Request for Incidental Harassment Authorization

Chevron Richmond Refinery Long Wharf Maintenance and Efficiency Project

Chevron Richmond Refinery – Capital Projects

Prepared by

AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612-1924

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Acronyms

μPa	microPascal
Caltrans	California Department of Transportation
CBC	California Building Code
CFR	Code of Federal Regulations
CSLC	California State Lands Commission
dB	decibel(s)
EFH	Essential Fish Habitat
FHWG	Fisheries Hydroacoustic Working Group
FMP	Fisheries Management Plan
ft	feet
HAPC	Habitat Areas of Particular Concern
Hz	hertz
IHA	Incidental Harassment Authorization
lbs	pounds
L_{eq}	unweighted average noise level
L_{max}	unweighted maximum noise level
LOA	Letter of Authorization
MMPA	Marine Mammal Protection Act
MOTEMS	Marine Oil Terminal Engineering and Maintenance Standards
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RMS	root square mean
RSRB	Richmond-San Rafael Bridge
SPL_{peak}	instantaneous peak sound pressure level
WMEP	Wharf Maintenance and Efficiency Project

1 Detailed Description of the Activity

1.1 Project History

The Chevron Products Company's Richmond Refinery Long Wharf (Long Wharf or Wharf) is the largest marine oil terminal in California. Between 2008 and 2010, volume transfers averaged 145 million barrels per year with an average of 720 vessel calls per year. The Long Wharf has six berths for receiving raw materials and shipping final products. Its operations are regulated primarily by the California State Lands Commission (CSLC) through a State Lands lease, Article 5 of CSLC regulations, and Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS; California Building Code (CBC) Chapter 31F).

The Long Wharf has existed in its current location since early 1900s (Figure 1-1). The Berth 2 fender system (timber pile and whaler) was designed and installed in 1940. Marine loading arms, gangways, and fender systems at Berths 1, 3 and 4 were installed in 1972. The marine loading arms were recently replaced between 2016 and 2018. The Berth 4 fender panels were replaced in 2011 and the Berth 1 fender panels were replaced in 2012. The existing configuration of these systems have limitations to accepting more modern, fuel efficient vessels with shorter parallel mid-body hulls and in some cases do not meet current MOTEMS requirements.

1.2 Project Location

The Long Wharf is located in central San Francisco Bay (the Bay) just south of the eastern terminus of the Richmond-San Rafael Bridge in Contra Costa County. Figure 1-1 illustrates the Project vicinity and specific location.

1.3 Project Purpose

The purpose of the proposed Long Wharf Maintenance and Efficiency Project (LWMEP or Project) is to comply with current MOTEMS requirements and to improve safety and efficiency at the Long Wharf. To meet MOTEMS requirements, the fendering system at Berth 2 is being upgraded and the Berth 4 loading platform will undergo seismic retrofit to stiffen the structure and reduce movement of the Wharf in the event of a level 1 or 2 earthquake. Safety will be improved by replacing gangways and adding fire monitors. Efficiency at the Wharf will be improved by updating fender system configuration at Berth 4 to accommodate newer, more fuel efficient vessels and thus reduce idling time for vessels waiting to berth. Further, efficiency will be improved by updating the fender system at Berth 1 to accommodate barges, enabling balanced utilization across Berths 1, 2, and 3. While construction of the Project will take multiple years to complete, only a portion of the activities described below will occur during the 2019 construction season, as discussed in Section 2.

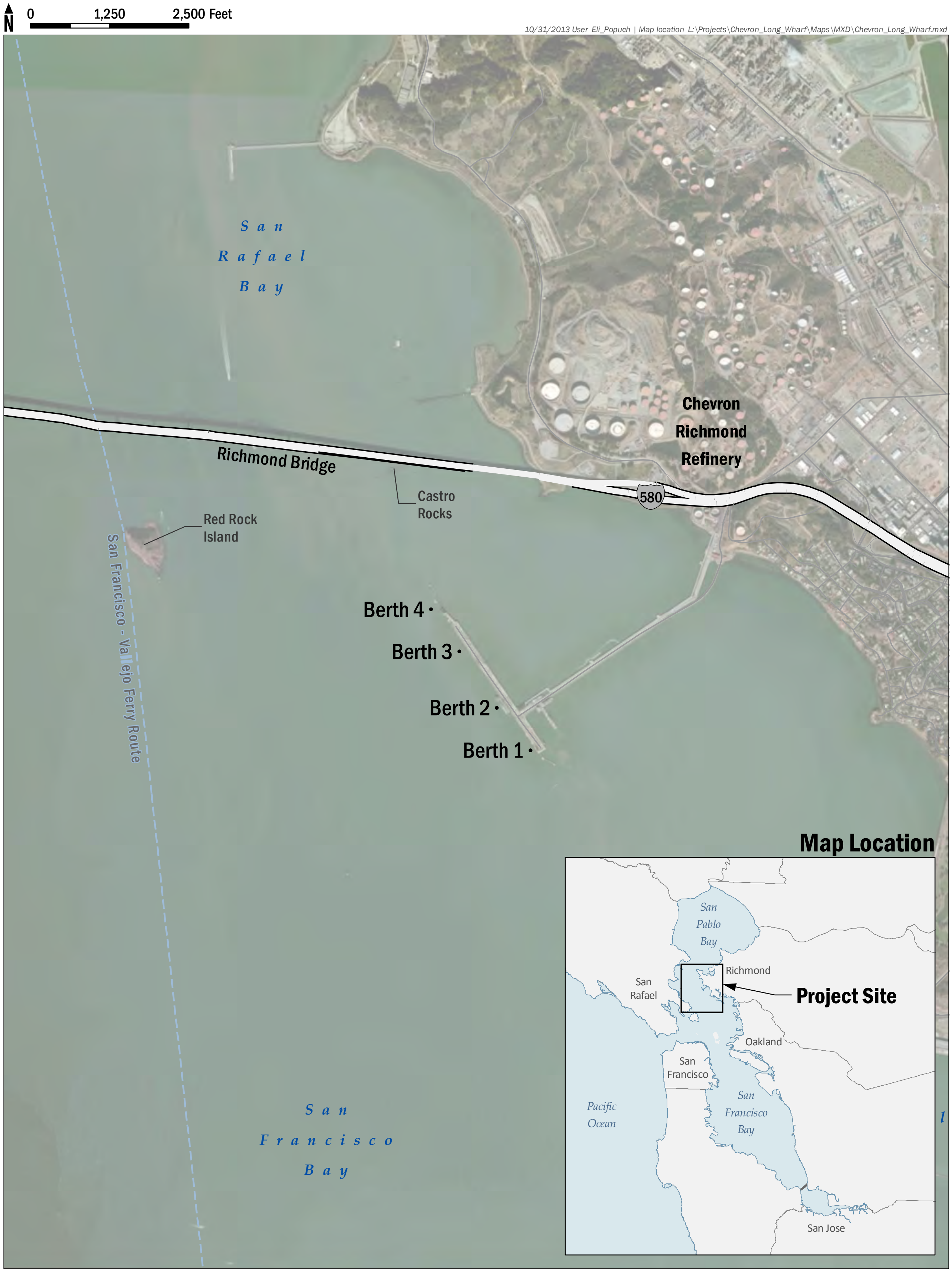

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FIGURE 1-1
Chevron Long Wharf - Project Location

Actions being taken for MOTEMS compliance purposes include:

- Berth 2 fender replacement
- Berth 4 loading platform seismic retrofit

Actions being taken to improve safety include:

- Berth 2 permanent gangway and fire monitor
- Berth 3 permanent gangway and fire monitor
- Berth 4 fender intermediate fender points

Actions being taken for operational efficiency include:

- Berth 1 gangway to accommodate barges
- Berth 1 mooring hook dolphin and fender additions to accommodate barges

The Project would not result in an increase or expansion of the operational capacity of the Long Wharf and would not result in an increase in vessel calls to the Wharf.

1.4 Description of Proposed Project

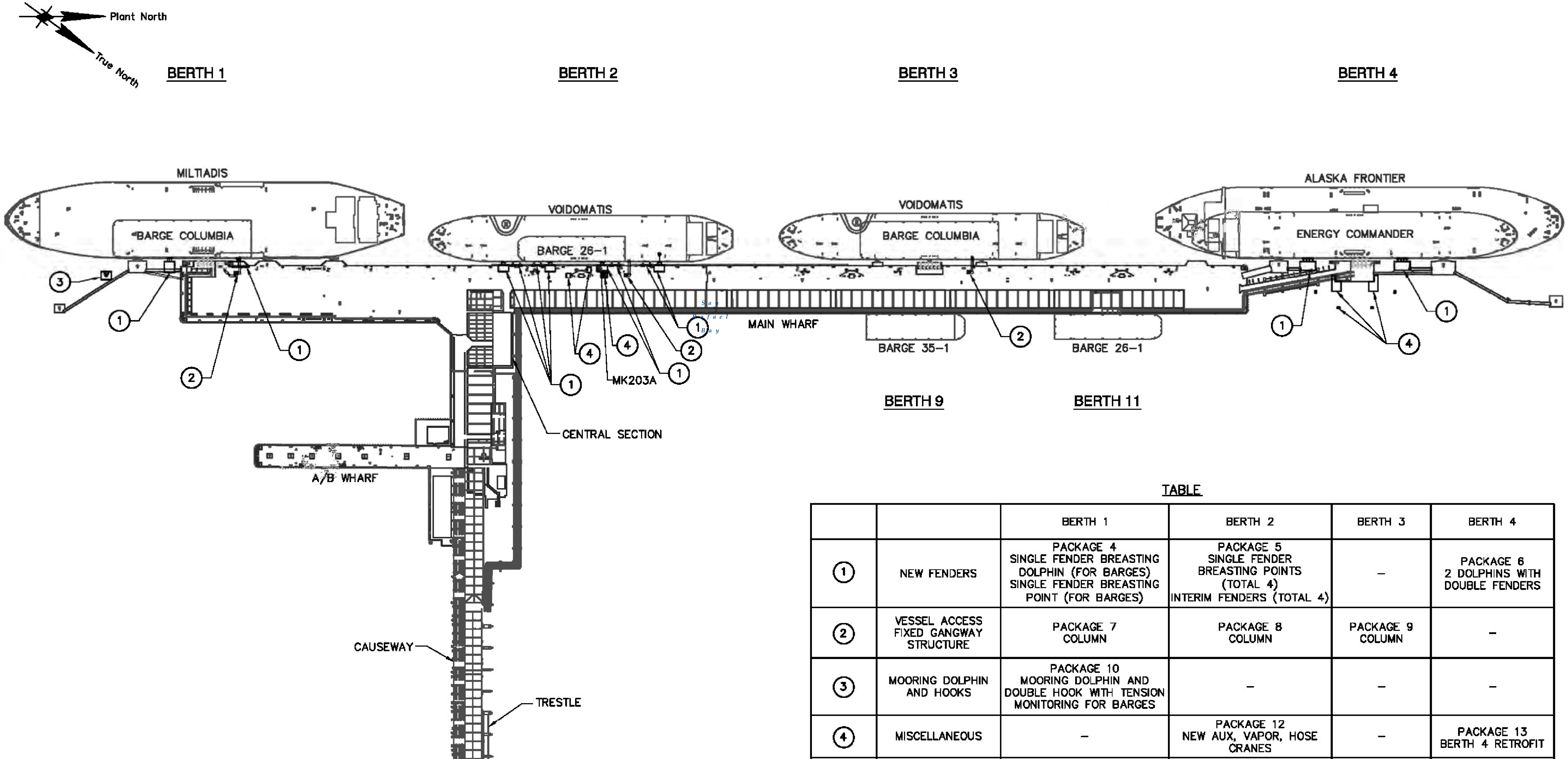
The Project would involve modifications at Berths 1, 2, 3, and 4 as shown on Figure 1-1. Proposed modifications include replacing gangways and cranes, adding new mooring hooks and standoff fenders, adding new dolphins and catwalks, and modifying the fire water system at one or more of the four Berths, as well as the seismic retrofit to the Berth 4 loading platform. The type and numbers of piles to be installed, as well as those that will be removed, are summarized in Table 1-1 and an overview of the modifications at Berths 1 to 4 are shown in Figure 1-2.

The combined modifications to Berths 1 to 4 would require the installation of 141 new concrete piles to support new and replacement equipment and their associated structures. The Berth 4 loading platform would also add eight, 60-inch diameter steel piles as part of the seismic retrofit. The Project would also add four clusters of 13 composite barrier piles (concrete encased in plastic) each (52 total) as markers and protection of the new batter (driven at an angle) piles on the east side of the Berth 4 retrofit. The Project would remove 106 existing timber piles, two existing 18-inch and two existing 24-inch concrete piles. Also, a total of 16 temporary piles (8 – 20” diameter and 8 – 36” diameter steel pipe piles) would also be installed and removed during the seismic retrofit of Berth 4.

Completion of the modifications will require cutting holes in the concrete decking of the Wharf to allow piles to be driven. The removal of structures and portion of concrete decking may

Table 1-1: Pile Summary for Overall Project

Item		Description	Structure Area (ft^2)	No. Piles	Pile Fill Area (ft^2)	Pile Installation / Removal Method	Pile Volume Below Water (ft^3)
New Installation	1	Berth 1 Mooring Hook Dolphin	480	13	52	Impact	2,244
	2	Berth 1 Outer Breasting Dolphin	692	17	68	Impact	2,832
	3	Berth 1 Inner Breasting Point	489	8	32	Impact	1,280
	4	Berth 1 Gangway	0	4	16	Impact	640
	5	Berth 1 Walkways	438	0	-	-	-
	6	Berth 2 South Outside Fender	92	10	40	Impact	1,192
	7	Berth 2 South Inside Fender	92	10	40	Impact	1,192
	8	Berth 2 North Inside Fender	92	9	36	Impact	1,132
	9	Berth 2 North Outside Fender	92	10	40	Impact	1,192
	10	Berth 2 Main Hose Crane	0	4	16	Impact	262
	11	Berth 2 Aux Crane	0	4	16	Impact	440
	12	Berth 2 Vapor Recovery Hose Crane	0	0	0	-	-
	13	Berth 2 Gangway	0	4	16	Impact	276
	14	Berth 3 Gangway	0	4	16	Impact	525
	15	Berth 4 South Breasting Dolphin	904	22	88	Impact	4,774
	16	Berth 4 North Breasting Dolphin	904	22	88	Impact	4,691
	17	Berth 4 Walkways	340	0	-	-	-
		Total 24-inch Square Concrete Piles	**4,614**	**141**	**564**		**22,672**
	18	Berth 4 Loading Platform Retrofit (60-inch-diameter Steel Piles)	1070	8	157	Impact	2,483
	19	Berth 4 Barrier Piles (4 Clusters of 13 Composite Barrier Piles)	56	52	56	Vibrate	840
		Total Additional Fill	**5,740**	**201**	**777**		**25,996**
Permanent Removal	20	Berth 1 Pile Removal	-	-2	-4.5	Vibrate	-185
	21	Berth 2 Pile Removal (106 Wooden - Actual Count)	-	-106	-148	Vibrate	-5,299
	22	Berth 2 Whaler Removal (excluding wooden Piles)	-509.02	-	-	-	-
	23	Berth 2 Brace Piles (22-inch Square Concrete Jacketed Timber Piles)	-	-3	-10.1	Cut	-315
	24	Berth 4 Concrete Pile Removal	-	-2	-8	Cut	-127
	25	Berth 1 Existing Walkway	-400	-	-	-	-
		Total Removal	**-909**	**-113**	**-171**		**-5,926**
		Net Change	**4,831**	**88**	**606**	**-**	**20,070**
Temporary Fill	26	Berth 1 Pile Removal	13	36	13	Vibrate	466
	27	Berth 2 Pile Removal (106 Wooden - Actual Count)	448	-	-	-	-
	28	Berth 2 Whaler Removal (excluding wooden Piles)	192	12	38	Vibrate	565
	29	Berth 4 Loading Platform piles for driving template	-	16	74	Vibrate	1,109
		Total Temporary Fill	**653**				



TABLE

		BERTH 1	BERTH 2	BERTH 3	BERTH 4
1	NEW FENDERS	PACKAGE 4 SINGLE FENDER BREASTING DOLPHIN (FOR BARGES) SINGLE FENDER BREASTING POINT (FOR BARGES)	PACKAGE 5 SINGLE FENDER BREASTING POINTS (TOTAL 4) INTERIM FENDERS (TOTAL 4)	–	PACKAGE 6 2 DOLPHINS WITH DOUBLE FENDERS
2	VESSEL ACCESS FIXED GANGWAY STRUCTURE	PACKAGE 7 COLUMN	PACKAGE 8 COLUMN	PACKAGE 9 COLUMN	–
3	MOORING DOLPHIN AND HOOKS	PACKAGE 10 MOORING DOLPHIN AND DOUBLE HOOK WITH TENSION MONITORING FOR BARGES	–	–	–
4	MISCELLANEOUS	–	PACKAGE 12 NEW AUX, VAPOR, HOSE CRANES	–	PACKAGE 13 BERTH 4 RETROFIT
5	ELECTRICAL		PACKAGE 14 ELECTRICAL		
6	PIPING/FIREWATER	PACKAGE 15			

NOTE: PACKAGES 1, 2, 3, AND 11 DELETED FROM PROJECT SCOPE

FIGURE 1-2

Overview of WMEP Project Features

Source: Moffat & Nichol Engineers, 2015

involve the use of jack hammers to break up concrete, torches to cut metal, and various cutting and grinding power tools. This work will occur at various times throughout the construction schedule. When there is potential for construction debris to fall into the water below the Wharf, temporary work platforms will be used to capture debris. A typical debris catchment system that has been previously used at the Wharf consists of a platform suspended beneath the deck or in some cases a smaller platform immediately below the work area, and a second larger platform beneath that. Debris that falls on the platform is collected and disposed of in an appropriate manner.

The modifications at each berth are summarized below.

Berth 1 Modifications

Modifications at Berth 1 include the following:

- Replace gangway to accommodate barges and add a new raised fire monitor.
- Construct a new 24’ x 20’ mooring dolphin and hook to accommodate barges.
- Construct a new 24’ x 25’ breasting dolphin and 13’ x 26’ breasting point with standoff fenders to accommodate barges. The new breasting dolphin will require removal of an existing catwalk and two (2) piles and replacing with a new catwalk at a slightly different location, and adding a short catwalk to provide access to the breasting dolphin.
- A portion of the existing gangway will be removed. The remaining portion is used for other existing services located on its structure.

Much of this work will be above the water or on the Wharf deck . The mooring dolphin and hook, breasting dolphin, and new gangway will require installation of 42 new 24-inch square concrete piles using impact driving methods. The number of piles that will be installed at Berth 1 are summarized in Table 1-1 and features are shown on Figure 1-3.

Berth 2 Modifications

Modifications at Berth 2 include the following:

- Install new gangway to replace portable gangway and add a new elevated fire monitor.
- Replace one bollard with a new hook.
- Install four(4) new standoff fenders (to replace timber fender pile system).
- Replace existing auxiliary and hose cranes and vapor recovery crane to accommodate the new standoff fenders.
- Remove the existing timber fender pile system along the length of the Berth (~650’)
- Three (3) existing Brace Piles (22 inch Square Concrete Jacketed Timber Piles) would be removed by cutting below the mud line if possible.

These modifications will require the installation of 51 new 24-inch square concrete piles, using impact driving methods, to support the gangway, standoff fenders, hose crane, and auxiliary crane. To keep Berth 2 operational during construction, four temporary fenders will be installed, supported by 36 temporary 14-inch H-piles driven using vibratory methods. It is expected that the H-piles would largely sink under their own weight and would require very little driving. The H-piles and temporary fenders will be removed once the permanent standoff fenders are complete. The auxiliary and hose cranes are being replaced with cranes with longer reach to accommodate the additional distance of the new standoff fenders. The new vapor recovery crane would be mounted on an existing pedestal and not require in-water work.

The number of piles that will be installed at Berth 2 are summarized in Table 1-1 and modifications are shown on Figure 1-4.

Berth 3 Modifications

Modifications at Berth 3 include the following:

- Install new fixed gangway to replace portable gangway and add a new raised fire monitor.

The gangway would be supported by four, 24-inch square concrete piles. This would be the only in-water work for modifications at Berth 3. The number of piles that will be installed at Berth 3 are summarized by location in Table 1-1 and features are shown on Figure 1-5.

Berth 4 Modifications

Modifications at Berth 4 include the following:

- Install two (2) new 36’ x 20’ dolphins with two (2) standoff fenders per dolphin and two (2) catwalks.
- Seismically retrofit the Berth 4 loading platform including bolstering and relocation of piping and electrical facilities.

The new fenders would add 44 new 24 inch square concrete piles.

The seismic retrofit would structurally stiffen the Berth 4 Loading Platform under seismic loads. This will require cutting holes in the concrete decking and driving eight (8), 60-inch diameter hollow steel batter (angled) piles, using impact pile driving. To accommodate the new retrofit, an existing sump will be replaced with a new sump and two(2), 24-inch square concrete piles will be removed or cut to the “mudline”. To drive the 60-inch steel pipe batter piles, 16 temporary steel piles, including eight (8) 36-inch diameter and eight (8) 20-inch diameter, will be needed to support a guide template for the permanent 60-inch steel piles. Two (2) templates are required and would be supported by the temporary piles. The templates will be above water.

The Project would also add four (4) clusters of 13 composite barrier piles each (52 total composite piles) as markers and protection of the new batter piles on the east side of the retrofit. The number of piles that will installed at Berth 4 are summarized in Table 1-1 and features are shown on Figure 1-6.

