenuated	--[d]	736 m *[2,414 ft]*	64 m *[209 ft]*	117 m [383 ft]
Impact	Steel pile in water	36-in	6	1,015[e]	Unattenuated	22 m [71 *ft*]	4,200/1,700[g] m *[13,780/5,577 ft]*	1,585 m [5,200 ft]	1,585 m [5,200 ft]
					Attenuated	10 m [33 *ft*]	3,415/1,700[g] m *[11,202/5,577 ft]*	736 m *[2,414 ft]*	736 m *[2,414 ft]*
Impact	Steel pile in water	48-in	1	1,015[e]	Unattenuated	30 m *[96 ft]*	4,200/1,700[g] m *[13,780/5,577 ft]*[g]	296 m *[970 ft]*	547 m *[1,793 ft]*
					Attenuated	14 m *[45 ft]*	2,929/1,700[g] m *[9,608/5,577 ft]*	137 m *[450 ft]*	254 m *[832 ft]*
Vibrate	Steel pile on land	24-in	2	--[f]	Unattenuated	--[d]	5 m *[18 ft]*	N/A	N/A
Vibrate	Steel pile in water	36-in	6	--[f]	Unattenuated	--[d]	158 m *[520 ft]*	N/A	N/A
Vibrate	Steel pile in water	48-in	1	--[f]	Unattenuated	--[d]	158 m *[520 ft]*	N/A	N/A

[a] Attenuated condition assumes 5-dB lower sounds.
[b] dB re 1 µPa
[c] dB re 1 µPa^2-sec
[d] Within the near-field of the sound source - < 10 meters [33 feet]
[e] Assuming impact hammer usage for 20-30 mins with about 1015 strikes per pile.
[f] Piles vibrated in at 45 minutes each (2,700 sec.).
[g] Constrained by bends in the Oakland Estuary and relatively shallow water bathymetry near the shipping channel, 4,200 m [13,780 ft] west and 1, 700 m [5,577 ft] east.

Predicted Impacts on Marine Mammals

The following threshold distances were computed to assess impacts on pinnipeds:

- Distance to onset PTS isopleth for each hearing group (considered Level A impacts)
  - Unattenuated
  - Attenuated
- Distance for unweighted 120-dB vibratory and 160-dB impulse behavior isopleth (considered Level B impacts)
  - Unattenuated
  - Attenuated

The Companion User Spreadsheet (Version 2.2 [2020])[4] to the *NMFS Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing* was used to predict zones where the onset of PTS to marine mammal hearing could occur. A spreading loss calculation is included in the spreadsheet to predict the distance to the onset PTS from accumulated SEL and peak sound pressure. The spreadsheet incorporates a frequency weighting function that accounts

[4] Distances to Marine Mammal thresholds also calculated using Optional Multi Species Pile Driving Calculator Version 1.2 (2022) - https://www.fisheries.noaa.gov/s3/2023-05/BlankMultiSpecies-August2022b-Public-OPR1.xlsx . Screenshots of calculated results shown in Attachment B

for sensitivity for different hearing groups when computing the accumulated SEL. These are referred to as weighting frequency adjustments. The default weighting frequency adjustments are 2 kHz for impact pile driving and 2.5 kHz for vibratory driving. Because the onset of PTS based on SEL_{cum} is computed as further from the pile than it would be using peak sound pressure computations, the onset of PTS is based on SEL computations; therefore, the onset of PTS based on peak sound levels is not provided in this assessment.

The extent of the Level B Zone was calculated using the 10-meter (33-foot) sound levels and applying a transmission loss coefficient of 15 times the Log_{10} of the distance, as recommended by NMFS when there is no site-specific information for the area. Substantial sound is not expected to propagate outside the Middle Harbor because of the narrow propagation path westward combined with the higher sound attenuation rates that have been measured in the Bay (see Caltrans 2020)[5].

Table 9 presents the anticipated distances to the adopted marine mammal thresholds (Level A and Level B Zones). When the piles are installed with a vibratory hammer, the cumulative SEL thresholds apply for sounds greater than 150 dB (re 1 μPa^2-sec) SEL. The peak PTS thresholds that apply to marine mammals will not be reached. Distances are shown for both unattenuated and attenuated pile-driving activities expected from the project, for the estimated number of strikes and piles per day proposed.

Attenuation Methods

Air bubble curtains, either confined or un-confined, have been shown to reduce sound pressure levels for pile driving in water by up to about 5 to 20 dB within 300 meters of the pile. However, in accordance with Caltrans guidance, only a 5-dB reduction was used for calculating the distances to the fish and marine mammal thresholds (Caltrans 2020). The amount of attenuation may be more, especially at distant locations from the pile because of the contribution of sound propagating through the bottom substrate. At the Benicia-Martinez Bridge and San Francisco-Oakland Bay Bridge projects (Caltrans 2020), more than 10 dB of sound reduction was obtained using bubble curtains. At the Humboldt Bay Seismic Retrofit Project, reductions of between 12 and 16 dB were achieved using either an unconfined bubble ring or a bubble ring in an isolation casing, with the best results being the unconfined bubble ring (Caltrans 2020).

The design of the specific bubble ring configuration will depend on several factors, such as the depth of water and the water current, and must be designed individually for each project and location within the project. Air bubble curtain systems are used during production pile driving to reduce underwater sound pressures. Typically, a system consists of stacked rings to generate air bubbles throughout the entire water column surrounding the piles, even with currents. A bubble curtain system is generally composed of air compressors, supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipes, and a frame. The frame is used to facilitate transportation and placement of the system, keep the aeration pipes stable, and provide ballast to counteract the buoyancy of the aeration pipes during pile-driving operations. Bubble curtain designs consist of single or multiple concentric layers of perforated aeration pipes (stacked vertically). Pipes in any layer are arranged in a geometric pattern that allows the pile-driving

[5] Technical Guidance for Assessment of the Hydroacoustic Effects of Pile Driving on Fish, Chapter I.9 San Francisco-Oakland Bay Bridge East Span Replacement Project page I-229

operation to be completely enclosed by bubbles for the full depth of the water column. The lowest layer of perforated aeration pipe is designed to ensure contact with the mud line without sinking into the bottom substrates. A proper combination of bubble density and closeness of bubbles to the pile is most effective. Numerous smaller bubbles are more effective because they displace more water between the bubbles. This pattern has to be maintained throughout the water column.

TABLE 9 Distance to the Adopted Marine Mammal Thresholds for Different Pile-driving Activities – Level A and B Zones

Driving Method	Pile Type	Size	Piles per Day	Estimated No. of Strikes per Pile	Condition[a]	Level A Injury Zone Using SEL_{cum} Threshold		Level B Harassment Zone
						Pinnipeds		
						Phocid	Otariid	
Impact	Steel pipe pile on land	24-inch	2	1,015[e]	Unattenuated	63 m *[207 ft]*	--[b]	158 m *[518 ft]*
Impact	Steel pipe pile in water	36-inch	6	1,015[e]	Unattenuated	1,782 m *[5,847 ft]*	130 m *[427 ft]*	1,585 m *[5,200 ft*]
					Attenuated	827 m *[2,713 ft]*	60 m *[197 ft]*	736 m *[2,415 ft]*
Impact	Steel pipe pile in water	48-inch	1	1,015[e]	Unattenuated	292 m *[958 ft]*	21 m *[69 ft]*	1,359 m *[4,459 ft*]
					Attenuated	136 m *[446 ft]*	10 m *[33 ft]*	631 m *[2070 ft]*
Vibrate	Steel pipe pile on land	24-inch	2	--[c]	Unattenuated	--[b]	--[b]	541 m *[1,775 ft]*
Vibrate	Steel pipe pile in water	36-inch	6	--[c]	Unattenuated	33 m *[108 ft]*	--[b]	4,200/1,700[d] m *[13,780/5,577 ft*]
Vibrate	Steel pipe pile in water	48-inch	1	--[c]	Unattenuated	10 m *[33 ft]*	--[b]	4,200/1,700[d] m *[13,780/5,577 ft*]

[a] Attenuated condition assumes 5-dB lower sounds.
[b] Within the near-field of the sound source - < 10 meters [33 feet]
[c] Piles vibrated in at 45 minutes each.
[d] Constrained by bends in the Oakland Estuary and relatively shallow water bathymetry near the shipping channel, 4,200 m [13,780 ft] west and 1, 700 m [5,577 ft] east.
[e] Assuming impact hammer usage for 20-30 mins with about 1,015 strikes per pile.