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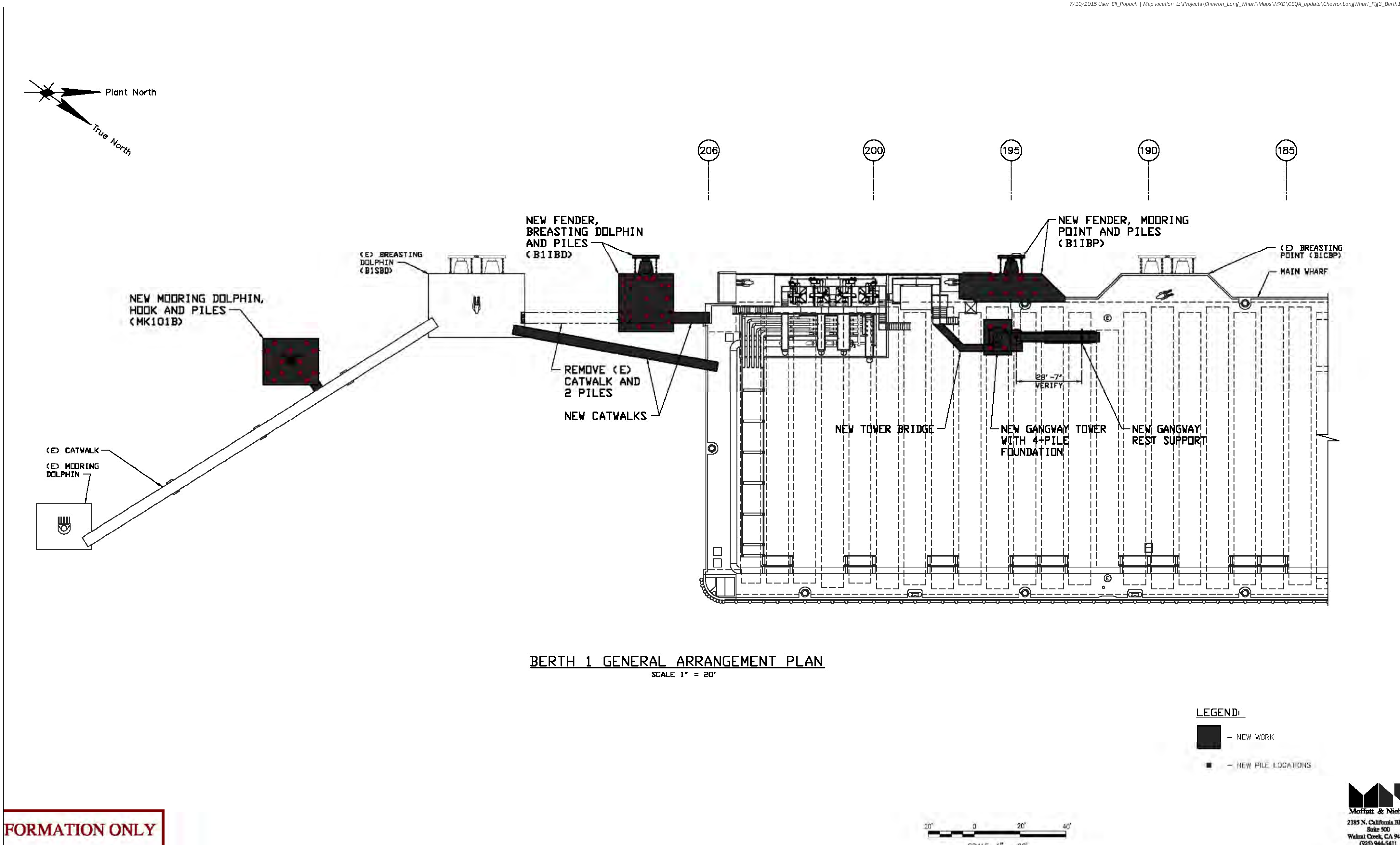

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FIGURE 1-3

Berth 1 Features

Source: Moffat & Nichol Engineers, 2015

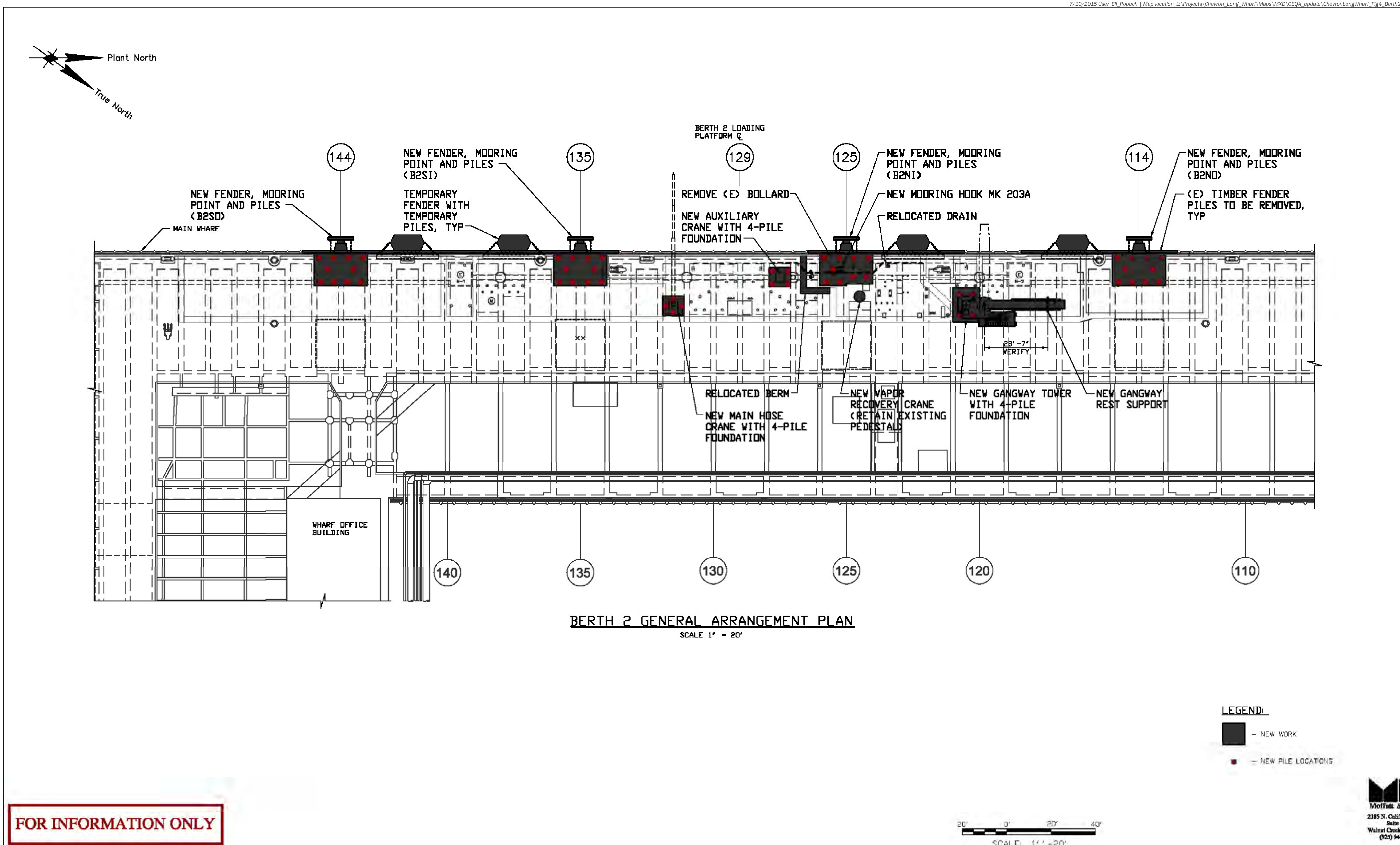

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FIGURE 1-4
Berth 2 Features
Source: Moffat & Nichol Engineers, 2015

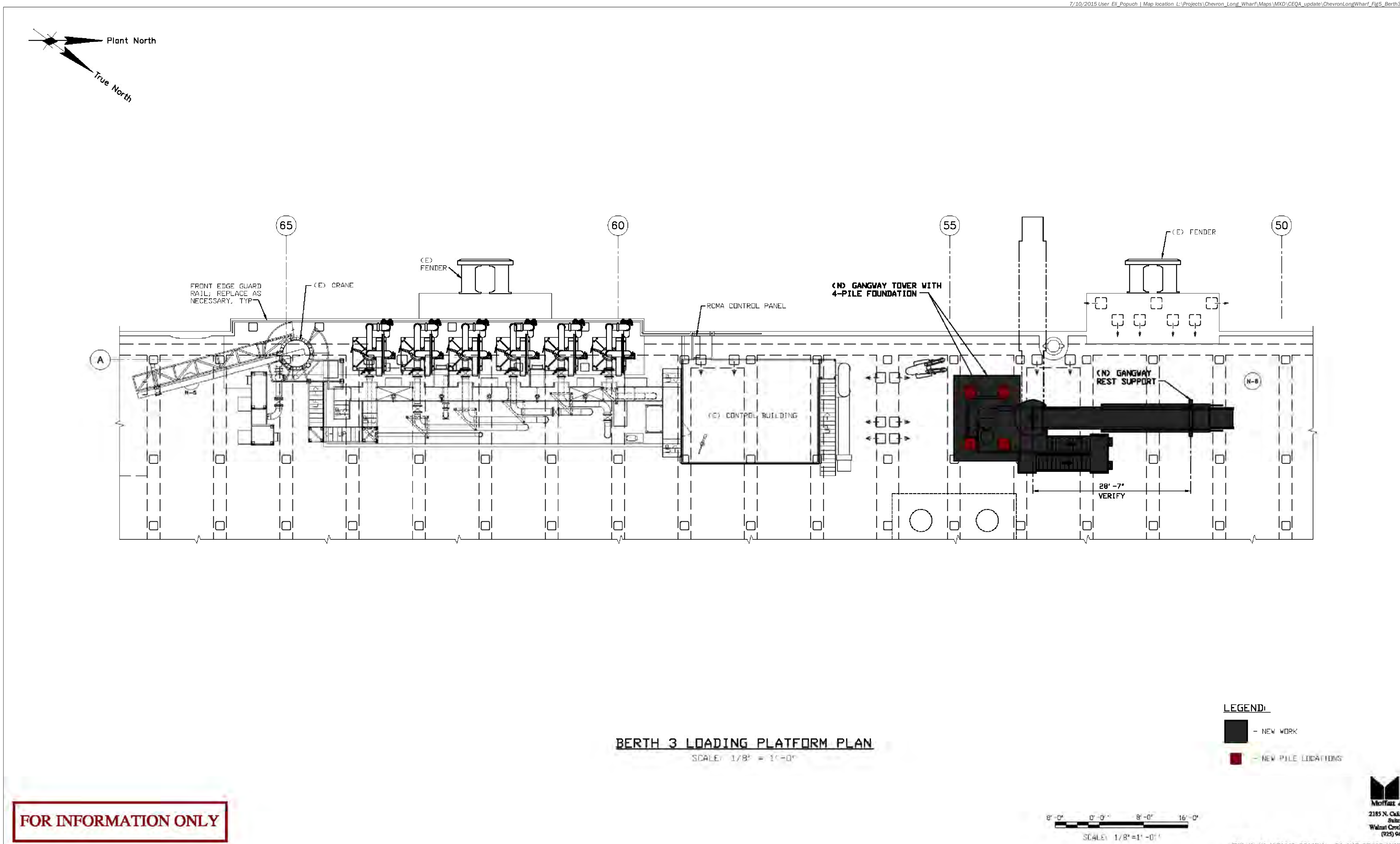

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FIGURE 1-5

Berth 3 Features

Source: Moffat & Nichol Engineers, 2015

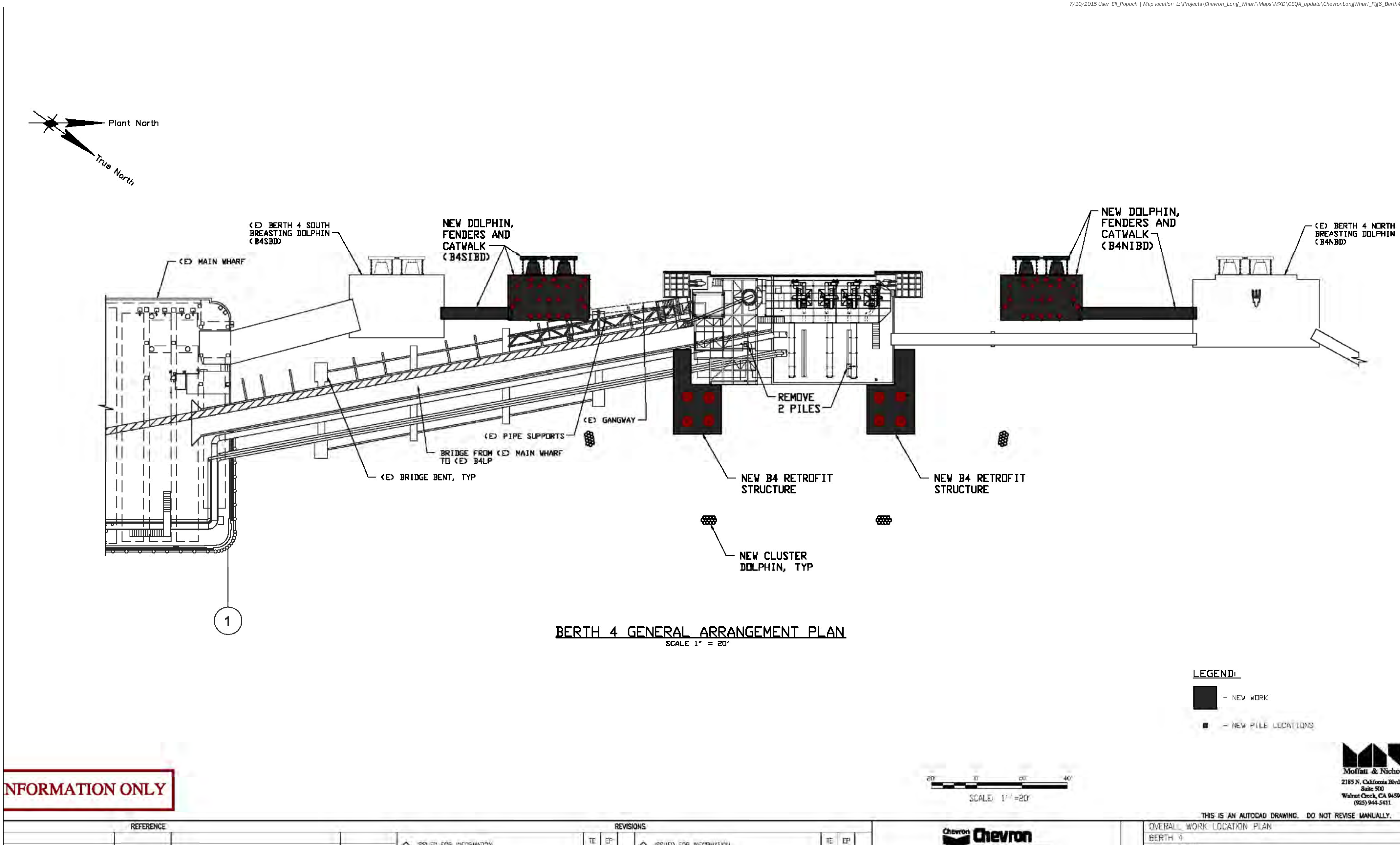

FIGURE 1-6

Berth 4 Features

Source: Moffat & Nichol Engineers, 2015

2 Dates, Duration, and Region of Activity

2.1 Dates and Duration of Construction

Construction would be scheduled such that the Long Wharf is able to remain operational during construction. The general construction sequence is as follows:

- Berth 2 Crane Reconstruction
- Berth 4 Seismic Work
- Berth 2 Fender Construction
- Berth 1 Dolphin and Mooring Hook Construction
- Berth 1 Inner Breasting Dolphin Construction
- Berth 4 Inner Fender Construction
- Berth 1 Gangway Tower installation
- Berth 2 Gangway Tower installation
- Berth 3 Gangway Tower installation
- Berth 4 Breasting Fender Dolphin Construction

There would be periods when more than one of the above Project features would be under construction at the same time. This is necessary to accommodate the Project schedule and to ensure minimal disruption to Wharf operations. Pile driving activities would be timed to occur within the standard NMFS work windows for listed fish species (June 1 through November 30). While this application presents a description of the complete Project, it will take several years to construct. Therefore, this application is only requesting take for the pile driving that will occur during the 2019 work season, as provided in Table 2-1. It should be noted that some of the piles listed in Table 2-1 were scheduled for installation in 2018 and were part of the 2018 IHA request. After construction began, it was discovered that the water depth in the area where piles must be installed for the Berth 4 seismic retrofit is too shallow due to unexpected heavy sedimentation. As a result, Chevron will need to dredge the area before installing the piles. Because of this, the 36-inch steel template piles and the concrete pile removal that were part of the previous request were not completed in 2018. Note that the current temporary pile design is different from that contained in the 2018 IHA request (for 12 36-inch temporary steel pipe piles) and will include eight (8) 20-inch and eight (8) 36-inch steel template piles that will be driven in 2019 after the dredging is complete.

Table 2-1: Pile Driving Summary for 2019 Work Season

Pile Type	Pile Driver Type	Number of Piles	Number of Driving Days
60-inch steel pipe piles	Impact	8	8
36-inch steel template pile (Installation and removal)	Vibratory/Impact Proofing	8	4
20-inch steel template pile (Installation and removal)	Vibratory	8	4
22-inch concrete pile removal	Vibratory	5	1
24-inch square concrete	Impact	39	30
12-inch composite barrier piles	Vibratory	52	11
Timber pile removal	Vibratory	106	9

2.2 Project Location

As described in Section 1, the Long Wharf is located in San Francisco Bay at Richmond, California (Figure 1-1).

3 Species and Numbers of Marine Mammals

Although at least 35 species of marine mammals can be found off the coast of California, very few species venture into San Francisco Bay, and only Pacific harbor seals, California sea lions, and possibly harbor porpoises make the Bay a permanent home. Small numbers of humpback and gray whales are regularly sighted in the Bay during their yearly migration, though most sightings tend to occur in the Central Bay near the Golden Gate. Four other species which may occasionally occur within San Francisco Bay are considered in this application: Northern elephant seal, Northern fur seal, Steller sea lion and bottlenose dolphin.

3.1 Pacific Harbor Seal

The Pacific harbor seal is one of five subspecies of *Phoca vitulina*, or the common harbor seal. They are a true seal, with a rounded head and visible ear canal, distinct from the eared seals, or sea lions, which have a pointed head and an external ear. Males and females are similar in size and can exceed 2 meters (6 feet) and 136 kilograms (300 pounds). Harbor seals generally do not migrate annually. They display year-round site fidelity, though they have been known to swim several hundred kilometers to find food or suitable breeding habitat. The number of harbor seals in the San Francisco Bay increases in the winter foraging period compared to the spring breeding season. This pattern differs from remote coastal sites nearby where the higher abundance of seals occurs in the breeding season (Codde and Allen 2013).

The harbor seal diet generally consists of fish, though they also consume shrimp and shellfish. In San Francisco Bay, harbor seals forage in shallow, intertidal waters on a variety of fish, crustaceans, and a few cephalopods (e.g., octopus). The most numerous prey items identified in harbor seal fecal samples from haul-out sites in the 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).

Although generally solitary in the water, harbor seals come ashore at “haul-outs” — shoreline areas where pinnipeds congregate to rest, socialize, breed, and molt — that are used for resting, thermoregulation, birthing, and nursing pups. Haul-out sites 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 (Green et al. 2006). The nearest haul-out site to the Project is Castro Rocks, approximately 650 meters (0.4 mile) north of the northernmost point on the Long Wharf.

The haul-out sites at Mowry Slough, in the south Bay, Corte Madera Marsh and Castro Rocks, in the north Bay, and Yerba Buena Island, in the central Bay, support the largest concentrations of harbor seals within the San Francisco Bay. Caltrans conducted marine mammal surveys before and during seismic retrofit work on the Richmond–San Rafael Bridge (RSRB) in northern San Francisco Bay. The surveys included extensive monitoring of marine mammals at points throughout the Bay. Although the study focused on harbor seals hauled out at Castro Rocks and Red Rock Island near the RSRB, all other observed marine mammals were recorded. Monitoring took place from May 1998 to February 2002 (Green et al. 2002.) and determined that at least 500 harbor seals populate San Francisco Bay. This estimate agrees with previous seal counts in San Francisco Bay, which ranged from 524 to 641 seals from 1987 to 1999, and 558 to 621 in 2002 and 2004 (Goals Project 2000, Lowry et al. 2008).

Although births of harbor seals have not been observed at Corte Madera Marsh and Yerba Buena Island, a few pups have been seen at these sites. The main pupping areas in the San Francisco Bay are at Mowry Slough and Castro Rocks (Caltrans 2012). Seals haul out year-round on Castro Rocks during medium to low tides; few alternative low tide sites are available within San Francisco Bay. The seals at Castro Rocks are habituated to a degree to some sources of human disturbance such as large tanker traffic and the noise from vehicle traffic on the bridge, but often flush into the water when small boats maneuver close by or when people work on the bridge (Kopec and Harvey 1995). Long-term monitoring studies have been conducted at the largest harbor seal colonies in Point Reyes National Seashore and Golden Gate National Recreation Area since 1976. Castro Rocks and other haul-outs in San Francisco bay are part of the regional survey area for this study and have been included in annual survey efforts. Between 2007 and 2012, the average number of adults observed ranged from 126 to 166 during the breeding season (March through May) and from 92 to 129 during the molting season (June through July) (Truchinski et al. 2008, Flynn et al. 2009, Codde et. al 2010, Codde et. al 2011, Codde et. al. 2012, Codde and Allen 2013).

Because of the close proximity of the active haul-out site, it is likely that harbor seals would be incidentally harassed during construction. During the pile driving that occurred in the 2018 construction season, 25 harbor seals were observed by marine mammal observers in proximity to the Long Wharf (AECOM 2018).

3.2 California Sea Lion

The California sea lion (*Zalophus californianus*) belongs to the family Otariidae or “eared seals,” referring to the external ear flaps not shared by other pinniped families. California sea lions are sexually dimorphic: males can reach up to 2.4 meters (8 feet) long and weigh 320 kilograms (700 pounds), whereas females are smaller, at approximately 2 meters (6 feet) long and 90 kilograms (200 pounds). Sexual maturity occurs within 4 to 5 years. While California sea lions forage and conduct many activities within the water, they also use haul-outs. California sea lions breed in

Southern California and along the Channel Islands during the spring. They are extremely intelligent and social. 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 (NOAA 2012a).

In the Bay, sea lions haul out primarily on floating docks at Pier 39 in the Fisherman's Wharf area of the San Francisco Marina, approximately 12.5 (7.8 miles) kilometers southwest. This species utilized the Bay in greater numbers during El Niño conditions. Based on counts done in 1997 and 1998, the number of California sea lions that haul out at Pier 39 fluctuates with the highest occurrences in August and the lowest in June. Of the California sea lions observed, approximately 85% were males. An estimated 1,105 animals were observed in September 2001 at Pier 39 (Parsons Brinckerhoff 2001), and winter numbers are generally over 500 animals (Goals Project 2000). The California sea lions usually arrive at 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 the Bay. They are seen swimming off mainly the San Francisco and Marin shorelines within the Bay but may occasionally enter the Project area to forage. Over the monitoring period for the RSRB, monitors sighted at least 90 California sea lions in the North Bay and at least 57 in the Central Bay. No pupping activity has been observed at this site or at other locations within the San Francisco Bay (Caltrans 2012).

Although there is little information regarding the foraging behavior of the California sea lion in the San Francisco Bay, they have been observed foraging on a regular basis in the shipping channel south of Yerba Buena Island. The California sea lions that use the Pier 39 haul-out site may be feeding on Pacific herring (*Clupea harengus*), northern anchovy, and other prey within the waters of the Bay (Caltrans 2013). A relatively deep shipping channel is present to the west and north of the Long Wharf, which may provide foraging areas for California sea lions.

Because California sea lions forage over a wide range in San Francisco Bay, it is likely that some individuals would be incidentally harassed during construction.

3.3 Steller Sea Lion

Steller sea lions (*Eumetopias jubatus*) have been reported at Año Nuevo Island between Santa Cruz and Half Moon Bay and at the Farallon Islands about 48 kilometers (30 miles) off the coast of San Francisco (Fuller 2012). Two studies of Steller sea lion distribution did not detect individuals in San Francisco Bay. The SF Bay Subtidal Habitat Goals Report, Appendix 2-1 contains one reference to Steller sea lions in the San Francisco Bay, stating that since 1989, several hundred California Sea Lions have congregated in the winter on docks at Pier 39, which are on rare occasions joined by a few Steller sea lions (Cohen 2010). This species is a rare visitor to San Francisco Bay and is not expected to occur in the Project area during construction. As a result, this species is not considered further.

3.4 Northern Elephant Seal

Northern elephant seals (*Mirounga angustirostris*) are common on California coastal mainland and island sites where they pup, breed, rest, and molt. The largest rookeries are on San Nicolas and San Miguel islands in the Northern Channel Islands. In the vicinity of San Francisco Bay, elephant seals breed, molt, and haul out at Año Nuevo Island, the Farallon Islands, and Point Reyes National Seashore (Lowry et al., 2014). Adults reside in offshore pelagic waters when not breeding or molting. Northern elephant seals haul out to give birth and breed from December through March, and pups remain onshore or in adjacent shallow water through May, when they may occasionally make brief stops in San Francisco Bay (Caltrans, 2015b). When pups of the year return in the late summer and fall to haul out at rookery sites, they may also occasionally make brief stops in San Francisco Bay. Incidental take of this species is being requested in the rare event a few individuals are present in San Francisco Bay during pile driving.

3.5 Northern Fur Seal

The range of the northern fur seal (*Callorhinus ursinus*) extends from southern California, north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (NMFS, 2015e). During the breeding season, the majority of the worldwide population is found on the Pribilof Islands in the southern Bering Sea, with the remaining animals spread throughout the North Pacific Ocean. On the coast of California, small breeding colonies are present at San Miguel Island off southern California, and the Farallon Islands off central California (NMFS, 2015e). Northern fur seal are a pelagic species and are rarely seen near the shore away from breeding areas. Juveniles of this species occasionally strand in San Francisco Bay, particularly during El Niño events (TMMC, 2016). Incidental take of this species is being requested in the rare event a few individuals are present in San Francisco Bay during pile driving.

3.6 Harbor Porpoise

The harbor porpoise (*Phocoena phocoena*) is a member of the Phocoenidae family. They generally occur in groups of two to five individuals, and are considered to be shy, relatively nonsocial animals. The harbor porpoise has a small body, with a short beak and medium-sized dorsal fin. They can grow to approximately 1.5 meters (5 feet) and 80 kilograms (176 pounds). Females are slightly larger than the males, and reach sexually maturity at 3 to 4 years. They are typically found in waters less than 75 meters (246 feet) deep within coastal waters, bays, estuaries, and harbors. Their prey base consists of demersal and benthic species, such as schooling fish and cephalopods (NOAA 2012b).

In prior years, harbor porpoises were observed primarily outside of San Francisco Bay. The few harbor porpoises that entered did not venture far into Bay. No harbor porpoises were observed during marine mammal monitoring conducted before and during seismic retrofit work on the RSRB, which is located just north of the Long Wharf (Figure 1-1). However, in recent years there have been increasingly common observations of harbor porpoises within San Francisco Bay. According to observations by the Golden Gate Cetacean Research Team, as part of their multi-year assessment, approximately 225 harbor porpoises have been observed in the San Francisco Bay (Caltrans 2012). During six (6) days of marine mammal monitoring in 2017 for the San Francisco – Oakland Bay Bridge dismantling (monitoring was conducted for an average of 2 hours and 45 minutes per day), a total of 32 harbor porpoises were observed (Caltrans 2018). In San Francisco Bay, Harbor Porpoises are generally concentrated in the vicinity of the Golden Gate (approximately 12 kilometers [7.5 miles] south west of the Project site) and Angel Island (6 kilometers [3.7 miles] south west of the Project site), with lesser numbers sighted in the vicinity of Alcatraz and around Treasure Island (Keener 2011). Because this species is more frequently venturing into the Bay east of Angel Island, there is a chance that a small number of individuals could be incidentally harassed.

3.7 Bottlenose Dolphins

The range of the bottlenose dolphin (*Tursiops truncatus truncatus*) has expanded northward along the Pacific Coast since the 1982-1983 El Niño (Carretta et al. 2013, Wells and Baldridge 1990). They now occur as far north as the San Francisco Bay region and have been observed along the coast in Half Moon Bay, San Mateo, Ocean Beach in San Francisco, and Rodeo Beach in Marin County. Observations indicate that bottlenose dolphin occasionally enter San Francisco Bay, sometimes foraging for fish in Fort Point Cove, just east of the Golden Gate Bridge (Golden Gate Cetacean Research 2014). Transient individuals of this species occasionally enter San Francisco Bay, observations indicate that they remain in proximity to the Golden Gate near the mouth of the Bay and would not be within the Project area during construction. .

3.8 Whales

3.8.1 Gray Whale

Gray whales (*Eschrichtius robustus*) are large baleen whales. They grow to approximately 15 meters (49 feet) in length and weigh up to 36 metric tons (40 short tons). They are one of the most frequently seen whales along the California Coast, easily recognized by their mottled gray color and lack of dorsal fin. Adult whales carry heavy loads of attached barnacles, which add to the mottled appearance. Gray whales are the only baleen whales known to feed on the sea floor, where they scoop up bottom sediments to filter out benthic crustaceans, mollusks, and worms (NOAA 2012c). They feed in northern waters primarily off the Bering, Chukchi, and western

Beaufort seas during the summer, before heading south to the breeding and calving grounds off Mexico over the winter. Between December and January, late-stage pregnant females, adult males, and immature females and males will migrate southward. The northward migration occurs between February and March. During this time, recently pregnant females, adult males, immature females, and females with calves move north to the feeding grounds (NOAA 2003). A few individuals will enter into the San Francisco Bay during their northward migration.

RSRB project monitors recorded 12 living and two (2) dead gray whales, all in either the Central or North Bay, and all but two sightings occurred during the months of April and May (Winning 2008). One gray whale was sighted in June and one in October (the specific years were unreported). The Oceanic Society has tracked gray whale sightings since they began returning to the Bay regularly in the late 1990s. The Oceanic Society data show that all age classes of gray whales are entering the Bay and that they enter as singles or in groups of up to five individuals. However, the data do not distinguish between sightings of gray whales and number of individual whales (Winning 2008). It is likely that two to six gray whales enter the Bay in any given year, typically from March to May, outside of the June to November window when pile driving would occur.

3.8.2 Humpback Whale

Humpback whales (*Megaptera noveangliae*) are rare, though well-publicized, visitors to the interior of San Francisco Bay. A humpback whale nicknamed “Humphrey” journeyed through the Bay and up the Sacramento River in 1985 and re-entered the Bay in the fall of 1990, stranding on mudflats near Candlestick Park (Fimrite 2005). In May 2007, a humpback whale mother and calf spent just over two (2) weeks in San Francisco Bay and the Sacramento River before finding their way back out to sea. Although it is possible that a humpback whale will enter the Bay and find its way into the Project area during construction activities, their occurrence is unlikely, and measures taken to reduce and mitigate the effects to gray whales would adequately protect a stray humpback whale if any did enter the Project vicinity.

4 Status and Distribution of the Affected Species

4.1 Pacific Harbor Seal

Pacific harbor seals have the broadest range of any pinniped, inhabiting both the Atlantic and Pacific oceans. In the Pacific, they are found in near-shore coastal and estuarine habitats from Baja California to Alaska, and from Russia to Japan. Pacific harbor seals generally do not migrate annually. Of the three recognized populations of Pacific harbor seals along the west coast of the continental United States, the California stock occurs within California coastal waters. Although the different populations are genetically distinct, the geographical boundary between the Oregon/Washington Coastal stock (Oregon and Washington Outer Coast and Inland Waters of Washington) and the California stock is determined by the boundary between Oregon and California. There are approximately 400-600 harbor seal haul-out sites in California, distributed widely along the mainland and offshore islands. The estimated population of the California stock is 30,968 (Table 4-1). The population assessments are extrapolated from observations of the number of Pacific harbor seals ashore during the peak haul-out period (May to July) during the 2012 surveys. The number of pacific harbor seals observed was multiplied by a correction that is equal to the “inverse of the estimated fraction of seals on land” (NOAA 2017). Pacific harbor seals are precocial, with the pups entering the water right after birth. As a result, it was not possible to count the number of pups. Information from most recent Marine Mammal Stock Assessment Report for the Pacific Region was used to describe the California stock of Pacific harbor seals (NOAA 2017).

Between 1981 and 2004, the Pacific harbor seal population increased, followed by a steady decrease between 2005 and 2010. A partial reason for this decrease could be mortalities associated with commercial hook and line fisheries, vessel strikes, entrainment in power plants, and research-related deaths. There has been a slight increase in the total California stock of Pacific harbor seals from 2010 to 2012. (NOAA 2017).

Table 4-1: Stock Assessment of Marine Mammal Stocks Present in San Francisco Bay

Species	Stock Name	Stock Abundance	Relative Occurrence in San Francisco Bay	Season(s) of Occurrence
Pacific harbor seal *Phoca vitulina*	California stock	30,968	Common	Year-round
California sea lion *Zalophus californianus*	Eastern U.S. stock	296,750	Common	Year-round
Harbor porpoise *Phocoena phocoena*	San Francisco-Russian River Stock	9,886	Common in the vicinity of the Golden Gate and Richardson's Bay, Rare elsewhere	Year-round
Gray Whale *Eschrichtius robustus*	Eastern North Pacific stock	20,990	Rare to occasional	February and March
Humpback whale (*Megaptera novaeangliae*)	California/Oregon/ Washington stock	1,918	Rare to occasional, in the vicinity of the Golden Gate	Summer and fall
Bottlenose dolphin *(Tursiops truncates)*	California Coastal stock	453	Common in the vicinity of the Golden Gate and Richardson's Bay. Rare elsewhere.	Year-round
Northern elephant seal (*Mirounga angustirostris*)	California Breeding Stock	81,368	Rare	Spring and fall
Northern fur seal (*Callorhinus ursinus*)	California stock	14,050	Rare; stranding may occur in San Francisco Bay during El Niño years.	Year-round

Source:

NMFS 2017

4.2 California Sea Lion

Based on genetic variations in the mitochondrial DNA, there are five genetically distinct populations of California sea lions: Pacific temperate, Pacific subtropical, Southern Gulf of California, Central Gulf of California, and the Northern Gulf of California. Members of the Pacific temperate population, which range between Canada and Baja California, occur within the Project area. This population is estimated to be around 296,750 individuals (Table 4-1). Because different age and sex classes are not all ashore at any given time, the population assessment is based on an estimate of the number of births and number of pups in relation to the known population. The current population estimate is derived from visual surveys, conducted in 2007, of the different age and sex classes observed ashore at the primary rookeries and haul-out sites in southern and central California, coupled with an assessment done in 2008 of the number of pups born in the southern California rookeries (NOAA 2017). Estimates of the total population size based on the more recent pup counts made in 2011, which show the highest record to date, are currently being developed. Information from the 2016 Marine Mammal Stock Assessment

Report for the Pacific Region was used to describe the Pacific temperate stock of California sea lions (NOAA 2017).

Statistical analysis of the pup counts between 1975 and 2010 determined an approximate 5.4 percent annual increase of the California stock. However, this does not take into account decreases associated with El Niño years observed in 1983, 1984, 1992, 1993, and 2003. During these periods, pup counts decreased by between 20 and 64 percent. Although pup counts reached pre-El Niño levels within 2 years of the 1992-1993, 1997-1998, and 2003 El Niño events, it took 5 years after the 1983-1984 El Niño event for pup production to reach pre-1982 levels. According to NOAA, one of the reasons for this could be that during El Niño events, there is an increase in pup and juvenile mortality, which in turn affects future age and sex classes. Additionally, because there are fewer females present in the population after such events, pup production is further limited. The decline in pup production observed during 2000 and 2003 can be attributed in part to previous El Niño events, which affected the number of reproductive females within the population; and in part to domoic poisoning and an infestation of hookworms, which caused an increase in pup mortality (NOAA 2017).

An Unusual Mortality Event (UME) of California sea lions also occurred in 2013, which was not an El Niño year. This UME was classified due to unusually high numbers of stranded juvenile "young of the year" sea lions that exhibited symptoms of dehydration, emaciation, and low weight for their age (NOAA 2017). This event was generally limited to California Counties south of and including Santa Barbara County. The cause of this UME is still under investigation, but two likely contributors were a change in the availability of sea lion prey, especially sardines, which are a high value food source for mothers when nursing pups, and unknown disease agents during that time period (NOAA 2017). Although current data show changes in availability of sea lion prey in Southern California waters and unknown disease agents were likely contributors to the UME, the exact mechanism is still under investigation (NOAA 2017). This event, combined with strong El Niño conditions in 2015-2016 will likely have reduced or eliminated recent population gains of the California stock.

4.3 Harbor Porpoise

Harbor porpoise have a broad range in both the Atlantic and Pacific Oceans. In the Pacific, they are found from Point Conception, California to the Alaska; and from Kamchatka and Japan. The harbor porpoise population along the Pacific coastline consists of nine distinct stocks (the Morro Bay, Monterey Bay, San Francisco-Russian River, northern California/southern Oregon, northern Oregon/Washington coast, Inland Washington, Southeast Alaska, Gulf of Alaska, and Bering Sea stocks). The San Francisco-Russian River stock is the population that could occur within the Project area. The San Francisco-Russian River stock consists of 9,886 individuals.

These estimates are based on aerial surveys that were conducted between 2007 and 2011. The current population estimate is similar to the 2002-2007 estimates of 9,189 individuals (NOAA 2017) (Table 4-1). Over the last five years, there have been no reported fishery-related deaths or injury of harbor porpoises within the range of the San Francisco-Russian River stock (NOAA 2017).

4.4 Gray Whale

Although gray whales were once found in three populations across the globe, the Atlantic population is believed extinct, and the species is now limited to the Pacific Ocean, where they are divided into eastern and western stocks. Eastern North Pacific gray whales migrate each year along the west coast of North America. Based on shore observations in 2006 and 2007, the population is estimated to consist of 20,990 individuals (Table 4-1). With the exception of an unusual mortality event in 1999 and 2000, the population of the Eastern North Pacific gray whale stock has increased over the last 20 years (NOAA 2017).

4.5 Northern Elephant Seal

The Northern elephant seal is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA, nor is it listed as endangered or threatened under the ESA (NMFS, 2015c). Northern elephant seal population size is estimated by approximation from the number of pups produced because all age classes are not ashore simultaneously. Based on counts of elephant seals at U.S. rookeries in 2010, Lowry et al. (2014) reported that 40,684 pups were born. From this, a total population estimate of approximately 179,000 elephant seals has been made (Lowry et al., 2014), of which approximately 81,000 are the California Breeding stock (NMFS, 2015c).

Northern elephant seals haul out to give birth and breed from December through March. Pups remain onshore or in adjacent shallow water through May. Both sexes make two foraging migrations each year: one after breeding and the second after molting (Stewart and DeLong, 1995). Pup mortality is high when they make the first trip to sea in May, and this period correlates with the time of most strandings. Pups of the year return in the late summer and fall to haul out at rookery sites, but may occasionally make brief stops in San Francisco Bay. Approximately 100 juvenile northern elephant seals of the California Breeding stock strand in San Francisco Bay each year, including individual strandings at Yerba Buena Island and Treasure Island (fewer than 10 strandings per year) (Caltrans, 2015b).

4.6 Northern Fur Seal

The Northern fur seal is separated into two stocks: the California and the Eastern Pacific stock. Both are protected under the MMPA. The Eastern Pacific stock is listed as strategic and depleted under the MMPA, but not threatened or endangered under the ESA. The California stock is not listed as strategic or depleted under the MMPA, nor is it listed as threatened or endangered under the ESA (NMFS, 2015d). The Eastern Pacific stock uses the Pribilof and Bogoslof Islands off of Alaska for breeding; the California stock breeds on the Farallons and San Miguel Island (NMFS, 2015d). The most recent estimate of the California stock is 14,050 seals, based on surveys from 2008 to 2013. The Eastern Pacific stock is estimated at 626,734 seals (NMFS, 2015d). Both the Eastern Pacific and California stocks forage in offshore waters outside San Francisco Bay. Northern fur seal populations experience significant declines as a result of El Niño events, which reduced food availability for the species (NMFS, 2015e). In normal years, TMMC in Sausalito admits about five northern fur seals that stranded on the Central California Coast (TMMC, 2016). During El Niño years, this number dramatically increases; for example, during the 2006 El Niño event, 33 fur seals were admitted (TMMC, 2016). Some of these stranded animals were collected from shorelines in San Francisco Bay.

4.7 Bottlenose Dolphin

The California Coastal Stock of Common bottlenose dolphin is protected under the MMPA but is not listed as a strategic or depleted species under the MMPA, nor is it listed as endangered or threatened under the ESA (NMFS, 2017). The California Coastal Stock is relatively small (453 animals), but they are frequently seen because they spend the majority of time in nearshore waters (NMFS, 2017). Bottlenose dolphin are most often seen just within the Golden Gate or just east of the bridge when they are present in San Francisco Bay, and their presence may depend on the tides (GGCR, 2018). Beginning in the summer of 2015, as many as two bottlenose dolphins have been observed frequently swimming in the Oyster Point area of South San Francisco (GGCR, 2018; Perlman, 2017). Despite this recent occurrence, this stock is highly transitory in nature, and is not expected to spend extended periods of time in San Francisco Bay; however, the number of sightings in the Central Bay has increased, which may indicate they are becoming more of a resident species.

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5 Type of Incidental Take Authorization Requested

5.1 Take Authorization Request

Under Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), Chevron requests an authorization from NMFS for incidental take (as defined by Title 50 Code of Federal Regulations, Part 216.3) of small numbers of marine mammals, specifically Pacific harbor seals, California sea lions, harbor porpoise, Northern elephant seal, Northern fur seal, bottlenose dolphin, and gray whales during pile driving activities associated with the Richmond Refinery LWMEP in San Francisco Bay. With implementation of the measures outlined in Section 11, no serious injury is anticipated, and the potential for take through non-serious injury (Level A Harassment) will be minimized. Chevron requests an Incidental Harassment Authorization (IHA) for incidental take of marine mammals described in this application. It is anticipated that Chevron would request an annual reissuance of an IHA, since the Project is unlikely to be completed within the year that the IHA is issued.

The noise exposure assessment methodology used in this IHA request attempts to quantify potential exposures to marine mammals resulting from underwater and airborne noise generated during pile extraction and pile driving. Section 6 presents a detailed description of the acoustic exposure assessment methodology. Results from this approach tend to provide an overestimation of exposures because all animals are assumed to be available to be exposed 100 percent of the time. The effects will depend on the species, received level of sound, duration of exposure, and distance from the work area; however, temporary behavioral reactions are most likely to occur. The analysis for the Project evaluates potential exposures (see Section 6 for estimates of exposures by species) over the course of the construction that could be classified as Level A or Level B Harassment, as defined under MMPA.

5.2 Method of Take

The proposed Project, as outlined in Sections 1 and 2, has the potential to result in incidental take of marine mammals by underwater and airborne noise disturbance during the removal of existing piles and driving of new piles. These activities have the potential to disturb or displace marine mammals, or have effects on hearing capacity. Specifically, the proposed activities may result in "take" in the form of Level B Harassment (behavioral disturbance only) from airborne or underwater noise generated from pile extraction and driving. Impact pile driving during the proposed Project may also result in small numbers of Level A Harassment to harbor seals and harbor porpoises. Section 11 contains additional details on impact reduction and mitigation measures that are proposed for this Project.

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6 Number of Marine Mammals that May Be Affected

Project activities may result in temporary behavioral changes in marine mammals due to underwater and airborne noise levels generated during extraction and pile driving activities. This section describes the noise levels that are expected to be generated by the Project activities, and the potential impacts of the noise levels on marine mammal species that could be found in the Project area.

6.1 Fundamentals of Sound

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of a sound, and is measured in the number of cycles per second, or hertz (Hz). Intensity describes the pressure per unit of area, (i.e., loudness) of a sound, and is measured in decibels (dB). A dB is a unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. For underwater sounds, a reference pressure of 1 microPascal (µPa) is commonly used to describe sounds in terms of decibels, and is expressed as "dB re 1 µPa." Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 µPa. Sound levels in dB are calculated on a logarithmic basis. An increase of 10 dB represents a tenfold increase in acoustic energy, while 20 dB is 100 times more intense, 30 dB is 1,000 times more intense, etc. For airborne sound pressure, the reference amplitude is usually 20 µPa, and is expressed as "dB re 20 µPa."

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects that of human hearing. This method is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. The method is called "A" weighting, and the dB level that is measured using this method is called the A weighted sound level. Sounds levels measured underwater are not weighted, and include the entire frequency range of interest.

When a pile driving hammer strikes a pile, a pulse is created that propagates through the pile and radiates sound into the water, substrate, and air. The sound pressure pulse is a function of time, and is referred to as the waveform. The instantaneous peak sound pressure level (SPL_{peak}) is the highest absolute value of pressure over the measured waveform, and can be a negative or positive pressure peak. Sound is frequently described as a root mean square (RMS) level, which is a statistical average of the sound wave amplitude. The RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that constitutes the portion of the waveform containing 90 percent of the sound energy (Richardson et al., 1995).

Sound levels are also described in relation to cumulative sound exposure levels (cSEL) where the A-weighted instantaneous sound pressures are squared and summed[1] throughout the duration of an event, referenced to 1 µPa. Table 6-1 contains definitions of these terms. In this document, dB for underwater sound is referenced to 1 µPa, and dB for airborne noise is references to 20 µPa.

Table 6-1: Definitions of Underwater Acoustical Terms

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 µPa and 1 µPa for underwater.
SPL_{peak} Sound Pressure Level (dB)	Peak sound pressure level based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to a pressure of 1 µPa) but can also be expressed in units of pressure, such as µPa or psi.
cSEL, cumulative Sound Exposure Level (dB)	cSEL is calculated by summing the cumulative pressure squared over the measurement duration, integrating over time, and normalizing to 1 second, referenced to 1 $microPascal^2$-second (1 $µPa^2$-sec).
RMS Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile driving impulse.
Notes: dB = decibel µPa = microPascal psi = pounds per square inch RMS = root mean square	

In common use, noise refers to any unwanted sound. This meaning of noise will be used in the following discussion in reference to marine mammals; that is—pile driving noise may harass marine mammals.

6.2 Applicable Noise Thresholds

In 2010, NMFS established interim thresholds regarding the exposure of marine mammals to high-intensity noise that may be considered take under the MMPA. Updated NOAA guidance on assessing the effects of underwater noise on marine mammals for agency impact analysis was adopted in 2016 (NMFS, 2016a). The 2016 guidance includes sound thresholds for slight injury to an animal's hearing, or PTS (Level A Harassment). The underwater sound pressure threshold for slight injury or PTS (Level A Harassment) is a dual metric criterion for impulse noise (e.g., impact pile-driving), including both a peak pressure and cSEL threshold, which is specific to the species hearing group (i.e., high-frequency cetaceans [i.e., harbor porpoise], mid-frequency

[1] SEL values are logarithms and must first be converted to antilogs for summation. Because the single strike SEL varies over the sequence of strikes, a linear sum of the energies for all the different strikes needs is computed. This is done as follows: divide each SEL decibel level by 10 and then take the antilog to convert the decibels to linear units (or uPa^2-s). Then the linear units can be summed and converted back into dB by taking 10Log10 of the value. This will be the cumulative SEL for all of the pile strikes.

cetaceans [i.e., bottlenose dolphin], low-frequency cetacean [i.e., gray whale], phocids [i.e., Pacific harbor seal and northern elephant seal], and otariids [i.e., California sea lion and northern fur seal]). For continuous noise (e.g., vibratory pile extraction or driving), the PTS threshold is based on cSEL for each species hearing group.

The 2010 thresholds for Level B Harassment levels are still applicable: 160 dB RMS for impulse sounds and 120 dB for nonimpulsive or continuous sounds. Level B Harassment is considered to have occurred when marine mammals are exposed to noise of 160 dB RMS or greater for impulse noise and 120 dB RMS for continuous noise. In some instances, ambient noise levels may be used in place of the 120 dB RMS threshold for continuous noise. For continuous noise, RMS levels are based on a time constant of 10 seconds, and those RMS levels are averaged across the entire event. For impact pile-driving, the overall RMS level are characterized by integrating sound energy for each acoustic pulse across 90 percent of the acoustic energy in each pulse, and averaging all the RMS levels for all pulses. Harassment thresholds for the various types of airborne and underwater noise are shown in Table 6-2.