Illustration of Impacts

Attachment A includes Google Earth maps displaying the extent of both fish injury zones and marine mammal Level A and B Zones around the proposed project site for the piles driven.

REFERENCES

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Attachment A

Maps Illustrating the 187-dB Cumulative SELs, 206-dB Peak Adopted Fish Injury Zones and Marine Mammal Level A and B Zones (Source: Google Earth 2022)

Figure A1 – Fish Injury Zones – 206 dB Peak, 150 dB RMS and 187 SEL_{cum}; for 24-inch Steel pile on Land impact driven

Figure A2 – Fish Injury Zones – 206 dB Peak, 150 dB RMS and 187 SEL_{cum}; for 36-inch Steel pile impact driven

Figure A3 – Fish Injury Zones – 206 dB Peak, 150 dB RMS and 187 SEL_{cum}; for 48-inch monopile impact driven

Figure A4 – Fish Injury Zones – 206 dB Peak, 150 dB RMS and 187 SEL_{cum}; for 24-inch Steel pile on Land driven using a vibratory hammer

Figure A5 – Fish Injury Zones – 206 dB Peak, 150 dB RMS and 187 SEL_{cum}; for 36-inch Steel pile driven using a vibratory hammer

Figure A6 – Fish Injury Zones – 206 dB Peak, 150 dB RMS and 187 SEL_{cum}; for 48-inch monopile driven using a vibratory hammer

SOURCE: Bing Maps 2021

DUDEK

0 1,250 2,500 Feet

FIGURE 3

Marine Mammal Thresholds Level A and B Impact Zones - 24-inch Steel Pile: Land Impact Driven

Alameda Main Street Terminal Refurbishment Project

SOURCE: Bing Maps 2021

DUDEK

0 1,250 2,500 Feet

FIGURE 4A

Marine Mammal Thresholds Level A and B Impact Zones - 36-inch Steel Pile: Impact Driven

Alameda Main Street Terminal Refurbishment Project

SOURCE: Bing Maps 2021

DUDEK

0 1,250 2,500 Feet

FIGURE 4B

Marine Mammal Thresholds Level A and B Impact Zones - 36-inch Steel Pile: Impact Driven

Alameda Main Street Terminal Refurbishment Project

SOURCE: Bing Maps 2021

DUDEK

0 1,250 2,500 Feet

FIGURE 5A

Marine Mammal Thresholds Level A and B Impact Zones - 48-inch Monopile: Impact Driven

Alameda Main Street Terminal Refurbishment Project

SOURCE: Bing Maps 2021

DUDEK 0 1,250 2,500 Feet

FIGURE 5B

Marine Mammal Thresholds Level A and B Impact Zones - 48-inch Monopile: Impact Driven