Table 6-2: Injury and Behavioral Disruption Thresholds for Airborne and Underwater Noise

	Airborne Threshold (Impact and Vibratory Pile-Driving)	Underwater Continuous Noise Thresholds (e.g., Vibratory Pile-Driving)		Underwater Impulse Noise Thresholds (e.g., Impact Pile-Driving)		
Hearing Group and species considered	Level B RMS Threshold[1]	Level A cSEL Threshold	Level B RMS Threshold	Level A Peak Threshold[2]	Level A cSEL Threshold[2]	Level B RMS Threshold
Phocids (Pacific harbor seals, northern elephant seals)	90 dB (unweighted)	201 dB	120 dB	218 dB	185 dB	160 dB
Otariids (California sea lions, northern fur seals)	100 dB (unweighted)	219 dB	120 dB	232 dB	203 dB	160 dB
Low-Frequency Cetaceans (gray whales)	N/A	199 dB	120 dB	219 dB	183 dB	160 dB
Mid-Frequency Cetaceans (bottlenose dolphins)	N/A	198 dB	120 dB	230 dB	185 dB	160 dB
High-Frequency Cetaceans (harbor porpoises)	N/A	173 dB	120 dB	202 dB	155 dB	160 dB

Notes:
1 The airborne disturbance guideline applies to hauled-out pinnipeds.
2 Level A threshold for impulse noise is a duel criterion based on peak pressure and cSEL. Thresholds are based on the NMFS 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing.
cSEL = cumulative sound exposure level dB = decibel
N/A = Not applicable, no thresholds exist RMS = root mean square
Underwater peak and RMS are re: 1 µPa; cSEL is re: 1 μPa^2-sec; Airborne RMS is re: 20 µPa.

The application of the standard 120 dB RMS threshold for underwater continuous noise can sometimes be problematic, because this threshold level can be either at or below the ambient noise level of certain locations, and not all species may respond to noise at that level. Exposure thresholds for continuous noise have been developed based on the best available scientific information on the response of gray whales to underwater noise. To date, there is very little research or data supporting a response by pinnipeds or odontocetes to continuous noise from vibratory pile extraction and driving as low as the 120 dB threshold. Southall et al. (2007) summarized numerous behavioral observations made of low-frequency cetaceans to a range of non-pulse noise sources, such as vibratory pile-driving. Generally, the data suggest no or limited responses to received levels of 90 to 120 dB RMS, and an increasing probability of behavioral effects in the 120 to 160 dB RMS range. There is limited data available on the behavioral effects of continuous noise on pinnipeds while underwater; however, field and captive studies to date collectively suggest that pinnipeds do not react strongly to exposures between 90 and 140 dB re 1 µPa RMS (Southall et al. 2007). Additionally, ambient underwater noise levels in urbanized estuaries often far exceeds 120 dB RMS, as a result of the nearly continuous noise from recreational and commercial boat traffic.

6.3 Estimation of Pile Extraction and Driving Noise

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory pile extraction and driving and impact pile driving. Pile driving sound from similar type and sized piles have been measured from other projects and can be used to estimate the noise levels that the Project would generate. This analysis utilizes the practical spreading loss model the use of which NMFS and the US Fish and Wildlife Service have accepted to estimate transmission loss of sound through water.

The primary sources of underwater noise produced during construction would be pile driving and pile extraction. This includes the installation of the 60-inch hollow steel piles, 24-inch square concrete piles, 12-inch composite barrier piles, installation and removal of the temporary 20-inch and 36-inch hollow steel pipe piles for the guide template, and removal of existing timber and concrete piles as described in Section 2.

All pile removal will be completed using vibratory equipment or by cutting them at the mud line. All pile installation and extraction would occur in water depths ranging from approximately 4.6 to 15 meters (15 to 49 feet) MLLW, depending on location. Water depths in the vicinity average about 3 meters (10 feet) MLLW to the east of the Wharf and about 12 meters (39 feet) MLLW to the west of the Wharf. The substrate at the pile driving locations is primarily Bay mud, although other substrate types such as sand or gravel may be encountered as the pile penetrates deeper. To estimate underwater noise levels for the LWMEP, measurements from a number of underwater pile driving projects conducted under similar circumstances (similar water depths in areas of soft substrate) were reviewed for use as source level data.

For pile driving that does not have project specific hydroacoustic data available, the NMFS standard transmission loss factor of 15(4.5 dB per doubling of distance) is used. However, project-specific transmission loss values have been measured for the impact driving of concrete piles and the vibratory driving of concrete piles. For those types of pile driving, a transmission loss factor of 20 (~8 dB per doubling of distance) has been measured and will be applied. This value is calculated from hydroacoustic monitoring of vibratory driving of steel piles and attenuated impact driving of concrete piles conducted at the Long Wharf in 2018 as part of the LWMEP. The results of the 2018 hydroacoustic monitoring are provided in Appendix A. Copies of the NMFS PTS calculation sheets used to develop PTS isopleths for Level A Harassment are provided in Appendix B. Table 6-3 and 6-4 provides a summary of the underwater noise impact analysis that is presented in the following paragraphs.

Table 6-3: Expected Underwater Pile Driving Noise Levels and Distances of Threshold Exceedance with Impact and Vibratory Driver

Pile Type	Source Levels at 10 meters (dB)		Distance to Threshold 160/120 dB RMS (Level B)* meters (feet)
	Peak	RMS	
Attenuated Impact Driving (with bubble curtain)			
60-inch steel pipe (1 per day)	203	188	736 (2,413)
24-inch square concrete (1-2 per day)	191	173	45 (147)
Impact Pile Proofing (no bubble curtain)			
36-inch steel pipe pile (2 total)	210	193	1,585 (5,198)
Vibratory Driving/Extraction			
12-Inch Composite Barrier Piles (5 per day)	178	168	15,849 (51,984)
36-inch steel pipe pile (4 per day)	180	170	3,162 (10,372)
20-inch steel pipe pile (4 per day)	180	163	1,413 (4,633)
Wood and concrete pile extraction (12 per day)	No Data Available	152	1,359 (4,459)

Notes:
dB decibels
RMS root mean square
* For underwater noise, the Level B Harassment threshold is 160 dB for impulsive noise and 120 dB for continuous noise

Table 6-4: Expected Pile-Driving Noise Levels and Distances of Level A Threshold Exceedance with Impact and Vibratory Driver

Project Element Requiring Pile Installation	Source Levels at 10 meters (dB)		Distance to Level A Threshold[1] meters (feet)				
	Peak[2]	RMS/SEL	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
Attenuated Impact Driving (with bubble curtain)							
60-inch steel pipe (1 per day)	203	178 SEL	831 (2,726)	30 (97)	990 (3,247)	445 (1,459)	32 (106)
24-inch square concrete (1-2 per day)	191	161 SEL	19 (64)	2 (5)	22 73)	12 (40)	2 (6)
Impact Pile Proofing (no bubble curtain)							
36-inch steel pipe pile (2 total)	210	180 SEL	97 (317)	3 (11)	115 (377)	52 (170)	4 (12)
Vibratory Driving/Extraction							
12-inch Composite Barrier Pile (5 per day)	178	168 RMS	18 (58)	2 (5)	26 (86)	11 (35)	1 (2)
36-inch steel pipe pile (4 per day)	195	170 RMS	17 (57)	3 (9)	23 (76)	12 (39)	2 (5)
20-inch steel pipe pile (4 per day)	180	163 RMS	8 (25)	1 (4)	10 (34)	5 (17)	1 (2)
Wood and concrete pile extraction (12 per day)	No Data	152 RMS	2 (7)	0 (<1)	3 (10)	1 (4)	0 (<1)

Notes:
For calculation worksheets used to develop these numbers is provided in Appendix B.
[1] Level A thresholds are based on the NMFS 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing; cSEL threshold distances are shown. See footnote 3 below.
[2] All distances to the peak Level A thresholds are less than 33 feet (10 meters).
Distances are rounded to the nearest foot or to "<1.0 (0)" for values less than 1 foot.
Peak and cSEL are re: 1 µPa and 1 µPa^2-sec, respectively.
dB = decibels
SEL = sound exposure level
RMS=Root Mean Square

The area of effect of a particular noise in the natural environment is also dependent on the background noise levels. Ambient underwater noise in the vicinity of the Long Wharf is generated by shipping activity at the facility, including the arrival, departure, loading, and offloading of vessels that occurs daily, the presence of a nearby high speed ferry route, and the potential sound generated by the Richmond Bridge piers in the water to the north of the Long Wharf. Underwater noise measurements were made near the Wharf from July 20 to July 22, 2015 found that ambient noise at both berth locations was greater than 120 dB RMS. Noise levels at Berth 1 were consistently higher than noise levels at Berth 4. This is likely due to a combination of factors, including greater vessel activity at the Berth 1, proximity to the main shipping channel used by ferries, large ships, and other vessels, and current induced vibration of the piles supporting the Long Wharf. Other vessel traffic in the area that is unrelated to activities at the Long Wharf also likely contribute to underwater noise in the Project area. For example, the San Francisco Bay commuter ferries that pass near the Long Wharf and between Red Rock Island and Castro Rocks produce underwater noise levels of 152 to 177 dB peak (EIP Associates 2006). Since ambient noise levels at the Long Wharf will vary due to the presence of location and presence of vessels during construction, the default Level B threshold value of 120 dB is utilized in this analysis, even though ambient noise levels may often exceed this value during pile driving.

6.3.1 Underwater Noise from Impact Pile Driving

60-inch steel pipe piles

To limit displacement in a seismic event, a total of eight (8) batter steel pipe piles, 60-inch diameter would be installed adjacent to the existing Wharf structure to retrofit the Berth 4 loading platform. An impact driver will be used to install these piles, as it is difficult to vibrate in batter piles and these piles have very high axial design loads that can only be achieved by impact driving methods.

It is expected that just one 60-inch pile would be driven over one (1) hour of active driving in a given day. Because of preparation and set-up for each pile it is expected that just one pile per week would be installed, so the eight days of pile driving would occur over an eight-week period for this pile type. Installation could require up to 2,400 blows from an impact hammer, such as a HHK-16 or similar diesel hammer, producing approximately 173,000 to 217,000 ft. lbs. maximum energy per blow and 1.5 to 2 sec/blow average. Bubble curtains will be used during the installation of the 60-inch steel pipe piles in order to reduce underwater noise levels, with 7 dB of attenuation is assumed in this analysis.

Other projects conducted under similar circumstances were reviewed in order to estimate the approximate noise effects of the 60-inch steel piles. The best match found for sound source levels is from summary values provided by Caltrans in their hydroacoustic guidance document (Caltrans 2015). Summary values for the impact pile driving of 60-inch steel pipe piles indicates that noise levels of up to 210 peak, 185 dB SEL (single strike), and 195 RMS would be produced at 10 meters during pile driving using no sound attenuation such as a bubble curtain. The use of properly functioning bubble curtains is expected to reduce the peak and RMS noise levels by about 7 dB. As a result, noise levels of 203 dB peak, 178 dB SEL (single strike), and 188 dB

RMS at a distance of 10 meters (33 feet) are anticipated during driving of 60-inch piles for the LWMEP.

Based on the above sound levels, installation of the 60-inch steel pipe piles could have the potential to produce RMS values above the Level B threshold at distances summarized in Table 6-3, during attenuated impact driving. During installation of the 60-inch steel pipe piles with sound attenuation from a bubble curtain, the 160 dB RMS Level B threshold is expected to be exceeded over the areas shown in Figure 6-1. With attenuation, cumulative noise from impact driving of these piles could produce noise levels above the Level A threshold over the relatively short distances provided in Table 6-4.

24-inch square concrete piles

Modifications at the four berths require the placement of new 24-inch diameter square concrete piles. Approximately one to two of these piles would be installed in one work day, using impact driving methods and a bubble curtain attenuation system. Based on measured blow counts for 24-inch concrete piles driven at the Long Wharf Berth 4 in 2011, installation for each pile could require up to approximately 300 blows from a DelMag D62 22 or similar diesel hammer, producing approximately 165,000 ft lbs maximum energy (may not need full energy) and 1.5 second per blow average over a duration of approximately 20 minutes per pile, with 40 minutes of pile driving time per day if two (2) piles are installed.

To estimate the noise effects of the 24-inch square concrete piles, the underwater noise measurements recorded for this pile type at the Long Wharf during the 2018 construction season are utilized. These measured values were: 191 dB peak, 161 dB SEL (single strike), and 173 dB RMS during attenuated impact driving (AECOM 2018). Based on these measured levels, installation of the 24-inch concrete piles is expected to produce underwater sound exceeding the Level B 160 dB RMS threshold over the distances summarized in Table 6-3 and areas shown on Figure 6-1. Cumulative noise from impact driving of these piles could produce noise levels above the Level A threshold over the relatively short distances provided in Table 6-4.

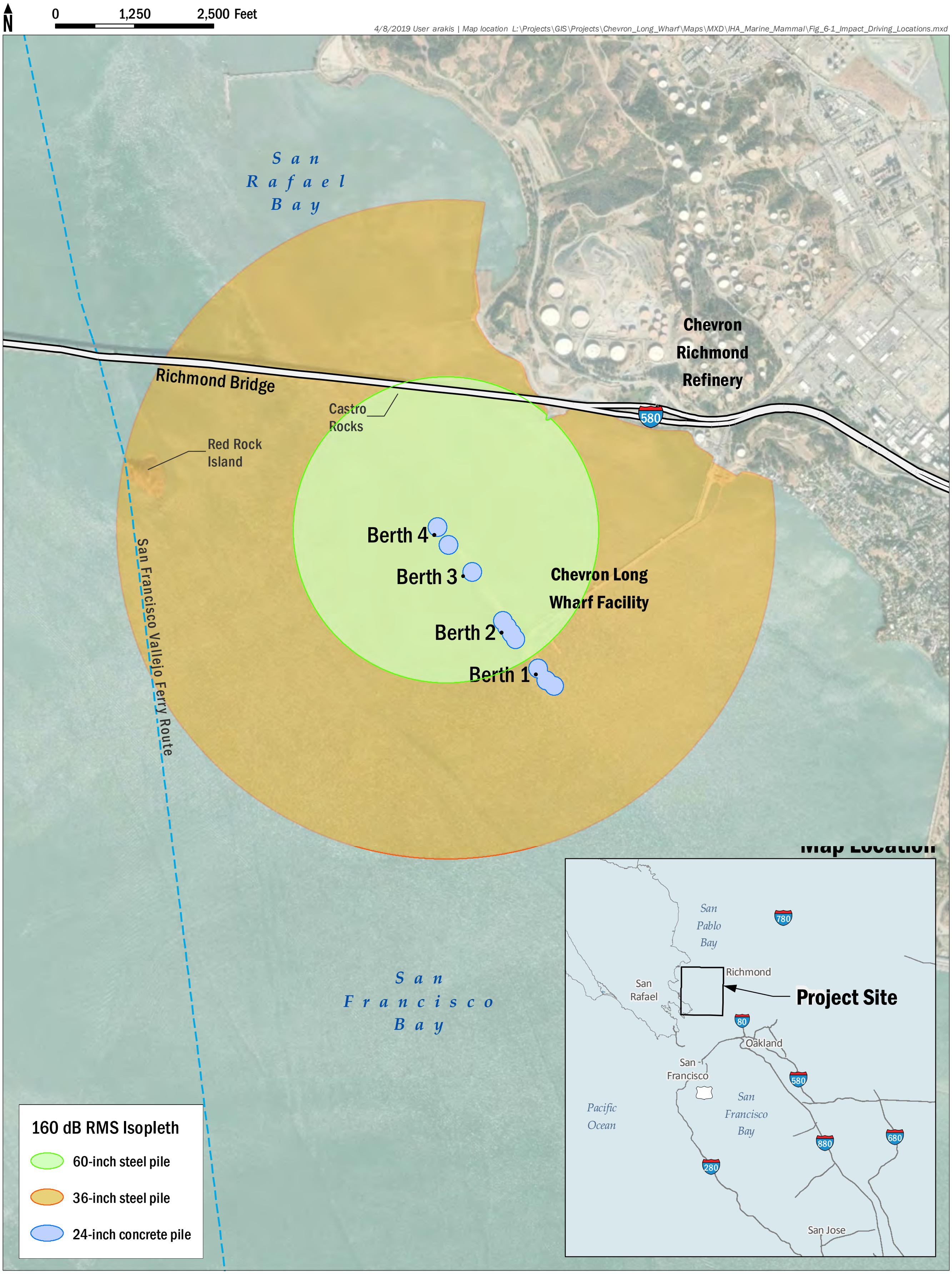

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FIGURE 6-1
Underwater Impact Driving Noise (Area Exceeding 160 dB Level B Threshold)

6.3.2 Underwater Noise from Vibratory Pile Extraction and Driving

12-inch Composite Barrier Piles[2]

As part of the Berth 4 Loading Platform seismic retrofit, four (4) clusters of 13 composite piles (52 piles total) will be installed to provide protection to the infrastructure. These plastic encased concrete piles would be installed with a vibratory pile driver (APE 400B King Kong or similar vibratory driver), with a drive time of approximately 10 minutes per pile. Up to five (5) of these piles could be installed in any single work day.

Projects conducted under similar circumstances with similar piles were reviewed in order to approximate the noise effects of the 12-inch composite barrier piles. Since these piles will be composed of concrete encased in plastic, vibratory installation of similarly sized concrete piles would provide a good surrogate. However, concrete piles are rarely installed with a vibratory driver, and no suitable data could be located. In the absence of this data, we are conservatively using data from the Anacortes Ferry Terminal in Washington State, where 13-inch plastic coated steel piles were installed with a vibratory hammer. RMS noise levels produced during this installation varied from 138 to 158 dB RMS at 43 meters (141 feet) from the pile (Laughlin 2012). From these measurements, a peak noise value of 178 dB and an average RMS value of 168 dB normalized to a 10 meter (33 feet) distance was used to estimate the extent of underwater noise from installation of the 12-inch composite piles. Cumulative noise from vibratory driving of these piles could produce noise levels above the Level A PTS threshold over the relatively short distances provided in Table 6-4. During installation of the 12-inch composite barrier piles for the proposed Project, up to 50 minutes of vibratory driving could occur per day; during this time, the Level B threshold would be exceeded over the distances shown in Table 6-3.

36-inch Temporary Steel Pipe Piles (including proofing)

For the Berth 4 Loading Platform seismic retrofit, eight (8) 36-inch diameter temporary steel piles would be installed using a vibratory pile driver (APE 400B King Kong or similar vibratory driver) will be needed to support the guide template for the driving of the permanent 60-inch steel pipe piles. Each 36-inch temporary pile has an estimated drive time of approximately 10 minutes per pile. Up to four (4) of these piles could be installed in any single work day.

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[2] The barrier piles are 14 inches in diameter above the mud line and 12.25 inches in diameter below the mud line. For purposes of this IHA request we have used the 14-inch diameter to describe the piles and calculate underwater noise effects.

Projects conducted under similar circumstances with similar piles were reviewed in order to approximate the noise effects of the 36-inch steel pipe. The best match for estimated noise levels is from the Explosive Handling Wharf-2 (EHW-2) project located at the Naval Base Kitsap in Bangor, Washington (Illingworth and Rodkin 2013) During vibratory pile driving associated with this Project, which occurred under similar circumstances, average peak noise levels were approximately 180 dB, and the RMS was approximately 170 dB at a 10 meter (33 feet) distance (Caltrans 2015a). Based on these sources values, the cumulative noise from vibratory driving of the 36-inch template support piles could produce noise levels above the Level A PTS threshold over the relatively short distances provided in Table 6-4, and could have the potential to produce RMS values above the Level B threshold at distances summarized in Table 6-3. During installation of the 36-inch steel pipe piles, the Level B Threshold is expected to be exceeded for a duration of about 40 minutes per day within the areas shown in Figure 6-2.

In total, two of the eight 36" temporary piles will require proofing using an impact hammer. Each pile will require up to 30 strikes from an impact hammer during proofing which will take place during the last foot of pile driving. Up to two (2) piles would be proofed in one day, with each pile requiring up to 30 strikes from an impact hammer, for a total of 60 strikes in one day. The best match found for sound source levels is from summary values provided by Caltrans in their hydroacoustic guidance document (Caltrans 2015). Summary values for the impact pile driving of 36-inch steel pipe piles in water less than 5m deep indicates that noise levels of up to 210 peak, 180 dB SEL (single strike), and 193 RMS would be produced at 10 meters during pile driving. Since impact hammers are often operated at reduced power output during proofing, the source levels are likely to be lower than the values for impact driving used here. Due to very limited time that pile proofing would occur (60 strikes total, over a few minutes of active hammering total) no sound attenuation would be used. Based on the above sound levels, proofing of the 36-inch steel pipe piles could have the potential to produce RMS values above the Level B threshold at distances summarized in Table 6-3, and the Level B threshold is expected to be exceeded over the areas shown in Figure 6-1. Cumulative noise from impact driving of these piles could produce noise levels above the Level A threshold over the relatively short distances provided in Table 6-4.

20-inch Temporary Steel Pipe Piles

Also for the Berth 4 Loading Platform seismic retrofit, eight (8) 20-inch diameter temporary steel piles would be installed using a vibratory pile driver (APE 400B King Kong or similar vibratory driver) to support the guide template needed for the driving the permanent 60-inch steel pipe piles. Each 20-inch temporary pile has a drive time per pile of approximately 10 minutes. Up to four (4) of these piles could be installed in any single work day.

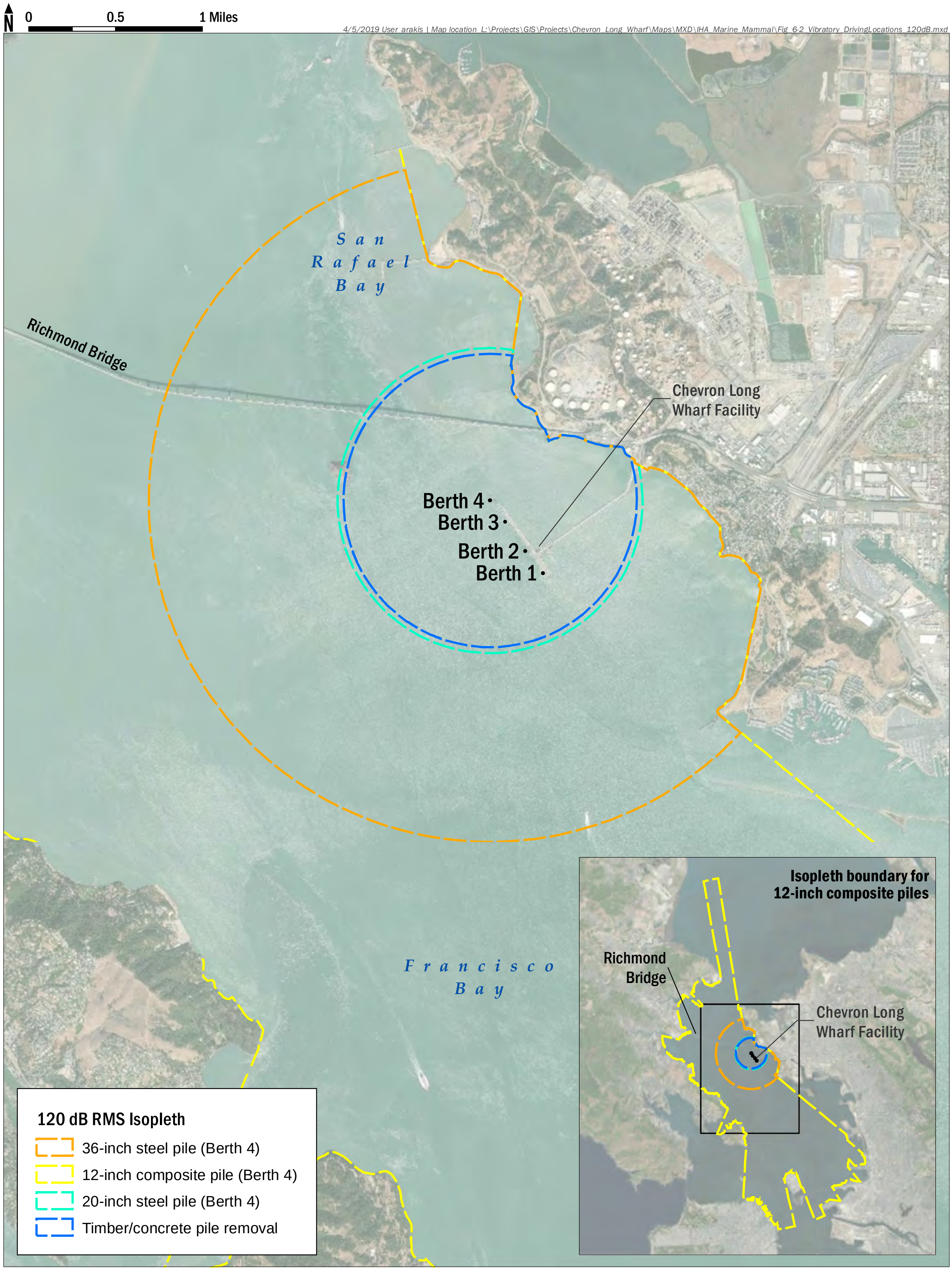

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FIGURE 6-2

Underwater Vibratory Driving Noise (Area Exceeding 120 dB Level B Threshold)

Projects conducted under similar circumstances with similar piles were reviewed in order to approximate the noise effects of the 20-inch steel pipe. The best match for estimated noise levels is from vibratory driving of 24-inch piles at the Explosive Handling Wharf-2 (EHW-2) project located at the Naval Base Kitsap in Bangor, Washington (Illingworth and Rodkin 2013). During vibratory pile driving associated with this Project, which occurred under similar circumstances, measured peak noise levels were approximately 180 dB, and the RMS was approximately 163 dB at a 10 meter (33 feet) distance (Illingworth and Rodkin 2013). Cumulative noise from vibratory driving of these piles could produce noise levels above the Level A PTS threshold over the relatively short distances provided in Table 6-4, and could have the potential to produce RMS values above the Level B threshold at distances summarized in Table 6-3. During installation of the 20-inch steel pipe piles, the Level B threshold is expected to be exceeded for a duration of about 40 minutes per day within the areas shown in Figure 6-2.

Extraction of Timber and Concrete Piles

The project includes the removal of 106 16-inch timber piles, and five (5) 18 to 24-inch square concrete piles using a vibratory pile driver. With the vibratory hammer activated, an upward force would be applied to the pile to remove it from the sediment. Up to 12 of these piles could be extracted in one (1) work day. Extraction time needed for each pile may vary greatly, but could require approximately 400 seconds (approximately seven (7) minutes) from an APE 400B King Kong or similar driver.

The most applicable noise values for wooden pile removal from which to base estimates for the WMEP are derived from measurements taken at the Pier 62/63 pile removal in Seattle, Washington. During vibratory pile extraction associated with this Project, which occurred under similar circumstances, the RMS was approximately 152 dB (WSDOT 2011). Applicable sound values for the removal of concrete piles could not be located, but they are expected to be similar to the levels produced by wooden piles described above, as they are similarly sized, non-metallic, and will be removed using the same methods.

Cumulative noise from vibratory driving of these piles would produce noise levels above the Level A PTS threshold over the relatively short distances provided in Table 6-4. The area over which the Level B threshold could be exceeded is shown on Figure 6-2.

6.3.3 Airborne Noise

Pile driving generates airborne noise that could potentially result in behavioral disturbance to pinnipeds (e.g., sea lions and harbor seals) which are hauled-out or at the water’s surface. As with the underwater noise, the practical spreading model is used to determine the extent over which sound levels may result in Level B Harassment of marine mammals. A 20 $\log_{10}$ attenuation rate was used to calculate the distances to the NMFS thresholds for pinnipeds presented in Table 6-2. The marine environment around the Project site is mostly water and would be considered a “hard” site, and no excess ground attenuation or atmospheric absorption is assumed. The 20 $\log_{10}$ attenuation rate of sound is based on spherical spreading loss and equates to a 6-dB reduction in sound per doubling distance (Richardson et al. 1995).

Source sound levels for impact driving of the 60-inch piles are based on measurements taken during installation of 72-inch piles for the SR 529 Ebey Slough Bridge Replacement Project in Washington (Laughlin 2011). During impact driving of the 72-inch piles, the greatest unweighted maximum noise level ($L_{max)}$ was 105 dB and the unweighted average noise level (L_{eq}) measured over a five minute interval was 102 dB (both sound values are standardized to 15 meters [49 feet] from the source). An unweighted Leq value is equivalent to the unweighted RMS specified in the airborne noise thresholds for pinnipeds. For simplicity, the analysis of airborne noise of the 60-inch piles is also applied for proofing of the 36-inch steel template piles.

Source levels for impact driving of the 24-inch concrete piles re based on measurements taken during installation of hollow 36-inch concrete piles for the Mukilteo Ferry Terminal in Washington (Laughlin 2007). During impact driving of the 36-inch concrete piles, the greatest L_{max} value was 98 dB, the unweighted average noise level (L_{eq}) was not reported, but would be less than the L_{max}. To conservatively estimate the distances to the specified in the airborne noise thresholds for pinnipeds, the L_{max} will be used.

Measured airborne noise levels from vibratory driving used in this analysis are based on measurements made during the Navy Test Pile Project in Bangor Washington (NAVFAC 2012). For vibratory driving of 36-inch steel shell piles, the greatest L_{max} value measured was 105 dB, and the average Lmax was 97 dB (standardized to 15 meters [49 feet]). Table 6-5 provides distances using the average L_{max} levels, which should conservatively estimate the distance to the NMFS threshold. Airborne noise levels from the vibratory installation of the 12-inch composite barrier piles and vibratory extraction of wood and concrete piles is expected to be similar to or less than the noise levels produced by installation of the steel piles.

Table 6-5: Modeled Extent of Sound Pressure Levels for Airborne Noise

Pile Driving Activity	Distance to Level B Thresholds	
	100 dB RMS (California Sea Lions)	90 dB RMS (Pacific Harbor Seals)
Impact Driving –60-inch Piles and Proofing of 36-inch Piles	19 meters (62 feet)	60 meters (196 feet)
Impact Driving –24-Inch Concrete Piles	12 meters (39 feet)	38 meters (124 feet)
Vibratory Extraction and Driving – All Pile types	11 meters (35 feet)	34 meters (110 feet)

Although airborne pile-driving RMS noise levels above the NMFS airborne noise thresholds will not extend to the Castro Rocks haul-out site, peak noise levels will be higher and may be audible over greater distances. It is expected that some pile-driving noise would be audible to harbor seals hauled out at Castro Rocks. However, the Castro Rocks haul out is subject to high levels of background noise from the Richmond Bridge, ongoing vessel activity at the Long Wharf, ferry traffic, and other general boat traffic. As a result, pile driving noise is not expected to regularly incite a reaction from hauled out harbor seals at Castro Rocks and would not cause incidental harassment.

Airborne noise from other construction activities associated with the Project, such as jack hammering of Wharf structures during removal, was not specifically modeled, but is expected to produce noise levels similar to or less than the pile driving described above (FHWA 2006). While other construction noise may be occasionally audible to harbor seals hauled out at Castro Rock, it is not expected to regularly incite a reaction and would not result in incidental harassment.

Any pinnipeds that surface in the area over which the airborne noise thresholds may be exceeded would have already been exposed to underwater noise levels above the applicable thresholds and thus would not result in an additional incidental take.

6.4 Description and Estimation of Take

For this analysis, the potential numbers of marine mammals that may be exposed to take as defined in the MMPA is determined by comparing the calculated areas over which the Level B Harassment threshold may be exceeded, as described in Section 6.3, with the expected distribution of marine mammal species within the vicinity of the proposed Project, as described in Section 3. Limited at-sea densities for marine mammal species are available for San Francisco Bay and estimates here are determined using data taken during marine mammal monitoring associated with the RSRB retrofit project, the San Francisco-Oakland Bay Bridge replacement project, and other marine mammal observations for San Francisco Bay. For Pacific harbor seal, data was also derived from recent annual surveys of haul outs in the Bay conducted by the National Park Service (Codde, S. and S. Allen. 2013, 2015, and 2017).

The mechanisms of take requested are expected to be limited to temporary effects on individual animals and no significant effect on the populations of these species.

6.4.1 Pacific Harbor Seal

For the 2018 IHA application, a combination of nearby haul-out occupancy and at-sea densities were used to develop take estimates, in order to account for both local movements of animals that haul out at Castro Rocks and other individuals that may be foraging in the more distant part of the Level B Harassment zone. By using hydroacoustic data collected in 2018, this application for the 2019 IHA refined the extent of the harassment zones by using the transmission loss measured during 2018 pile driving (as described in Section 6.3). As the Level B Harassment zones estimated for the 2019 IHA are overall more localized, only the occupancy from the local Castro Rocks haul-out is used.

In terms of the number of animals that use the site, Castro Rocks is the largest harbor seal haul out site in the northern part of San Francisco Bay and is the second largest pupping site in the Bay (Green et al. 2002). The pupping season is from March to June in San Francisco Bay. During the molting season (typically June-July and coincides with the period when piles will be driven) as many as approximately 130 harbor seals on average have been observed using Castro Rocks as a haul out, as described in Section 3.1. Harbor seals are more likely to be hauled out in the late afternoon and evening, and are more likely to be in the water during the morning and early afternoon (Green et al. 2002). However, during the molting season, harbor seals spend more time hauled out and tend to enter the water later in the evening. During molting, harbor seals can stay onshore resting for an average of 12 hours per day during the molt compared to around seven (7) hours per day outside of the pupping/molting seasons (NPS 2014).

Tidal stage is a major controlling factor of haul out usage at Castro Rocks with more seals present during low tides than high tide periods (Green et al. 2002). Additionally, the number of seals hauled out at Castro Rocks also varies with the time of day, with proportionally more animals hauled out during the nighttime hours (Green et al. 2002). Therefore, the number of harbor seals in the water around Castro Rocks will vary throughout the work period. Pile driving would occur intermittently during the day with average active driving times typically of a few hours per day, so varying sets of animals may be hauled out or in the water. However, there are no systematic counts available for accurately estimating the number of seals that may be in the water near the Long Wharf at any given time. To provide a conservative assessment, the take estimates are based on the highest mean plus the standard error of harbor seals observed at Castro Rocks during recent annual surveys conducted by the National Park Service (Codde, S. and S. Allen. 2013, 2015, and 2017), a value of 176 seals. Further, the analysis assumes that all 176 seals would swim into the Level B zone each day that pile driving is occurring.

A summary of the estimated take for harbor seal is provided in Table 6-6. Also provided in Table 6-6 is the estimated Level A take for impact driving of the 60-inch and 36-inch steel pipe piles, which has been estimated by taking Level B take and multiplying it by the ratio of the Level A zone area to the Level B zone area as requested by NMFS[3]. Level A take is not requested for vibratory driving.

Table 6-6: Level A and Level B Harassment Estimate for Pacific Harbor Seal (Per Day)

				Estimated Take per Day	
Pile Type	**Level B Zone (sq km)**	**Exclusion Zone radius (m)**	**Level A Zone, minus Exclusion Zone (sq km)**	**Level B Take per Day- Total**	**Level A Take per Day- Total**
VIBRATORY DRIVING					
12-inch composite pile	165.62	10	0	176	NA
36-inch steel pipe pile	22.90	15	0	176	NA
20-inch steel pipe pile	5.72	10	0	176	NA
Timber/Concrete Pile Removal	5.33	15	0	176	NA
IMPACT DRIVING					
24-inch concrete pile	0.01	20	0	176	NA
60-inch steel pile	1.70	30	0.62	176	64.06
IMPACT PROOFING					
36-inch steel pile	6.92	30	0.01	176	0.14
* Based on 71% of 176 individuals that haul out at Castro Rocks, approximately 1,000 m from project site.					

Total take by Level A and Level B Harassment by pile type for the 2019 construction season is summarized in Section 6.5. For impact pile driving of the 60-inch steel piles, the PTS Zone is large enough to warrant a smaller exclusion zone and the authorization of some Level A Harassment for harbor seal so that pile driving can be completed on schedule. A 30 meter

[3] Teleconference. March 29, 2018 with Shane Guan and Rob Pauline of NMFS, and staff from Chevron, AECOM, and Illingworth and Rodkin.

exclusion zone (smaller than the Level A Zone) for this species is requested, but individuals that place themselves in the Level A zone but outside of the shut-down zone may experience Level A Harassment, if they reside in that area for a long enough duration.

6.4.2 California Sea Lion

Relatively few California Sea Lions are expected to be present in the Project area during periods of pile driving, as there are no haul-outs utilized by this species in the vicinity. However, monitoring for the RSRB did observe small numbers of this species in the north and central portions of the Bay during working hours. During monitoring for the San Francisco-Oakland Bay Bridge (SFOBB) Project in the central Bay, 83 California sea lions were observed in the vicinity of the bridge over a 17-year period from 2000-2017, and from these observations, an estimated at-sea density of 0.16 animals per square kilometer is derived (NMFS 2018). Using this in-water density and the areas of potential Level B Harassment, take is estimated for California sea lion as provided in Table 6-7. Due to the small size of the Level A zone for otariid pinnipeds, Level A take of this species is not requested.

Table 6-7: Level B Harassment Estimate for California Sea Lion (Per Day)

Pile Type	Level B Zone (sq km)	Level B Take Estimate (based on Central Bay density of 0.16 animals per km^2)
VIBRATORY DRIVING		
12-inch composite pile	165.62	26.50
36-inch steel pipe pile	22.90	3.66
20-inch steel pipe pile	5.72	0.91
Timber/Concrete Pile Removal	5.33	0.85
IMPACT DRIVING		
24-inch concrete pile	0.01	0.01
60-inch steel pile	1.70	0.27
IMPACT PROOFING		
36-inch steel pile	6.92	1.11
Total take by Level B harassment by pile type for the 2019 construction season is summarized in Section 6.5.		

6.4.3 Harbor Porpoise

As described in Section 3.3, a small but growing population of harbor porpoises utilizes San Francisco Bay. Harbor porpoises are typically spotted in the vicinity of Angel Island and the Golden Gate (6 and 12 kilometers [3.7 and 7.5 miles] southwest respectively) (Keener 2011) and the vicinity of treasure island (Caltrans 2018), but may utilize other areas in the Central Bay in low numbers, including the Project area. Based on monitoring conducted for the SFOBB project in 2017, an in-water density of 0.17 animals per square kilometer has been estimated by Caltrans for this species (NMFS 2018). Using this in-water density and the areas of potential Level A and Level B Harassment, take is estimated for California sea lion as provided in Table 6-8. Also provided in Table 6-8 is the estimated Level A take for impact driving of steel piles, which has been estimated by taking Level B take and multiplying it by the ratio of the Level A zone area to the Level B zone area. Level A take is not requested for vibratory driving.

Table 6-8: Level A and Level B Harassment Estimate for Pacific Harbor Porpoise (Per Day)

Pile Type	Level B Zone (sq km)	Exclusion Zone (m)	Level A Zone, minus Exclusion Zone (sq km)	Level B Estimate Central Bay In-Water - 0.17 per km2	Estimated Level A take per day
VIBRATORY DRIVING					
12-inch composite barrier pile	165.62	50	NA	28.16	NA
36-inch steel pipe pile	22.90	50	NA	3.89	NA
20-inch steel pipe pile	5.72	50	NA	0.97	NA
Timber/Concrete Pile Removal	5.33	50	NA	0.91	NA
IMPACT DRIVING					
24-inch concrete pile	0.01	50	0	0.01	0
60-inch steel pile	0.21	50	0.23	0.29	0.52
IMPACT PROOFING					
36-inch steel pile	0.31	80	0	1.18	<0.01

* Daily Level A take of this species is estimated using impact driving, which produces a larger Level A zone.

**Only displayed to provide the calculation of Level A take. Level B take authorized for vibratory driving would cover any level B take from occasional impact driving.

Total take by Level A and Level B Harassment by pile type for the 2019 construction season is summarized in Section 6.5. For impact pile driving of the 60-inch steel pipe piles, the Level A Zone is large enough to warrant the authorization of some Level A Harassment for harbor porpoise so that pile driving can be completed on schedule. A 50 meter exclusion zone for this species would be established, but individuals that place themselves in the Level A zone but outside of the shut-down zone may experience Level A Harassment, if they reside in that area for a long enough duration. A slightly larger shutdown zone (80 meters) for harbor porpoise would be used during the brief period of impact proofing, which would occur without the use of a bubble curtain or other noise attenuation system.

6.4.4 Northern Elephant Seal

As described in Section 4.5, small numbers of this may species haul out or strand on coastline within the Central Bay. Monitoring of marine mammals in the vicinity of the SFOBB has been ongoing for 15 years; from those data, Caltrans has produced an estimated at-sea density for northern elephant seal of 0.16 animal per square mile (0.06 animal per square kilometer)

(Caltrans, 2015b). Most sightings of northern elephant seal in San Francisco Bay occur in spring or early summer, and are less likely to occur during the periods of in-water work for this project. As a result, densities during pile driving for the proposed action would be much lower. Additionally, this species was not observed by the marine mammal observers in the vicinity of the Long Wharf during 2018 pile driving monitoring. However, it is possible that a lone northern elephant seal may enter the Level B Harassment area (Table 6-3) once per every three days during pile driving, for a total of 23 takes. Level A Harassment of this species is not expected to occur.

6.4.5 Northern Fur Seal

The incidence of northern fur seal in San Francisco Bay depends largely on oceanic conditions, with animals more likely to strand during El Niño events. Equatorial sea surface temperatures of the Pacific Ocean are above average across most of the Pacific Ocean, and El Niño is expected to form and continue through winter and into spring (NOAA 2018). There are no estimated at-sea densities for this species in San Francisco Bay a. Based on other recent IHA authorizations for similar construction projects in San Francisco Bay (such as the South Basin Improvements Project at the San Francisco Ferry Terminal, 83 FR 28826), it is anticipated that at most 10 animals would be in San Francisco Bay and enter the area of Level B Harassment (Table 6-3) during construction (NMFS 2016). Level A Harassment of this species is not expected.

6.4.6 Bottlenose Dolphin

When this species is present in San Francisco Bay, it is more typically found close to the Golden Gate. There are no estimated at-sea densities for this species in San Francisco Bay available for calculating a take estimate. Beginning in 2015, two individuals have been observed frequently in the vicinity of Oyster Point (GGCR, 2016; GGCR 2017; Perlman, 2017). The average reported group size for bottlenose dolphins is five. Reports show that a group normally comes into San Francisco Bay, is near Yerba Buena Island once per week for approximately a two (2)-week stint and then leaves (NMFS, 2017b). Assuming the dolphins come into San Francisco Bay approximately three times per year, 30 takes of up to five individuals would be anticipated, if the group enters the areas over which the Level B Harassment thresholds may be exceeded (Table 6-3).

Although a small Level A zone for mid-frequency cetaceans is estimated during impact driving, marine mammal monitoring of the exclusion zone, as outlined in Section 14, would ensure that driving does not occur if bottlenose dolphins are within the area of Level A Harassment for their hearing group, so Level A Harassment of this species is not expect to occur.

6.4.7 Whales

The only whale species that travels far into San Francisco Bay with any regularity is the gray whale. As described in Section 3.4.1, gray whales occasionally enter the Bay during their northward migration period, and are most often sighted in the Bay between February and May. Most venture only about 2 to 3 kilometers (about 1-2 miles) past the Golden Gate, but gray whales have occasionally been sighted as far north as San Pablo Bay. Pile driving is not expected to occur during this time, and gray whales are not likely to be present at other times of year. If pile driving does occur during the northward migration period, and in the very unlikely event that a gray whale or pair of gray whales makes its way close to the Long Wharf, we are requesting take by Level B Harassment of up to two (2) gray whales per year (Table 6-3).

While a small Level A zone for marine mammals resulting from cumulative noise is estimated during pile driving (Table 6-4), marine mammal monitoring, as outlined in Section 13 would detect the presence of a whale and stop the driving activity so that driving does not occur if gray whales are within this exclusion zone.[4]

6.5 Summary and Schedule of Estimated Take for 2019

Pile driving associated with the proposed Project would occur over a period of several years. Take that would occur through Level A or Level B Harassment would occur during short periods of pile driving within the construction seasons. Tables 6-9 and 6-10 summarize the estimate of Level B and Level A Harassment, respectively, for each species by pile driving activity for the 2019 construction season. The Level B Harassment estimates are based on the number of individuals assumed to be exposed per day, the number of piles driven per day and the number of days of pile driving expected based on an average installation rate. As described in Section 6.4, the Level A Harassment estimates are derived from the Level B Harassment estimates by taking the Level B Harassment and multiplying it by the fractional ratio of the area of the Level A zone to the Level B zone. It is also assumed that an individual animal can only be taken once per method of installation during a 24 hour period.

[4] As with the pinniped species, PTS areas for pile driving associated with this project have been calculated using the new NMFS approved calculation workbook, which is provided in Appendix A.

Table 6-9: Summary of Estimated Take by Species for 2019 Work Season (Level B Harassment)

Pile Type	Pile Driver Type	# of Piles	# of Driving Days	Species						
				Harbor Seal	CA sea lion	Harbor porpoise	Gray whale*	N. elephant seal	N. fur seal*	Bottlenose dolphin*
60-inch steel pipe	Impact	8	8	1,408	2.18	2.31	NA	2.66	NA	NA
36-inch steel pipe pile**	Vibratory	8	4	704	14.66	15.57	NA	1.33	NA	NA
36-inch steel pipe pile	Impact Proofing	2	1	176	1.11	1.18	NA	0.33	NA	NA
20-inch steel pipe pile**	Vibratory	8	4	704	3.66	3.89	NA	1.33	NA	NA
Concrete pile removal	Vibratory	5	1	176	0.91	0.97	NA	0.33	NA	NA
24-inch concrete	Impact	39	30	5,280	0.03	0.04	NA	10	NA	NA
12-inch composite pile installation	Vibratory	52	11	1,936	291.50	309.72	NA	3.66	NA	NA
Timber pile removal	Vibratory	106	9	1,584	7.68	8.16	NA	3	NA	NA
Total Take by Species (2019)				**11,968**	**322**	**342**	**2**	**23**	**10**	**30**

*Take is not calculated by activity type for these species, only a total estimate is given.
- Level B take for this pile type is based on vibratory driving, as the method produces the larger Level B zone.
**Piles will be installed and removed using a vibratory driver during the 2019 construction season – 2 days for installation, 2 days for removal.