Alameda Main Street Terminal Refurbishment Project

SOURCE: Bing Maps 2021

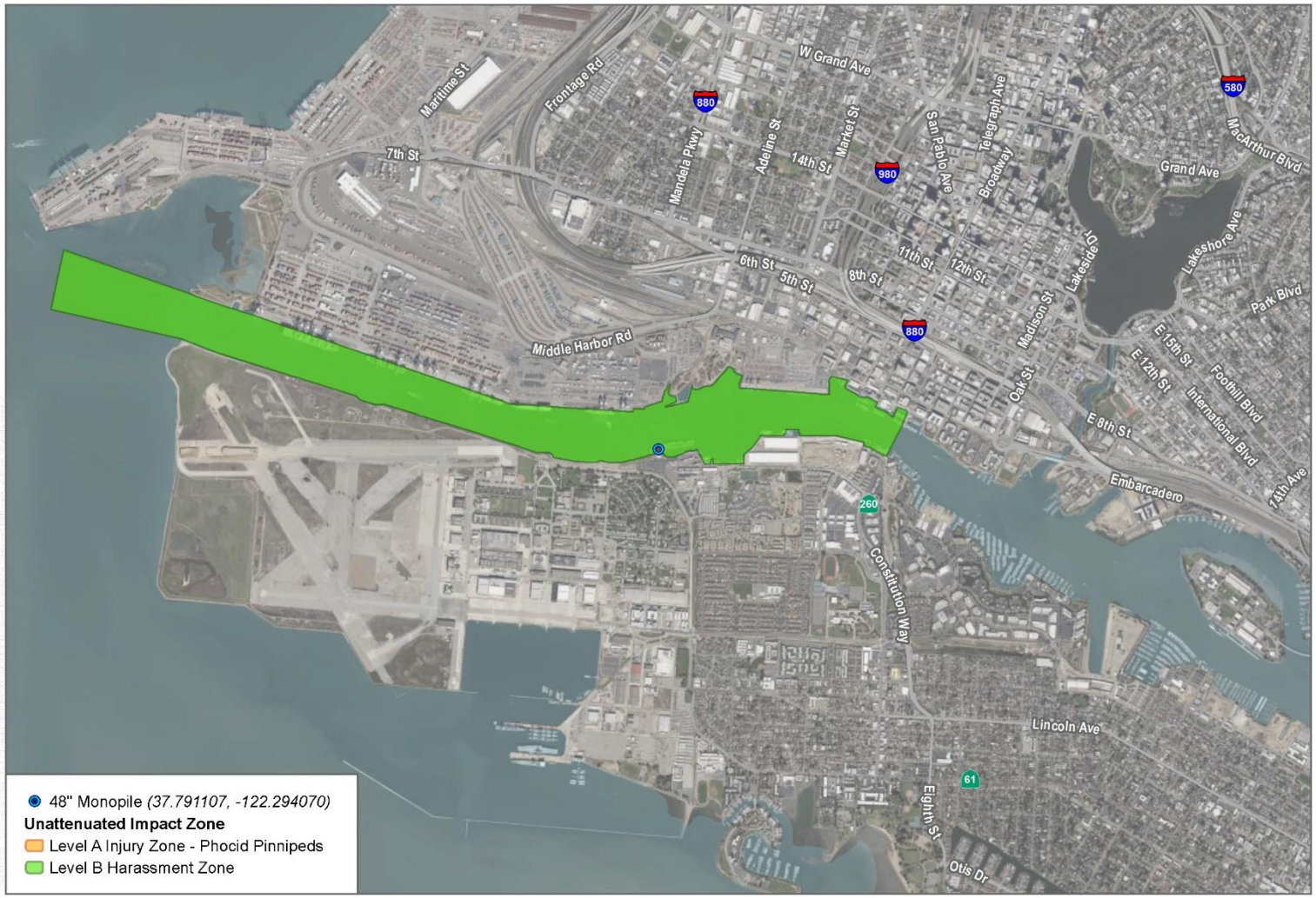
DUDEK

0 1,250 2,500 Feet

FIGURE 6

Marine Mammal Thresholds Level A and B Impact Zones - 24-inch Steel Pile: Land Driven with Vibratory Hammer

Alameda Main Street Terminal Refurbishment Project



SOURCE: Bing Maps 2021

DUDEK 0 1,400 2,800 Feet

FIGURE 7

Marine Mammal Thresholds Level A and B Impact Zones - 48-inch Monopile: Driven with Vibratory Hammer

Alameda Main Street Terminal Refurbishment Project

SOURCE: Bing Maps 2021

DUDEK

0 1,400 2,800 Feet

FIGURE 8

Marine Mammal Thresholds Level A and B Impact Zones - 48-inch Monopile: Driven with Vibratory Hammer

Alameda Main Street Terminal Refurbishment Project

Attachment B
Screenshots from NMFS Optional Multi Species Pile Driving Calculator
Version 1.2 (2022)

IMPACT PILE DRIVING REPORT

VERSION 1.2-Multi-Species: 2022

Alameda Main Street Ferry Terminal Refurbishment Project

PRINT IN LANDSCAPE TO CAPTURE ENTIRE SCREEN

(if OTHER INFO or NOTES get cut-off, please include information elsewhere)

Adwait Ambaskar - 707-794-0400 ext. 111

PROJECT INFORMATION	PEAK	SELss	RMS
Single strike level (dB)	195	166	178
Distance associated with single strike level (meters)	10	10	10
Transmission loss constant	15		
Number of piles per day	2		
Number of strikes per pile	1015		
Number of strikes per day	2030		
Cumulative SEL at measured distance	199		

OTHER INFO: 24-inch Steel Pipe Pile on Land.