Table 6-10: Summary of Estimated Take by Species for 2019 Work Season (Level A Harassment)

Pile Type	Pile Driver Type	# of Piles	# of Driving Days	Species						
				Harbor Seal	CA sea lion	Harbor porpoise	Gray whale*	N. elephant seal	N. fur seal*	Bottlenose dolphin*
60-inch steel pipe	Impact	8	8	512.49	0	4.18	0	0	0	0
36-inch steel pipe pile**	Vibratory	8	4	0	0	0	0	0	0	0
36-inch steel pipe pile	Impact Proofing	2	1	0.14	0	<0.01	0	0	0	0
20-inch steel pipe pile**	Vibratory	8	4	0	0	0	0	0	0	0
Concrete pile removal	Vibratory	5	1	0	0	0	0	0	0	0
24-inch concrete	Impact	39	30	0	0	0	0	0	0	0
12-inch composite pile installation	Vibratory	52	11	0	0	0	0	0	0	0
Timber pile removal	Vibratory	106	9	0	0	0	0	0	0	0
Total Take by Species (2019)				**513**	**0**	**4**	**0**	**0**	**0**	**0**

*Take is not calculated by activity type for these species, only a total is given.
- Level A take for this pile type is based on impact driving, as the method produces the larger Level A zone.
**Piles will be installed and removed using a vibratory driver during the 2019 construction season – 2 days for installation, 2 days for removal.

7 Anticipated Impact of the Activity on the Species or Stock

7.1 Effects of Underwater Noise on Marine Mammals

Marine mammals use hearing and sound transmission to perform vital life functions. The introduction of noise into their environment could disrupt those behaviors. Sound (hearing and vocalization/echolocation) serves four primary functions: (1) providing information about the environment; (2) communication; (3) prey detection; and (4) predator detection. The distances to which the construction noise associated with the Project are audible depend on source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and the sensitivity of the receptor (Richardson et al., 1995).

The effects of noise from pile driving on marine mammals can be physiological or behavioral, and may include one or more of the following depending on frequency and intensity: masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or nonauditory physical effects such as damage to other organs (Richardson et al., 1995). In assessing the potential effects of noise, Richardson et al. (1995) have suggested criteria for defining four zones of effect. These zones are discussed in Sections 7.1.1 through 7.1.4, from greatest effect to least.

7.1.1 Zone of Hearing Loss, Discomfort, or Injury

The zone of hearing loss, discomfort, or injury is the area in which the received sound energy is potentially high enough to cause discomfort or tissue damage to auditory or other systems. The possible effects of damaging sound energy are a temporary hearing threshold shift[5], a temporary loss in hearing, a permanent threshold shift and a loss in hearing at specific frequencies or deafness. Non-auditory physiological effects or injuries that can theoretically occur in marine mammals exposed to strong underwater noise are stress, neurological effects, bubble formation, resonance effects and other types of organ or tissue damage. These effects would be considered Level A Harassment; applicable NMFS acoustic thresholds for this type of harassment based by cumulative SEL and vary by hearing group, as discussed in Section 6.2.

[5] On exposure to noise, the hearing sensitivity may decrease as a measure of protection. This process is referred to as a shift in the threshold of hearing, meaning that only sounds louder than a certain level will be heard. The shift may be temporary or permanent.

Vibratory pile extraction and driving does not generate high-peak sound pressure levels commonly associated with physiological damage. Impact driving can produce noise levels in excess of the Level A thresholds; however, Chevron will implement measures (Section 11) that will limit the numbers of marine mammals may be exposed to sound pressure levels that could cause physical harm. During impact pile driving of the 60-inch piles, a noise attenuation system (i.e., bubble curtains) would be used to reduce sound pressure levels. Marine mammal observers will monitor the exclusion zones for the presence of marine mammals (Section 11 provides a detailed discussion of mitigation measures). They will alert work crews to the presence of pinnipeds or cetaceans in or near the exclusion zone, and advise when to begin or stop work to reduce the potential for acoustic harassment.

7.1.2 Zone of Masking

The zone of masking is the area in which noise may interfere with the detection of other sounds, including communication calls, prey sounds, and other environmental sounds. This effect would be considered Level B Harassment; the applicable threshold for the zone where this effect occurs are 160 dB for impact noise and 120 dB or ambient noise levels for continuous noise.

7.1.3 Zone of Responsiveness

The zone of responsiveness is the area in which animals react behaviorally. The behavioral responses of marine mammals to noise depend on a number of factors, including (1) the acoustic characteristics of the noise source of interest; (2) the physical and behavioral state of the animals at the time of exposure; (3) the ambient acoustic and ecological characteristics of the environment; and (4) the context of the noise (e.g., does it sound like a predator?) (Richardson et al., 1995; Southall et al., 2007). However, temporary behavioral effects are often simply evidence that an animal has heard a noise and may not indicate lasting consequence for exposed individuals (Southall et al., 2007). These types of effects would be considered Level B Harassment; the applicable threshold for the zone where these effects occur are 160 dB for impact noise and 120 dB or ambient noise levels for continuous noise.

7.1.4 Zone of Audibility

The zone of audibility is the area in which the marine mammal may hear the noise. Marine mammals as a group have functional hearing ranges of 10 Hz to 180 kHz, with best thresholds near 40 dB (Southall et al., 2007). Study data show reasonably consistent patterns of hearing sensitivity in three groups: small odontocetes (such as the harbor porpoise), medium-sized odontocetes (toothed whales such as killer whales), and pinnipeds (such as the California sea lion). No thresholds apply to this zone because it is difficult to determine the audibility of a particular noise for a particular species. This zone does not fall within the noise range of a take as defined by NMFS. The zone of audibility is also limited by background noise levels which may mask the particular noise in question. Background noise is produced both by natural (waves, rain, and other organisms) and anthropogenic sources (watercraft, bridges, etc.).

7.1.5 Expected Responses to Pile Extraction and Driving

With both vibratory extraction and vibratory and impact pile driving, it is likely that the onset of activities could result in temporary, short-term changes in typical behavior and/or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or may swim away from the noise source and avoid the area. Other potential behavioral changes could include increased swimming speed, increased surfacing time, and decreased foraging in the affected area. Pinnipeds may increase their haul-out time, possibly to avoid in-water disturbance. Because pile installation or removal work would occur for a just few hours a day, and only on intermittent days throughout the construction schedule, it is unlikely to result in permanent displacement of animals. Based on the best available science, exposures to marine mammal species and stocks from pile driving activities is anticipated to result in only short-term effects on individuals exposed, will likely not affect annual rates of recruitment or survival, and employed mitigation measures will limit Level A exposures and prevent mortality. Pupping at Castro Rocks would largely occur outside the window when pile driving would. Monitoring conducted during the seismic retrofit of the Richmond Bridge, which is considerably closer to Castro Rocks (20 to 100 meters (66 to 328 feet) vs 560 meters (1,837 feet) to the closest point on the Long Wharf), did not show a decline in the use of the haul-out site (Green 2006).

The expected responses to pile replacement work noise depend partly on the average ambient background noise of the site. San Francisco Bay in the area surrounding the Long Wharf experiences frequent boat traffic, foot traffic on accessible portions of the Wharf, and noise from the tankers and tugs accessing the wharf. For marine mammals that use San Francisco Bay regularly, or harbor seals which are part of a resident population, responses to noise may be lessened due to habituation. During the 2018 construction season of the Project, a total of 25 harbor seals were observed in the vicinity (~300m or closer) of the Long Warf during pile driving (AECOM 2018). None of the seals observed demonstrated signs of behavioral changes or distress as a result of pile-driving activities (AECOM 2018).

7.2 Effects of Airborne Noise on Marine Mammals

Marine mammals could be exposed to airborne noise levels at sound pressure levels that would constitute Level B Harassment during impact or vibratory pile driving (see Section 6 for results). Injury or Level A Harassment is not expected to occur from airborne noise.

Marine mammals that occur in the Project area would be exposed to airborne noise associated with pile driving that has the potential to cause harassment, depending on their distance from pile extraction and driving activities. Pacific harbor seals and California sea lions may be exposed to airborne noise if they surface in proximity to pile driving work. Airborne noise from the project would not exceed Level B thresholds at the Castro Rocks haul-out site, but would likely cause behavioral responses similar to those discussed above in relation to underwater noise. For instance, the noise generated could cause pinnipeds to exhibit changes in their normal behavior, such as causing them to move farther from the noise source.

As with underwater noise, because of the relatively short duration of the work and the limited amount of time per day when pile replacement work would occur, exposure to airborne noise would not result in population level impacts or affect the long-term fitness of these species.

7.3 Effects of Human Disturbance on Marine Mammals

The activities of workers in the Project area may also cause behavioral reactions such flushing from the haul-out, head alerts, or moving farther from the disturbance to forage.

The seals at Castro Rocks have habituated to a degree to some sources of human disturbance such as large tanker traffic and the noise from vehicle traffic on the bridge, but often flush into the water when small boats maneuver close by or when people work on the bridge (Kopec and Harvey 1995). During monitoring conducted for the RSRB project, construction activities caused a 5.4-fold increase in disturbance when compared to pre-construction monitoring. The majority of the construction related disturbance (72%) was due to construction related boats moving in the vicinity of Castro Rocks. The average distance at which construction boats caused flushing was 120 meters (394 feet) with a standard error of 7 meters (23 feet). The average distance at which other construction activities caused flushing is similar - 121 meters (397 feet) with a standard error of 15 meters (49 feet).

Construction activities associated with the proposed Project will involve minimal additional boat traffic and would occur at distances much greater than the average distances to activity that caused flushing during RSRB project activities.

8 Anticipated Impact on Subsistence Uses

No subsistence uses of marine mammals occur within San Francisco Bay. No impacts are expected to the availability of the species stock as a result of the proposed Project.

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9 Anticipated Impact of the Activity on the Habitat or the Marine Mammal Populations, and the Likelihood of Restoration of the Affected Habitat

The proposed Project would result in small net increase in Bay fill of approximately 0.01 acre of benthic habitat due to the placement of piles. The piles would be generally be placed within the existing footprint of the Long Wharf. This would not have a measurable influence on habitat for marine mammals in the Bay. A temporary, small-scale loss of foraging habitat may occur for marine mammals if marine mammals leave the area during pile extraction and driving activities.

Acoustic energy created during pile replacement work would have the potential to disturb fish within the vicinity of the pile replacement work. As a result, the affected area could have a temporarily decreased foraging value to marine mammals. During pile driving, high noise levels may exclude fish from the vicinity of pile driving; Hastings and Popper (2005) identified several studies that suggest fish will relocate to avoid areas of damaging noise energy. An analysis of potential noise output of the proposed Project indicates that the distance from underwater pile driving at which noise has the potential to cause temporary hearing loss in fish ranges from approximately 10 to 158 meters (33feet to 518 feet) from pile driving activity, depending on the type of pile[6]. Therefore, if fish leave the area of disturbance, pinniped foraging habitat may have temporarily decreased foraging value when piles are driven.

The duration of fish avoidance of this area after pile driving stops is unknown. However, the affected area represents an extremely small portion of the total area within foraging range of marine mammals that may be present in the Project area.

San Francisco Bay is classified as Essential Fish Habitat (EFH) under the Magnuson-Stevens Fisheries Conservation and Management Act, as amended by the Sustainable Fisheries Act. The EFH provisions of the Sustainable Fisheries Act are designed to protect fisheries habitat from being lost due to disturbance and degradation. The act requires implementation of measures to conserve and enhance EFH.

[6] Distance where underwater noise exceeded the Fisheries Hydroacoustic Working Group (FHWG 2008) threshold of 187 dB SEL for adult fish during vibratory extraction of concrete and timber piles (10 meters, 32 feet) and 60-inch steel piles (158 meters, 520 feet). Other distances include 23 meters (75 feet) during vibratory driving of the composite barrier piles, and 11 meters (37 feet) during impact driving of concrete piles. Noise levels during pile driving would not exceed peak levels (206 dB) that would cause mortality to fish.

San Francisco Bay, including the area of the Project, is classified as EFH for 20 species of commercially important fish and sharks that are federally managed under three fisheries management plans (FMPs): Coastal Pelagic, Pacific Groundfish, and Pacific Coast Salmon (Table 9-1). The Pacific Coast Salmon FMP includes Chinook salmon.

Table 9-1: EFH Managed Species in Central San Francisco Bay

Fisheries Management Plan	Species, Common Name	Species, Scientific Name
Coastal Pelagic	Northern anchovy	*Engraulis mordax*
	jack mackerel	*Trachurus symmetricus*
	Pacific sardine	*Sardinops sagax*
Pacific Groundfish	english sole	*Parophrys vetulus*
	sand sole	*Psettichthys melanostictus*
	curlfin sole	*Pleuronichthys decurrens*
	Pacific sanddab	*Citharichthys sordidus*
	starry flounder	*Platichthys stellatus*
	lingcod	*Ophiodon elongatus*
	brown rockfish	*Sebastes auriculatus*
	Pacific whiting (hake)	*Merluccius productus*
	kelp greenling	*Hexagrammos decagrammus*
	leopard shark	*Triakis semifasciata*
	spiny dogfish	*Squalus acanthias*
	skates	*Raja* ssp.
	soupfin shark	*Galeorhinus galeus*
	Bocaccio	*Sebastes paucispinis*
	Cabezon	*Scorpaenichthys marmoratus*
Pacific Coast Salmon	Chinook salmon	*Oncorhynchus tshawytscha*
	Coho salmon	*Oncorhynchus kisutch*

In addition to EFH designations, San Francisco Bay is designated as a Habitat Area of Particular Concern (HAPC) for various fish species within the Pacific Groundfish and Coastal Pelagic FMPs, as this estuarine system serves as breeding and rearing grounds important to these fish stocks. A number of these fish species are prey species for pinnipeds.

Given the short daily duration of increased underwater noise levels associated with the Project and the impact avoidance and minimization measures (Section 11), the proposed Project is not likely to have a permanent, adverse effect on EFH. Therefore, the Project is not likely to have a permanent, adverse effect on marine mammal foraging habitat.

10 Anticipated Impact of the Loss or Modification of Habitat

The Project's activities are not expected to result in any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or populations. Foraging and dispersal habitat for marine mammals will be temporarily modified by disturbance from increased airborne and underwater noise levels during pile extraction and driving. This modification is expected to have no impact on the ability of marine mammals to disperse and forage in undisturbed areas within their foraging range. While the proposed Project would result in a small net increase in Bay fill of approximately 0.01 acre of benthic foraging habitat, this would not have a measurable influence on habitat for marine mammals in the Bay.

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11 Impact Reduction Methods

Section 6 describes the potential number of marine mammals—by species—that may be exposed to acoustic sources that would be considered Level A and Level B Harassment by NMFS. Level A Harassment will be minimized through the use of bubble curtains and marine mammal monitoring within an exclusion zone; this section describes the methods used to identify the Level A exclusion zone. The following mitigation measures are proposed by Chevron in order to reduce the number of marine mammals potentially affected by this Project.

11.1 Mitigation for Pile Extraction and Driving Activities

As described in Section 6, cumulative noise from pile driving could produce noise levels above the Level A threshold over the distances provided in Table 6-4. The results of this modeling guided the establishment of an exclusion zone around each pile to reduce or prevent Level A Harassment to marine mammals. The following measures will be implemented to reduce the area of potential effects from Level A and Level B Harassment to marine mammals:

1. **Noise Attenuation**

Noise attenuation systems (i.e., bubble curtains) will be used during all impact pile driving of the 60-inch steel shell piles to interrupt the acoustic pressure and reduce the impact on marine mammals. The use of bubble curtains is expected to reduce underwater noise levels by approximately 7 dB, which would greatly decrease the area over which the cumulative SEL threshold for Level A Harassment may be exceeded. By reducing underwater sound pressure levels at the source, bubble curtains would also reduce the area over which Level B Harassment would occur, thereby potentially reducing the numbers of marine mammals affected.

2. **Exclusion Zone**

The exclusion zone established for each pile type will include all or a portion of the area where underwater sound pressure levels are expected to reach or exceed the cumulative SEL thresholds for Level A Harassment as provided in Table 6-4.

Exclusion zones for the various pile types will be established in the marine mammal monitoring plan that will be developed for the 2019 construction season. For those species where Level A Harassment is not being requested, a provisional exclusion zone larger than the modeled cumulative noise Level A zone will be established during initial pile driving, while hydroacoustic measurements are made to establish actual field conditions. For those species where Level A Harassment is being requested, the exclusion zones are established at the largest size that would allow completion of the pile driving in a timely manner by minimizing the number of potential shut-downs. These exclusion zones will be adjusted, in consultation with NMFS, once field conditions have been established through hydroacoustic monitoring, which is described in Section 13.

3. Visual Monitoring

The exclusion zone will be monitored for 30 minutes prior to any pile extraction and driving activities to obtain visual confirmation that the area is clear of any marine mammals. Visual monitoring will occur from clear vantage points along the Long Wharf. Pile extraction or driving will not commence until cetaceans have not been sighted within the exclusion zone for a 30 minute period and pinnipeds for a 15 minute period.

If a marine mammal enters the exclusion zone during pile driving, work will stop until the animal leaves the exclusion zone, and will not resume until no marine mammals are observed in the exclusion zone for 20 minutes. Further description of the proposed marine mammal monitoring is described in Section 13.

Monitoring will be conducted by qualified observers familiar with marine mammal species and their behavior. Up to two (2) marine mammal observers will be stationed to observe the exclusion zone and ensure that pile driving does not occur when cetaceans are present within the exclusion zone. These observers will also record information regarding the presence and behavior of marine mammals within the Level A and Level B Harassment zones. The observer will monitor the exclusion zone from the most practicable vantage point possible (the Long Wharf itself, or a boat) to determine whether marine mammals enter the exclusion zone.

4. Acoustic Monitoring

Hydroacoustic monitoring will be conducted during a portion of the vibratory and impact pile driving to verify and refine the limits of the exclusion zone. This monitoring is described further in Section 13.

5. Daylight Construction Period

Pile driving would occur only during daylight hours when visual marine mammal monitoring can be conducted.

6. Soft Start

A "soft-start" technique is intended to allow marine mammals to vacate the area before the pile driver reaches full power. For impact driving, an initial set of three strikes would be made by the hammer at 40 percent energy, followed by a 30-second waiting period, then two (2) subsequent three (3)-strike sets before initiating continuous driving. For vibratory hammers, the contractor will initiate the driving for 15 seconds at reduced energy, followed by a one 30-second waiting period when there has been downtime of 30 minutes or more. This procedure shall be repeated two additional times before continuous driving is started. This procedure would also apply to vibratory pile extraction.

Should any serious injury or mortality result during the course of the proposed activities, Chevron will suspend operations and will immediately contact NMFS.

11.2 Mitigation Effectiveness

Although Level A Harassment will be minimized through the use of bubble curtains and implementation of exclusion zones, monitoring of take will not be 100 percent effective. Visual observation of marine mammals depends on several factors, including the behavior of the animal (e.g., underwater swimming), the observer’s ability to detect the animal, environmental conditions and monitoring platforms. Additionally, since Level A Harassment is based on cumulative noise, it is difficult to establish the nature of take (Level A or Level B) for animals that enter the Level A zone for a short period of time.

Marine mammal observers will be biologists with experience in the detection and behavior of marine mammals so that the observers are able to adequately detect marine mammals in the exclusion zone; and to determine their behavior and whether they appear to be harassed by the pile extraction and driving activities.

Observers will be positioned in locations that provide the best vantage points for monitoring, but conditions such as fog or choppy waters may hinder observations. Observers are likely to be on the Long Wharf decking or structures adjacent to the work area.

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12 Arctic Subsistence Uses, Plan of Cooperation

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

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13 Monitoring and Reporting

Chevron would develop a detailed monitoring plan for conducting acoustic measurements and documenting marine mammal observations. The acoustic monitoring plan will outline the methods for underwater noise measurements to provide data on actual noise levels during construction, and provide data such that the marine mammal exclusion zone can be properly enforced during pile extraction and driving activities. The marine mammal monitoring portion of the plan will provide details on data collection for each distinct marine mammal species observed in the Project area during the construction period. Monitoring will include the following: marine mammal behavior observations, count of the individuals observed, and the frequency of the observations. The monitoring plan sections are described in more detail below.

13.1 Acoustic Monitoring

Hydroacoustic monitoring would be conducted by a qualified monitor during pile extraction and driving activities. Details would be developed during work plan preparation, but will include monitoring at least two (2) piles of each type. A reference location would be established at the estimated cumulative SEL contour for that pile type. Measurements would be taken at two depths: one in mid-water column, and one near the bottom (but at least 1 meter (3 feet) above the bottom). Additional details of the acoustical monitoring plan will be developed in conjunction with NMFS prior to the start of construction, but will likely include the following during 2019:

- Acoustic monitoring for at least two (2) 60-inch steel pipe piles at Berth 4;
- Acoustic monitoring for at least one (1) 36-inch pile at Berth 4;
- Acoustic monitoring for at least one (1) 20-inch pile at Berth 4;
- Acoustic monitoring of a representative pile removal; and
- Acoustic monitoring of two (2) composite piles.

13.2 Marine Mammal Monitoring

Specific details of the biological monitoring will be developed in conjunction with NMFS during finalization of the IHA, but will include monitoring when piles are being extracted or driven. Chevron will collect sighting data and observations on behavioral responses to construction for marine mammal species observed in the region of activity during the period of construction. All observers will be trained in marine mammal identification and behaviors, and would conduct the following general monitoring and reporting tasks:

- Biological monitoring would occur within one (1) week before the Project's start date, to establish baseline observations.
- Observation periods will encompass different tide levels and hours of the day. Monitoring of marine mammals around the construction site will be conducted using high-quality binoculars as necessary (e.g., Zeiss, 10 x 42 power).
- Data collection will consist of a count of all pinnipeds and cetaceans by species, a description of behavior (if possible), location, direction of movement, type of construction that is occurring, time that pile replacement work begins and ends, any acoustic or visual disturbance, and time of the observation. Environmental conditions such as weather, visibility, temperature, tide level, current and sea state would also be recorded.
- Biological monitoring would occur from appropriate monitoring locations on the Long Wharf to maintain a clear view of the exclusion zone and adjacent areas during the survey period. Monitors would be equipped with radios or cell phones for maintaining contact with work crews.
- During pile extraction and driving, the underwater exclusion zone will be monitored for 20 minutes prior to commencing work. If marine mammals are within the exclusion zone, the start of extraction or driving will be delayed until no animals are sighted within the zone for 20 minutes.
- A final report would be submitted to NMFS within 90 days after completion of the proposed Project (or annual pile driving work). If pile driving occurs for more than one year, a report will be submitted for each year within 90 days after the seasonal work period (June 1 through November 30) ends.

14 Coordinating Research to Reduce and Evaluate Incidental Take

To reduce the likelihood that impacts will occur to the species, stocks, and subsistence use of marine mammals, construction activities will be conducted in accordance with federal, state and local regulations and the minimization measures proposed in Section 11 to protect marine mammals. Chevron will coordinate all activities as needed with relevant federal and state agencies. These include, but are not limited to: NMFS, U.S. Army Corps of Engineers, and the California Department of Fish and Wildlife.

Marine mammal and acoustic monitoring reports would provide useful information that would allow design of future projects to reduce incidental take of marine mammals. Chevron will share field data and behavioral observations on marine mammals that occur in the Project area. Results of each monitoring effort will be provided to NMFS in a summary report at the conclusion of monitoring. This information could be made available to federal, state and local resource agencies, scientists and other interested parties upon written request to NMFS.

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Appendix A 2018 Hydroacoustic Monitoring Results

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Appendix A: 2018 Hydroacoustic Monitoring Results

This Appendix contains three memos that provide the methods and results of hydroacosutic monitoring conducted during 2018 Pile Driving:

The first memo provides the results of monitoring conducted during impact driving on June 6th, 2018;

The second memo provides results of monitoring conducted during vibratory driving on June 11th, 2018; and

The third memo provides the results of monitoring conducted during impact driving on July 22nd and 23rd, 2018.

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Acoustics • Air Quality

423 4th Street Suite S1W
Marysville, CA 95901
Ph (530) 777-9269
Email – kpommerenck@illingworthrodkin.com
www.iandrinc.com

Memo

To: Bill Martin
AECOM

From: Torrey Dion

Date: June 7, 2018

Re: Chevron Long Wharf Maintenance and Efficiency Project –Hydroacoustic Measurements

Subject: **Preliminary Results of the June 6, 2018 Hydroacoustic Measurements**

The following is a summary of the work completed on June 6, 2018 for the driving of one 24-inch concrete square pile at Chevron Long Wharf. Table 3 shows the summary of the hydroacoustic measurements.

The hydroacoustic monitoring will be conducted in accordance with the requirements of the United States Army Corps Engineers (Corps), and the National Marine Fisheries Service (NMFS) Biological Opinion 1. The monitoring will be done in accordance with the methodology outlined in this Hydroacoustic Monitoring Plan. The monitoring will be conducted based on the following:

- Be based on the dual metric criteria (Popper et al. 2006) and the accumulated sound exposure level (SEL);
- Establish field locations that will be used to document the extent of the area experiencing 187 decibels (dB) SEL accumulated;
- Describe the methods necessary to continuously assess underwater noise on a real-time basis, including details on the number, location, distance and depth of hydrophones, and associated monitoring equipment;
- Provide a means of recording the time and number of pile strikes, the peak sound energy per strike, and interval between strikes;

Three hydrophones were deployed to establish the needed data to calculate the attenuation rate and the distances to the various criteria. One hydrophone was placed at 10 meters, a second was placed at 55 meters, a third hydrophone was placed at 280 meters. Hydrophones were placed at mid depth in the water at approximately 20 feet deep for both the 10-meter and 55-meter locations. The hydrophone at 280 meters was placed at a depth of about 5 feet due to shallow water conditions further from the wharf.

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[1] National Marine Fisheries Service, West Coast Region, Tracking Number WCR-2016-5530, Dated June 20, 2017

The 55-meter hydrophone did not produce valuable data due to an unknown loose connection after installation. Due to the nature of the installation, underwater levels could not be validated during meter operation. For this reason, subsequent measurements will require a different 55-meter location to ensure valid data is being recorded.

The distances to the 187 dB and 183 dB Cumulative SEL thresholds was calculated using a conservative 20 log drop off rate and using the data measured in the field. Table 1 shows the per pile and daily distances to the two criteria.

Table 1 – Distances to the NMFS Cumulative SEL Thresholds (dB re: 1μPa-sec^2)
Distances are in Meters

Day	Pile ID	Distance to 187 dB $_{\text{Cumulative SEL}}$ (meters)	Distance to 183 dB $_{\text{Cumulative SEL}}$ (meters)
6/6	4	6 meters	9 meters

The distances to the 160 dB RMS for marine mammals and 150 dB RMS for fish were established based on the average daily maximum RMS levels measured. The attenuation rate used was a conservative 20 log drop off in this case. Typically, NMFS uses a 15 log drop off if there is no site-specific data available, however the 20 log drop off rate used based on a conservative assessment of the data collected at the site during the measurements. The drop off rates from the field measurements ranged from 20 log to over 30 log. Table 2 shows the various distances.

Table 2 - Distances are based on an
Average RMS level of 180 dB re 1μPa at 10 meters

Criteria	Distance in Meters
160 dB RMS for marine mammals	45 meters
150 dB RMS for fish	141 meters

The average number of pile strikes per minute is estimated to be approximately 38 blows per minute or approximately one blow every 1.5 seconds. Table 3 shows the number of blows per pile and the maximum peak, RMS, and SEL levels and range of RMS and SEL levels measured. The time histories for the 10-meter and 280-meter locations are shown in Figures 1 and 2.

Table 3 – June 6, 2018 Summary

Pile ID	Time	Distance	Peak	RMS		One-Second SEL		Single Pie Cumulative SEL	Number of pile strikes
			Max	Mean	Range	Mean	Range		
24” Concrete #4	10:38 10:48	10	191	173	175-165	161	165-154	182	71
		55	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	
		280	146	126	136-113	117	127-106	140	

[1]Data invalid for particular day.

Figure 1

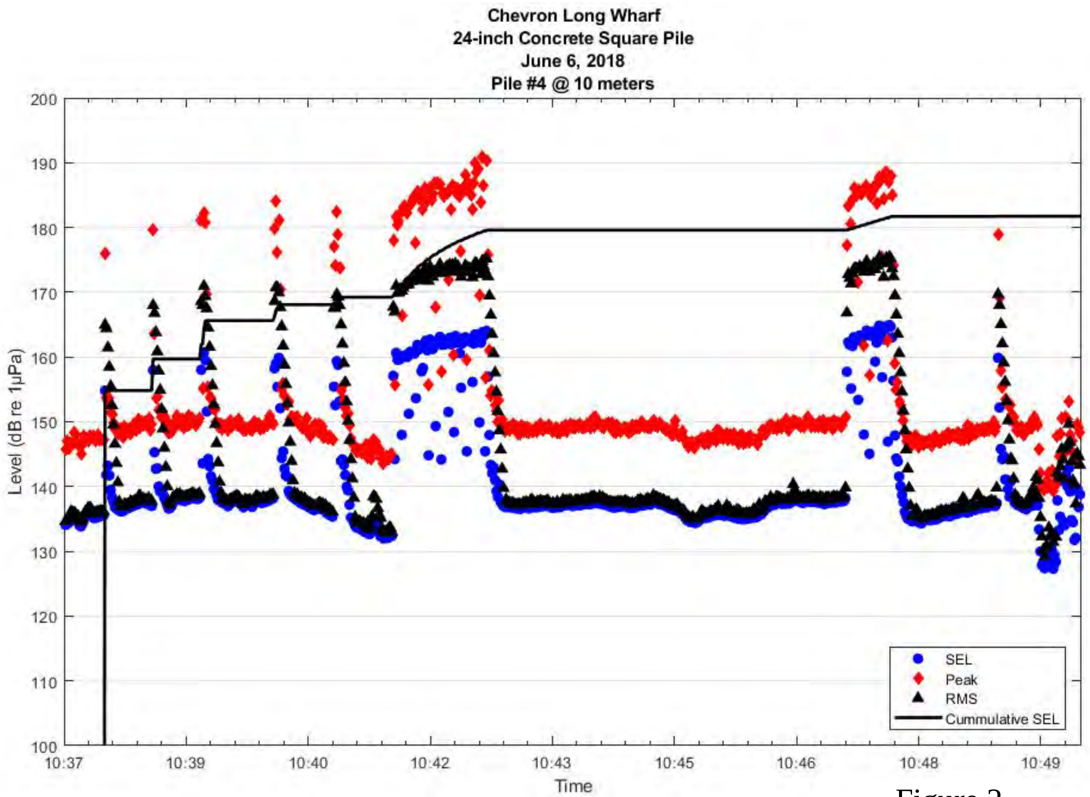
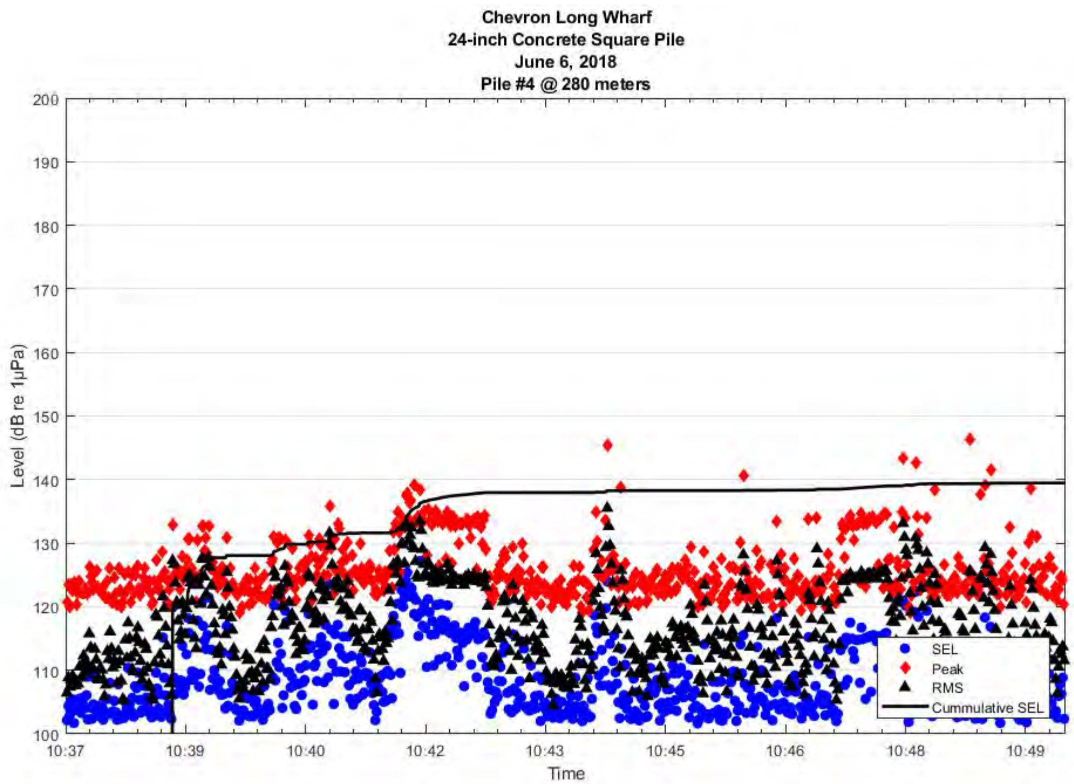


Figure 2

Figure 2


Chevron Long Wharf
24-inch Concrete Square Pile
June 6, 2018
Pile #4 @ 280 meters
Level (dB re 1µPa)
200
190
180
170
160
150
140
130
120
110
100
10:37
10:39
10:40
10:42
10:43
10:45
10:46
10:48
10:49
Time
SEL
Peak
RMS
Cummulative SEL

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423 4th Street Suite S1W
Marysville, CA 95901
Ph (530) 777-9269
Email – kpommerenck@illingworthrodkin.com
www.iandrinc.com

Memo

To: Bill Martin
AECOM

From: Torrey Dion

Date: June 13, 2018

Re: Chevron Long Wharf Maintenance and Efficiency Project –Hydroacoustic Measurements

Subject: **Preliminary Results of the June 11, 2018 Hydroacoustic Measurements**

The following is a summary of the work completed on June 11, 2018 for the driving of two 14-inch steel H piles at the Chevron Long Wharf. Table 3 shows the summary of the hydroacoustic measurements. Piles were installed using a vibratory hammer.

The hydroacoustic monitoring will be conducted in accordance with the requirements of the United States Army Corps Engineers (Corps), and the National Marine Fisheries Service (NMFS) Biological Opinion 1. The monitoring will be done in accordance with the methodology outlined in this Hydroacoustic Monitoring Plan. The monitoring will be conducted based on the following:

- Be based on the dual metric criteria (Popper et al. 2006) and the accumulated sound exposure level (SEL);
- Establish field locations that will be used to document the extent of the area experiencing 187 decibels (dB) SEL accumulated;
- Describe the methods necessary to continuously assess underwater noise on a real-time basis, including details on the number, location, distance and depth of hydrophones, and associated monitoring equipment;
- Provide a means of recording the time and number of pile strikes, the peak sound energy per strike, and interval between strikes;

Three hydrophones were deployed to establish the needed data to calculate the attenuation rate and the distances to the various criteria. One hydrophone was placed at 10 meters, a second was placed at 55 meters, a third hydrophone was placed at 280 meters. Hydrophones were placed at mid depth in the water at approximately 20 feet deep for both the 10-meter and 55-meter locations. The hydrophone at 280 meters was placed at a depth of about 5 feet due to shallow water conditions further from the wharf.

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[1] National Marine Fisheries Service, West Coast Region, Tracking Number WCR-2016-5530, Dated June 20, 2017

The 280-meter hydrophone did not record any distinguishable pile driving levels. Levels from the 280-meter hydrophone were representative of water current noise have been included in Figures 3 and 6.

The distances to the 187 dB and 183 dB Cumulative SEL thresholds were calculated using a 20 log drop off rate based off field measurements. Table 1 shows the per pile and daily distances to the two criteria.

Table 1 – Distances to the NMFS Cumulative SEL Thresholds (dB re: 1µPa-sec^2) Distances are in Meters

Day	Pile ID	Distance to 187 dB $_{\text{Cumulative SEL}}$ (meters)	Distance to 183 dB $_{\text{Cumulative SEL}}$ (meters)
6/11	14” Steel H Pile #6	Less than 10 meters	Less than 10 meters
6/11	14” Steel H Pile #7	Less than 10 meters	Less than 10 meters

The distances to the, 160 dB RMS for marine mammals and 150 dB RMS for fish were established based on the average daily maximum RMS levels measured. The attenuation rate used was a conservative 20 log drop off in this case. Typically, NMFS uses a 15 log drop off if there is no site-specific data available, however the 20 log drop off rate used based on a conservative assessment of the data collected at the site during the measurements. The drop off rates from the field measurements ranged from 20 log to over 30 log. Table 2 shows the various distances.

Table 2 - Distances are based on an Average RMS level of 150 dB re 1µPa at 10 meters

Criteria	Distance in Meters
160 dB RMS for marine mammals	Less than 10 meters
150 dB RMS for fish	10 meters

Table 3 shows the maximum peak, RMS, and SEL levels and range of RMS and SEL levels measured. The time histories for the 10-meter, 55-meter, and 280-meter locations are shown in Figures 1 through 6.

Table 3 – June 6, 2018 Summary

Pile ID	Time	Distance	Peak	10-Sec Average RMS		One-Second SEL	
			Max	Mean	Range	Mean	Range
14” Steel #6	8:14 8:30	10	162	150	151-146	147	151-138
		55	156	134	140-128	132	142-126
		280	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]
14” Steel #7	9:18 9:42	10	165	149	151-144	146	151-134
		55	154	132	137-119	130	141-112
		280	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]

[1]Levels not considered due to high water current noise.