NOTES: 0

Attenuation: 0

RESULTANT ISOPLETHS (Range to Effects)

FISHES

	ONSET OF PHYSICAL INJURY			BEHAVIOR
	Peak Isopleth	SEL_{cum} Isopleth		RMS Isopleth
		Fish ≥ 2 g	Fish < 2 g	
ISOPLETHS (meters)	1.8	63.8	116.6	735.6
Isopleth (feet)	6.1	209.4	382.5	2,413.5

Fishes present

SEA TURTLES

	PTS ONSET		BEHAVIOR
	Peak Isopleth	SEL_{cum} Isopleth	RMS Isopleth
ISOPLETHS (meters)	0.0	4.7	15.8
Isopleth (feet)	0.1	15.4	52.0

NO SEA TURTLES

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
PTS ONSET (Peak isopleth, meters)	0.3	0.0	3.4	0.3	0.0
PTS ONSET (Peak isopleth, feet)	0.8	0.2	11.2	1.0	0.1
PTS ONSET (SEL_{cum} isopleth, meters)	117.8	4.2	140.3	63.0	4.6
PTS ONSET (SEL_{cum} isopleth, feet)	386.4	13.7	460.3	206.8	15.1
	ALL MM	NO MF CET.	NO HF CET.	Phocids present	Otariids present
Behavior (RMS isopleth, meters)	158.5	NO LF CET.			
Behavior (RMS isopleth, feet)	520.0				

Figure B1 – NMFS Spreadsheet for 24-inch Steel Pipe pile Impact driven on Land.

IMPACT PILE DRIVING REPORT

VERSION 1.2-Multi-Species: 2022

Alameda Main Street Ferry Terminal Refurbishment Project

PRINT IN LANDSCAPE TO CAPTURE ENTIRE SCREEN

(if OTHER INFO or NOTES get cut-off, please include information elsewhere)

Adwait Ambaskar - 707-794-0400 ext. 111

PROJECT INFORMATION	PEAK	SELss	RMS
Single strike level (dB)	211	183	193
Distance associated with single strike level (meters)	10	10	10
Transmission loss constant	15		
Number of piles per day	6		
Number of strikes per pile	1015		
Number of strikes per day	6090		
Cumulative SEL at measured distance	221		

OTHER INFO: 36-inch Steel Pipe Pile in Water.

NOTES: 0

Attenuation: 0

RESULTANT ISOPLETHS

(Range to Effects)

FISHES

	ONSET OF PHYSICAL INJURY			BEHAVIOR	
	Peak Isopleth	SEL_{cum} Isopleth		RMS Isopleth	
		Fish ≥ 2 g	Fish < 2 g		
ISOPLETHS (meters)	21.5	1,584.9	1,584.9	7,356.4	Fishes present
Isopleth (feet)	70.7	5,199.8	5,199.8	24,135.2	

SEA TURTLES

	PTS ONSET		BEHAVIOR	
	Peak Isopleth	SEL_{cum} Isopleth	RMS Isopleth	
ISOPLETHS (meters)	0.4	132.9	158.5	NO SEA TURTLES
Isopleth (feet)	1.3	435.9	520.0	

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
PTS ONSET (Peak isopleth, meters)	2.9	0.5	39.8	3.4	0.4
PTS ONSET (Peak isopleth, feet)	9.6	1.8	130.6	11.2	1.3
PTS ONSET (SEL_{cum} isopleth, meters)	3,330.3	118.4	3,966.9	1,782.2	129.8
PTS ONSET (SEL_{cum} isopleth, feet)	10,926.2	388.6	13,014.8	5,847.2	425.7
	ALL MM	NO MF CET.	NO HF CET.	Phocids present	Otariids present
Behavior (RMS isopleth, meters)	1,584.9	NO LF CET.			
Behavior (RMS isopleth, feet)	5,199.8				

Figure B2 – NMFS Spreadsheet for 36-inch Steel Pipe pile Impact driven in Water.

IMPACT PILE DRIVING REPORT
VERSION 1.2-Multi-Species: 2022
Alameda Main Street Ferry Terminal Refurbishment Project

PRINT IN LANDSCAPE TO CAPTURE ENTIRE SCREEN
(if OTHER INFO or NOTES get cut-off, please include information elsewhere)
Adwait Ambaskar - 707-794-0400 ext. 111

PROJECT INFORMATION	PEAK	SELss	RMS
Single strike level (dB)	213	179	192
Distance associated with single strike level (meters)	10	10	10
Transmission loss constant	15		
Number of piles per day	1		
Number of strikes per pile	1015		
Number of strikes per day	1015		
Cumulative SEL at measured distance	209		

OTHER INFO: 48-inch Steel Pipe Pile in Water.
NOTES: 0
Attenuation: 0

RESULTANT ISOPLETHS
(Range to Effects)

FISHES

	ONSET OF PHYSICAL INJURY			BEHAVIOR	
	Peak Isopleth	SEL_{cum} Isopleth		RMS Isopleth	
		Fish ≥ 2 g	Fish < 2 g		
ISOPLETHS (meters)	29.3	295.8	546.6	6,309.6	Fishes present
Isopleth (feet)	96.1	970.4	1,793.2	20,700.7	

SEA TURTLES

	PTS ONSET		BEHAVIOR	
	Peak Isopleth	SEL_{cum} Isopleth	RMS Isopleth	
ISOPLETHS (meters)	0.5	21.8	135.9	NO SEA TURTLES
Isopleth (feet)	1.8	71.4	446.0	

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
PTS ONSET (Peak isopleth, meters)	4.0	0.7	54.1	4.6	0.5
PTS ONSET (Peak isopleth, feet)	13.1	2.4	177.5	15.2	1.8
PTS ONSET (SEL_{cum} isopleth, meters)	545.8	19.4	650.2	292.1	21.3
PTS ONSET (SEL_{cum} isopleth, feet)	1,790.7	63.7	2,133.1	958.3	69.8
	ALL MM	NO MF CET.	NO HF CET.	Phocids present	Otariids present
Behavior (RMS isopleth, meters)	1,359.4	NO LF CET.			
Behavior (RMS isopleth, feet)	4,459.8				

Figure B3 – NMFS Spreadsheet for 48-inch Steel Pipe pile Impact driven in Water.

VIBRATORY PILE DRIVING REPORT

PRINT IN **LANDSCAPE** TO CAPTURE ENTIRE SCREEN

VERSION 1.2-Multi-Species: 2022

(if OTHER INFO or NOTES get cut-off, please include information elsewhere)

Alameda Main Street Ferry Terminal Refurbishment Project

Adwait Ambaskar - 707-794-0400 ext. 111

PROJECT INFORMATION	RMS
Sound pressure level (dB)	146
Distance associated with sound pressure level (meters)	10
Transmission loss constant	15
Number of piles per day	2
Duration to drive pile (minutes)	45
Duration of sound production in day	5400
Cumulative SEL at measured distance	183

OTHER INFO: 24-inch Steel Pipe PileOn Land.

NOTES: 0

Attenuation: 0

RESULTANT ISOPLETHS

(Range to Effects)

FISHES

	BEHAVIOR
Fishes present	RMS Isopleth
ISOPLETHS (meters)	5.4
ISOPLETHS (feet)	17.8

SEA TURTLES

	PTS ONSET	BEHAVIOR
NO SEA TURTLE	SEL_{cum} Isopleth	RMS Isopleth
ISOPLETHS (meters)	0.0	0.1
ISOPLETHS (feet)	0.1	0.4

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
PTS ONSET (SELcum isopleth, meters)	0.9	0.1	1.3	0.5	0.0
PTS ONSET (SELcum isopleth, feet)	2.9	0.3	4.3	1.8	0.1
	ALL MM	NO MF CET.	NO HF CET.	Phocids present	Otariids present
Behavior (RMS isopleth, meters)	541.2	NO LF CET.			
Behavior (RMS isopleth, feet)	1,775.5				

Figure B4 – NMFS Spreadsheet for 24-inch Steel Pipe pile Vibrated on Land.

VIBRATORY PILE DRIVING REPORT

PRINT IN **LANDSCAPE** TO CAPTURE ENTIRE SCREEN

VERSION 1.2-Multi-Species: 2022

(if OTHER INFO or NOTES get cut-off, please include information elsewhere)

Alameda Main Street Ferry Terminal Refurbishment Project

Adwait Ambaskar - 707-794-0400 ext. 111

PROJECT INFORMATION	RMS
Sound pressure level (dB)	168
Distance associated with sound pressure level (meters)	10
Transmission loss constant	15
Number of piles per day	6
Duration to drive pile (minutes)	45
Duration of sound production in day	16200
Cumulative SEL at measured distance	210

OTHER INFO: 36-inch Steel Pipe Pile In Water.

NOTES: 0

Attenuation: 0

RESULTANT ISOPLETHS

(Range to Effects)

FISHES

	BEHAVIOR
Fishes present	RMS Isopleth
ISOPLETHS (meters)	158.5
ISOPLETHS (feet)	520.0

SEA TURTLES

	PTS ONSET	BEHAVIOR
NO SEA TURTLES	SEL_{cum} Isopleth	RMS Isopleth
ISOPLETHS (meters)	2.2	3.4
ISOPLETHS (feet)	7.2	11.2

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
PTS ONSET (SELcum isopleth, meters)	54.5	4.8	80.6	33.1	2.3
PTS ONSET (SELcum isopleth, feet)	178.9	15.9	264.5	108.7	7.6
	ALL MM	NO MF CET.	NO HF CET.	Phocids present	Otariids present
Behavior (RMS isopleth, meters)	15,848.9	NO LF CET.			
Behavior (RMS isopleth, feet)	51,997.8				

Figure B5 – NMFS Spreadsheet for 36-inch Steel Pipe pile Vibrated in Water.

VIBRATORY PILE DRIVING REPORT

PRINT IN **LANDSCAPE** TO CAPTURE ENTIRE SCREEN

VERSION 1.2-Multi-Species: 2022

(if OTHER INFO or NOTES get cut-off, please include information elsewhere)

Alameda Main Street Ferry Terminal Refurbishment Project

Adwait Ambaskar - 707-794-0400 ext. 111

PROJECT INFORMATION	RMS
Sound pressure level (dB)	168
Distance associated with sound pressure level (meters)	10
Transmission loss constant	15
Number of piles per day	1
Duration to drive pile (minutes)	45
Duration of sound production in day	2700
Cumulative SEL at measured distance	202

OTHER INFO: 48-inch Steel Pipe Pile In Water.

NOTES: 0

Attenuation: 0

RESULTANT ISOPLETHS

(Range to Effects)

FISHES

	BEHAVIOR
Fishes present	RMS Isopleth
ISOPLETHS (meters)	158.5
ISOPLETHS (feet)	520.0

SEA TURTLES

	PTS ONSET	BEHAVIOR
NO SEA TURTLES	SEL_{cum} Isopleth	RMS Isopleth
ISOPLETHS (meters)	0.7	3.4
ISOPLETHS (feet)	2.2	11.2

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
PTS ONSET (SELcum isopleth, meters)	16.5	1.5	24.4	10.0	0.7
PTS ONSET (SELcum isopleth, feet)	54.2	4.8	80.1	32.9	2.3
	ALL MM	NO MF CET.	NO HF CET.	Phocids present	Otariids present
Behavior (RMS isopleth, meters)	15,848.9	NO LF CET.			
Behavior (RMS isopleth, feet)	51,997.8				

Figure B6 – NMFS Spreadsheet for 48-inch Steel Pipe pile Vibrated in Water.