Figure 1

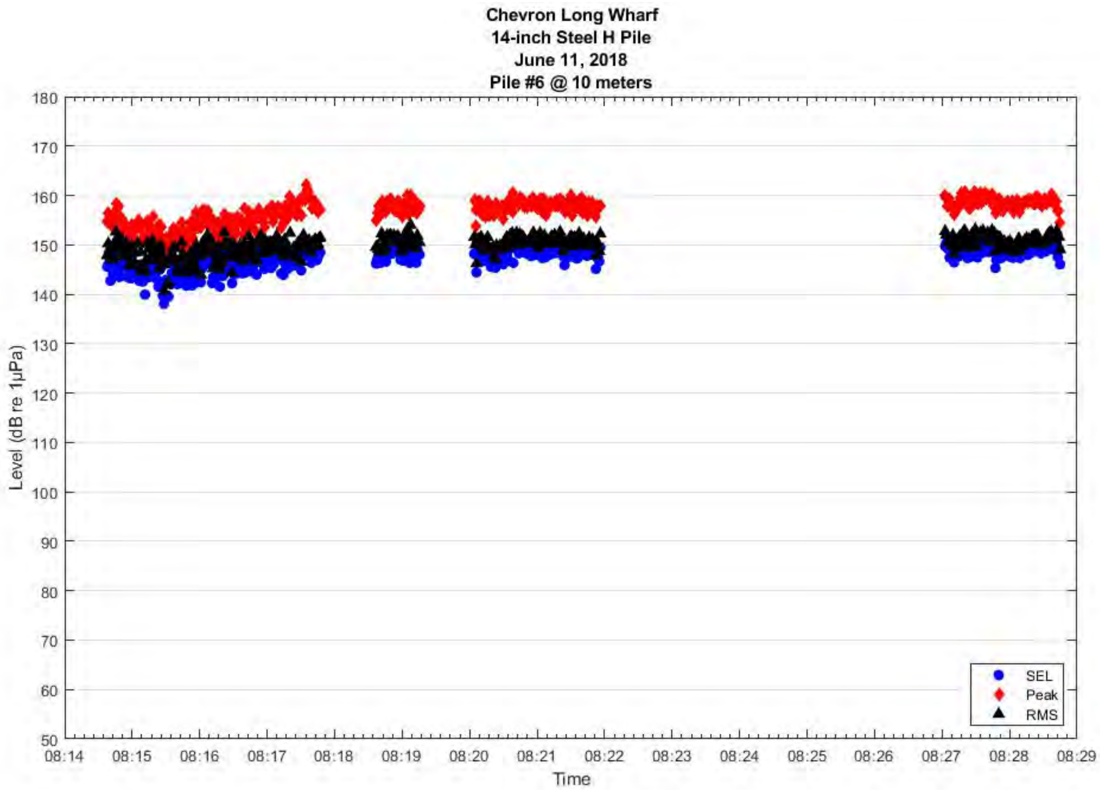


Figure 2

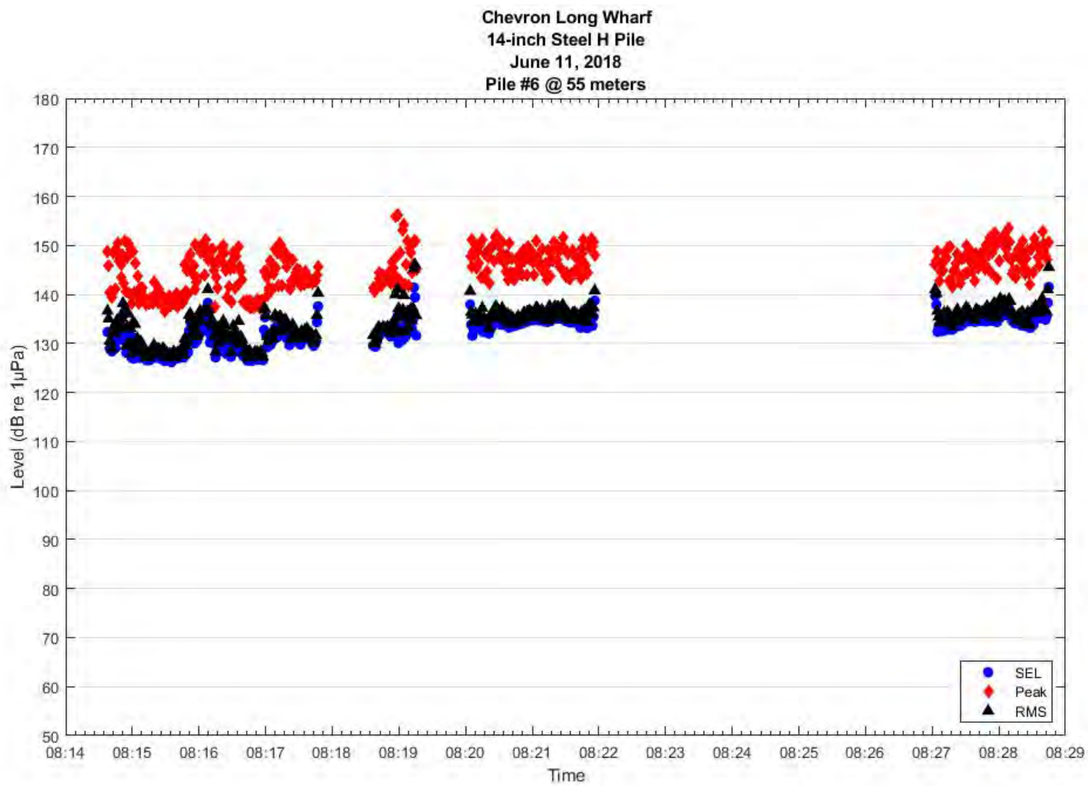


Figure 3

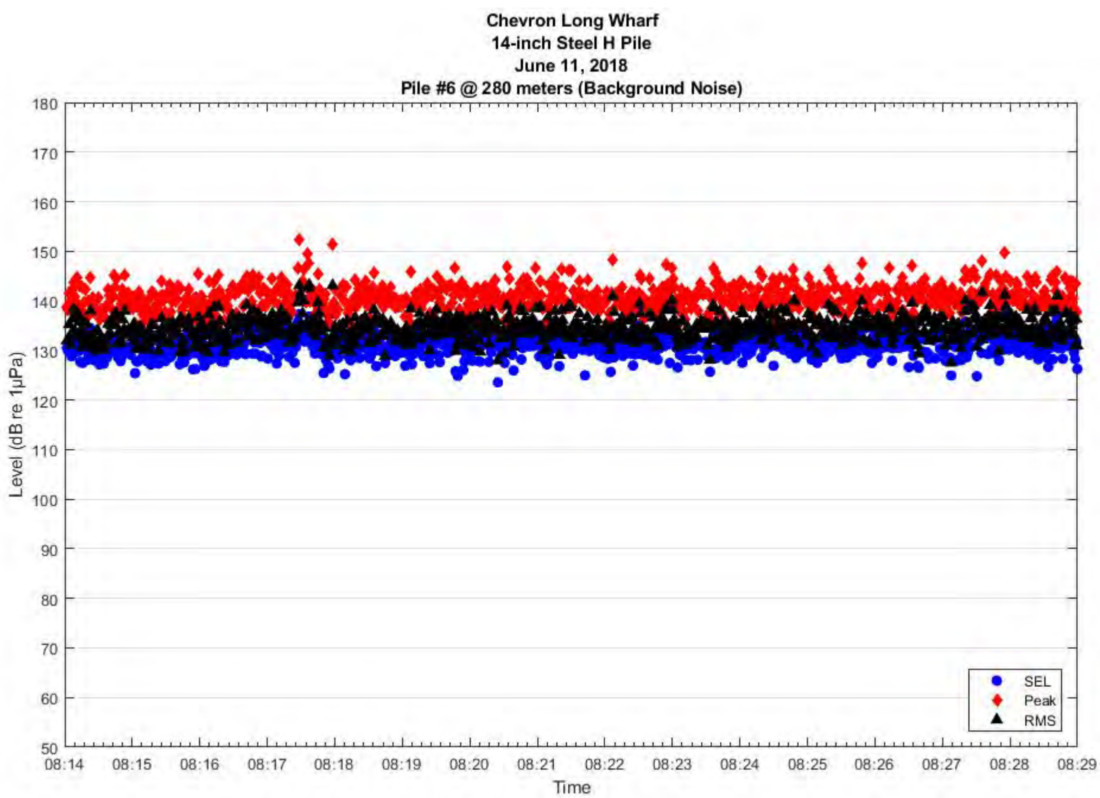


Figure 4

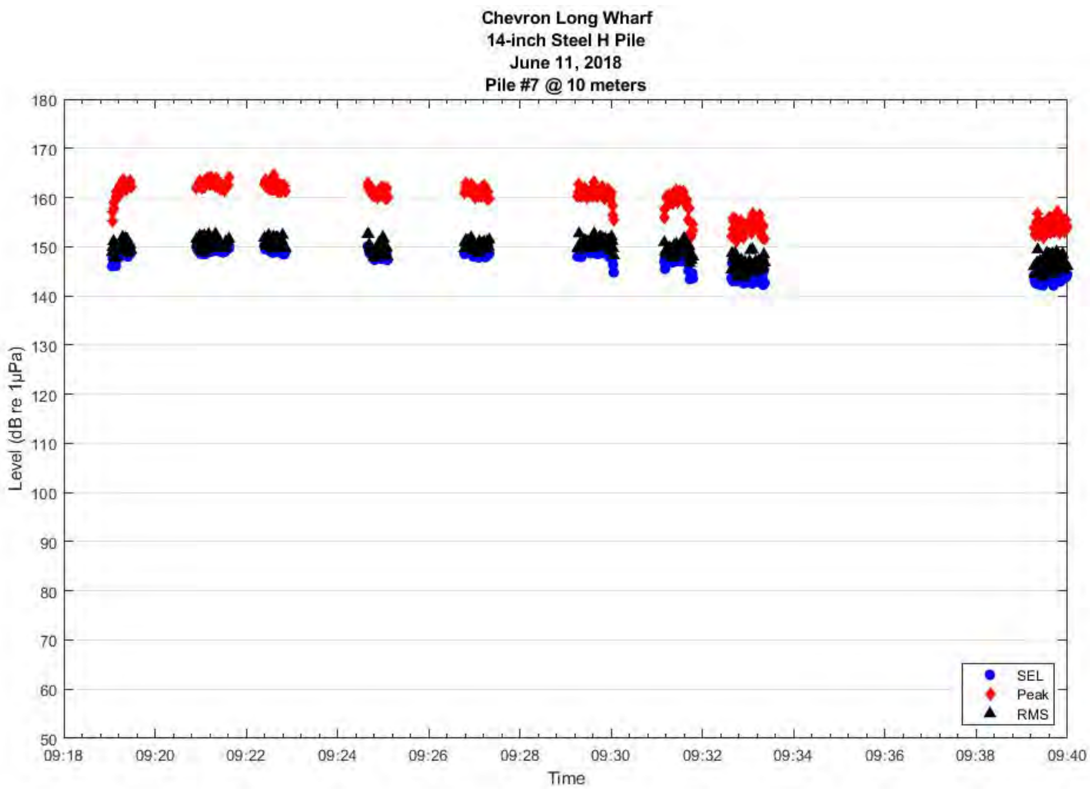


Figure 5

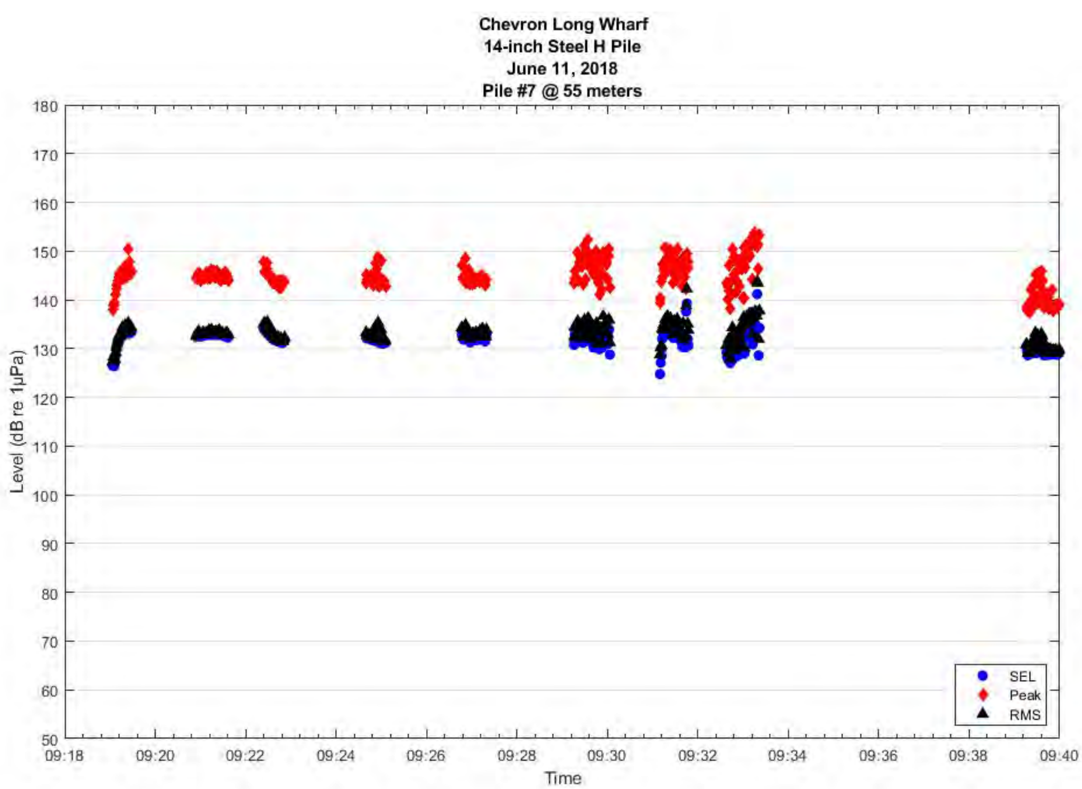
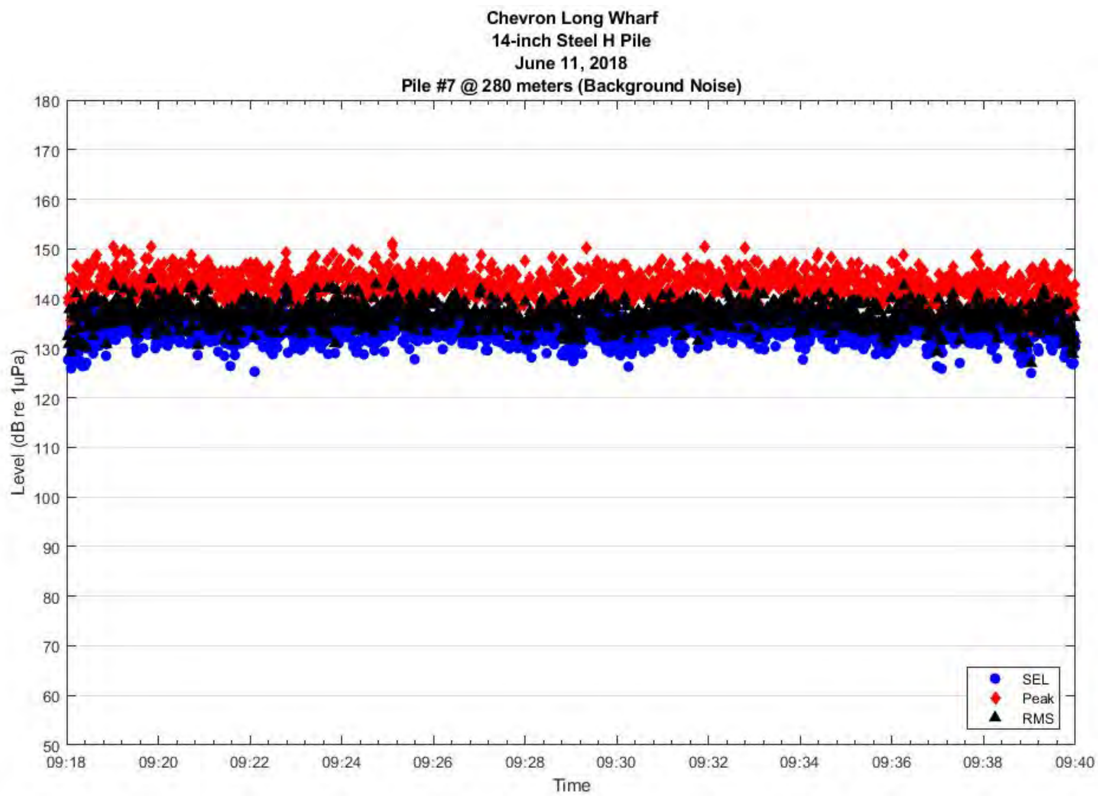


Figure 6


Chevron Long Wharf
14-inch Steel H Pile
June 11, 2018
Pile #7 @ 280 meters (Background Noise)
Level (dB re 1μPa)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
09:18
09:20
09:22
09:24
09:26
09:28
09:30
09:32
09:34
09:36
09:38
09:40
Time
SEL
Peak
RMS

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Memo

To: Bill Martin
AECOM

From: Torrey Dion

Date: July 31, 2018

Re: Chevron Long Wharf Maintenance and Efficiency Project –Hydroacoustic Measurements

Subject: **Preliminary Results of the July 22-23, 2018 Hydroacoustic Measurements**

The following is a summary of the work completed on June 22, 2018 through June 23, 2018 for the driving of four 24-inch concrete square piles at the Chevron Long Wharf. Table 3 shows the summary of the hydroacoustic measurements. Piles were installed using an impact hammer.

The hydroacoustic monitoring was conducted in accordance with the requirements of the United States Army Corps Engineers (Corps), and the National Marine Fisheries Service (NMFS) Biological Opinion [1]. The hydroacoustic Monitoring Plan required the following:

- Measure the dual metric criteria (Popper et al. 2006) and the accumulated sound exposure level (SEL);
- Establish field locations that will be used to document the extent of the area experiencing 187 decibels (dB) SEL accumulated;
- Describe the methods necessary to continuously assess underwater noise on a real-time basis, including details on the number, location, distance and depth of hydrophones, and associated monitoring equipment;
- Provide a means of recording the time and number of pile strikes, the peak sound energy per strike, and interval between strikes;

Three hydrophones were deployed to establish the needed data to calculate the attenuation rate and the distances to the various criteria. One hydrophone was placed at 12-15 meters from the pile, a second was placed at 60 meters, a third hydrophone was placed at 280 meters. Hydrophones were placed at mid depth in the water at approximately 7 meters deep for both the 12-15-meter and 60-meter locations. The hydrophone at 280 meters was placed at a depth of about 1.5 meter due to shallow water conditions further from the wharf.

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[1] National Marine Fisheries Service, West Coast Region, Tracking Number WCR-2016-5530, Dated June 20, 2017

The distances to the 187 dB and 183 dB Cumulative SEL thresholds were calculated using a 20 log drop off rate based off field measurements for the two closer positions. Table 1 shows the per pile and daily distances to the two criteria.

Table 1 – Distances to the NMFS Cumulative SEL Thresholds (dB re: 1μPa-sec^2)
Distances are in Meters

Day	Pile ID	Distance to 187 dB $_{\text{Cumulative SEL}}$ (meters)	Distance to 183 dB $_{\text{Cumulative SEL}}$ (meters)
7/22	24" Square Concrete Pile #1	Less than 10 meters	Less than 10 meters
7/22	24" Square Concrete Pile #2	Less than 10 meters	Less than 10 meters
7/22	All Piles	Less than 10 meters	11 meters
7/23	24" Square Concrete Pile #3	Less than 10 meters	Less than 10 meters
7/23	24" Square Concrete Pile #4	Less than 10 meters	Less than 10 meters
7/23	Al Piles	Less than 10 meters	12 meters

The distances to the 160 dB RMS for marine mammals and 150 dB RMS for fish were established based on the average daily maximum RMS levels measured. The attenuation rate was computed to be about a conservative 20 log drop off in this case. Typically, NMFS uses a 15 log drop off if there is no site-specific data available, however the 20 log drop off rate used based on a conservative assessment of the data collected at the site during the measurements. The drop off rates from the field measurements ranged from 20 log to over 30 log. Table 2 shows the various distances.

Table 2 - Distances are based on an
Average RMS level of 156 dB re 1μPa at 60 meters

Criteria	Distance in Meters
160 dB RMS for marine mammals	38 meters
150 dB RMS for fish	120 meters

Tables 3 and 4 show the maximum peak, RMS, and SEL levels and range of RMS and SEL levels measured. The time histories for the 12-15-meter, 60-meter, and 280-meter locations are shown in Figures 1 through 12.

Table 3 – July 22, 2018 Summary

	Pile ID	Hammer Type	# Strikes	Hydrophone Distance from Pile/ depth (m)	Water Depth (m)		Peak (dB)		SEL (dB)[1]			RMS (dB)			Notes
					At Pile	At H-phone	Max	Mean	Max	Mean	SEL cumulative	Max	Mean	Duration (Mean)	
7/22 2:06-2:30pm	1	A.P.E D70-52	128	13 / 7	~12	~12	181	178	157	156	177	170	168	0.057seconds	Impact hammer with bubble curtain attenuation
7/22 2:06-2:30pm	1	A.P.E D70-52	128	60 / 7	~12	~12	165	160	143	139	-[2]	153	150	0.057seconds	Impact hammer with bubble curtain attenuation
7/22 2:06-2:30pm	1	A.P.E D70-52	128	280 / 1	~2	~2	142	138	123	116	-[2]	128	126	0.057seconds	Impact hammer with bubble curtain attenuation
7/22 3:28-3:39pm	2	A.P.E D70-52	107	15 / 7	~12	~12	188	185	161	159	178	173	171	0.057seconds	Impact hammer with bubble curtain attenuation
7/22 3:28-3:39pm	2	A.P.E D70-52	107	60 / 7	~12	~12	172	170	149	147	-[2]	161	158	0.057seconds	Impact hammer with bubble curtain attenuation
7/22 3:28-3:39pm	2	A.P.E D70-52	107	280 / 1	~2	~2	147	141	134	126	-[2]	139	131	0.057seconds	Impact hammer with bubble curtain attenuation

[1] This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet).

Table 4 – July 23, 2018 Summary

Date and Time	Pile ID	Hammer Type	# Strikes	Hydrophone Distance from Pile/ depth (m)	Water Depth (m)		Peak (dB)		SEL (dB)[1]			RMS (dB)			Notes
					At Pile	At H-phone	Max	Mean	Max	Mean	SEL cumulative	Max	Mean	Duration (Mean)	
7/23 5:18-5:30pm	3	A.P.E. D70-52	92	15 / 7	~12	~12	186	182	160	158	178	172	169	0.057 seconds	Impact hammer with bubble curtain attenuation
7/23 5:18-5:30pm	3	A.P.E. D70-52	92	60 / 7	~12	~12	171	168	148	145	-[2]	160	156	0.057 seconds	Impact hammer with bubble curtain attenuation
7/23 5:18-5:30pm	3	A.P.E. D70-52	92	280 / 1	~2	~2	141	139	123	119	-[2]	129	126	0.057 seconds	Impact hammer with bubble curtain attenuation
7/23 4:25-4:32pm	4	A.P.E. D70-52	71	12 / 7	~12	~12	189	184	162	160	179	174	172	0.057 seconds	Impact hammer with bubble curtain attenuation
7/23 4:25-4:32pm	4	A.P.E. D70-52	71	60 / 7	~12	~12	175	170	149	146	-[2]	161	158	0.057 seconds	Impact hammer with bubble curtain attenuation
7/23 4:25-4:32pm	4	A.P.E. D70-52	71	280 / 1	~2	~2	142	140	126	121	-[2]	131	127	0.057 seconds	Impact hammer with bubble curtain attenuation

[1] This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet).

Figure 1

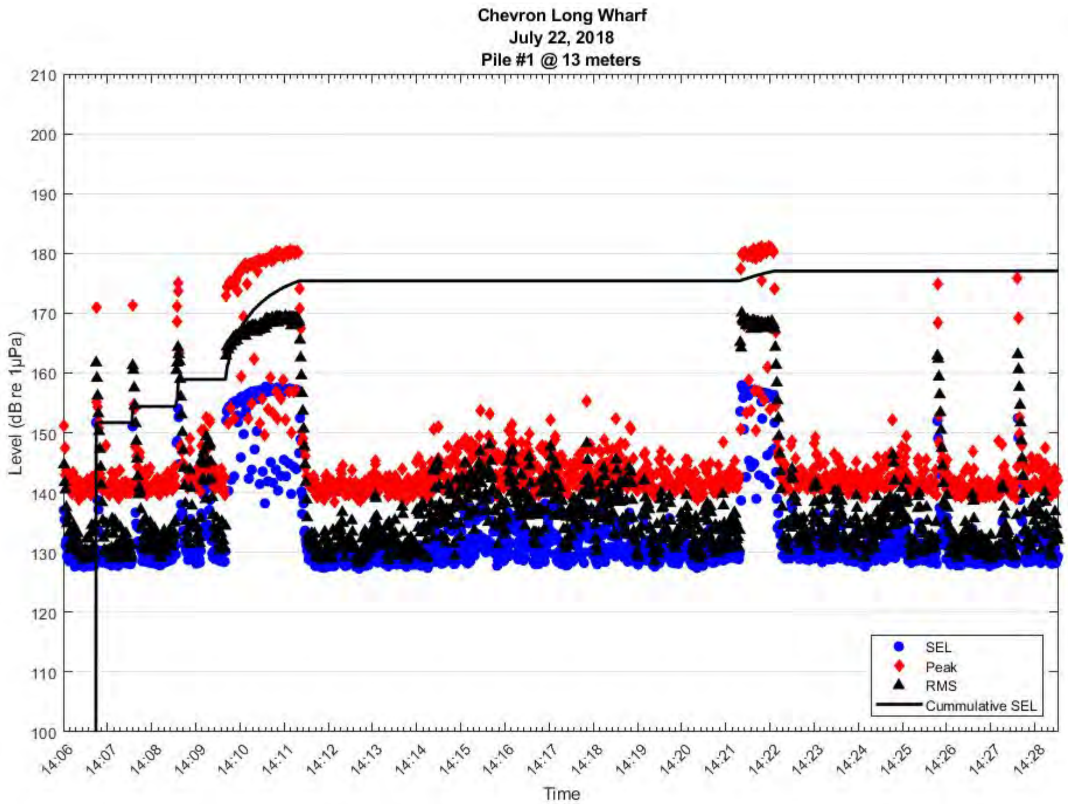


Figure 2

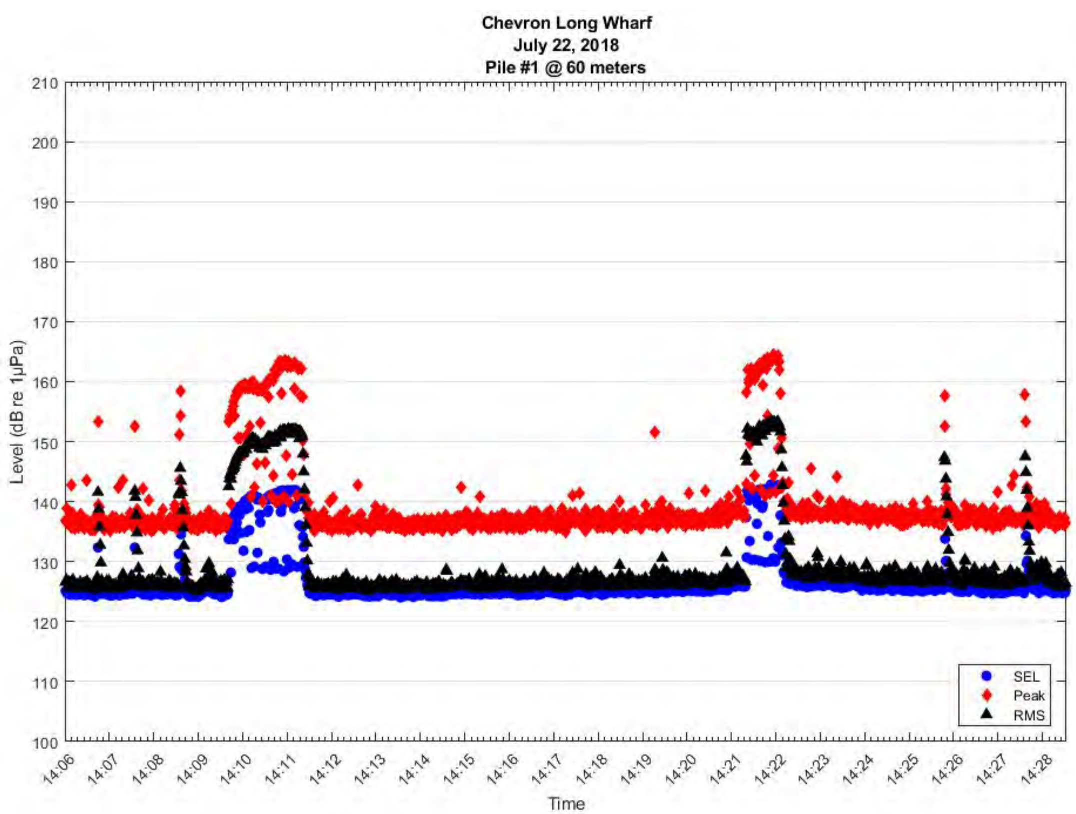


Figure 3

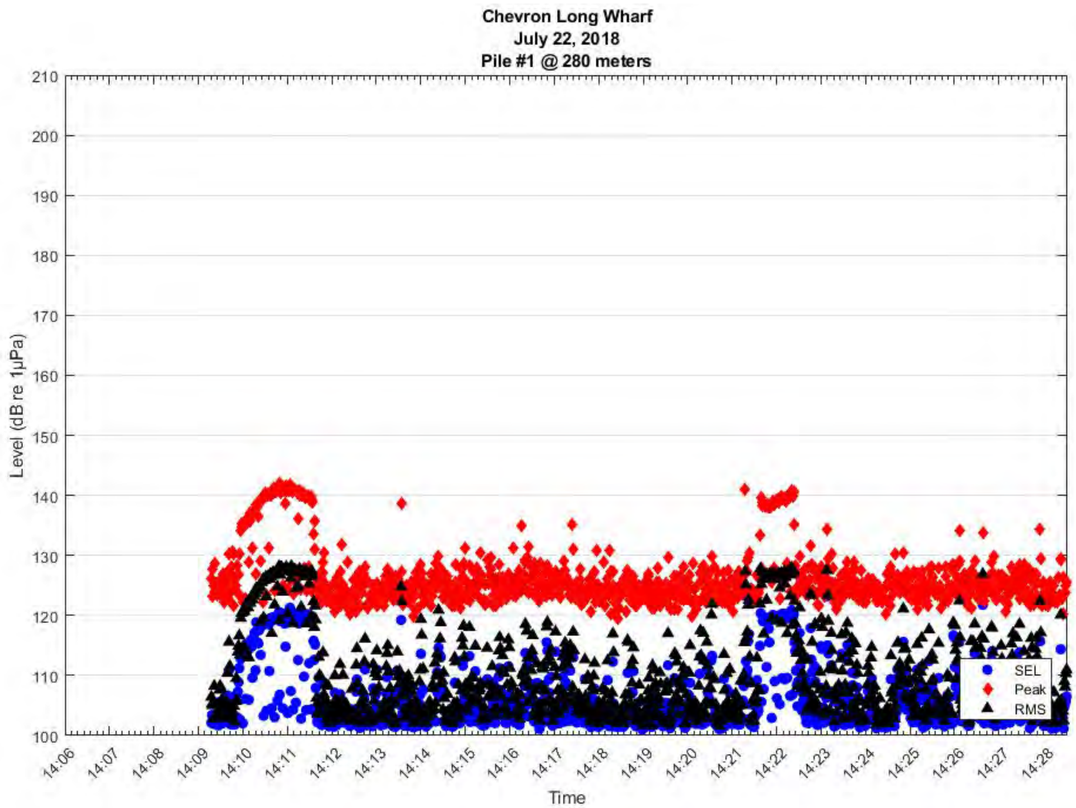
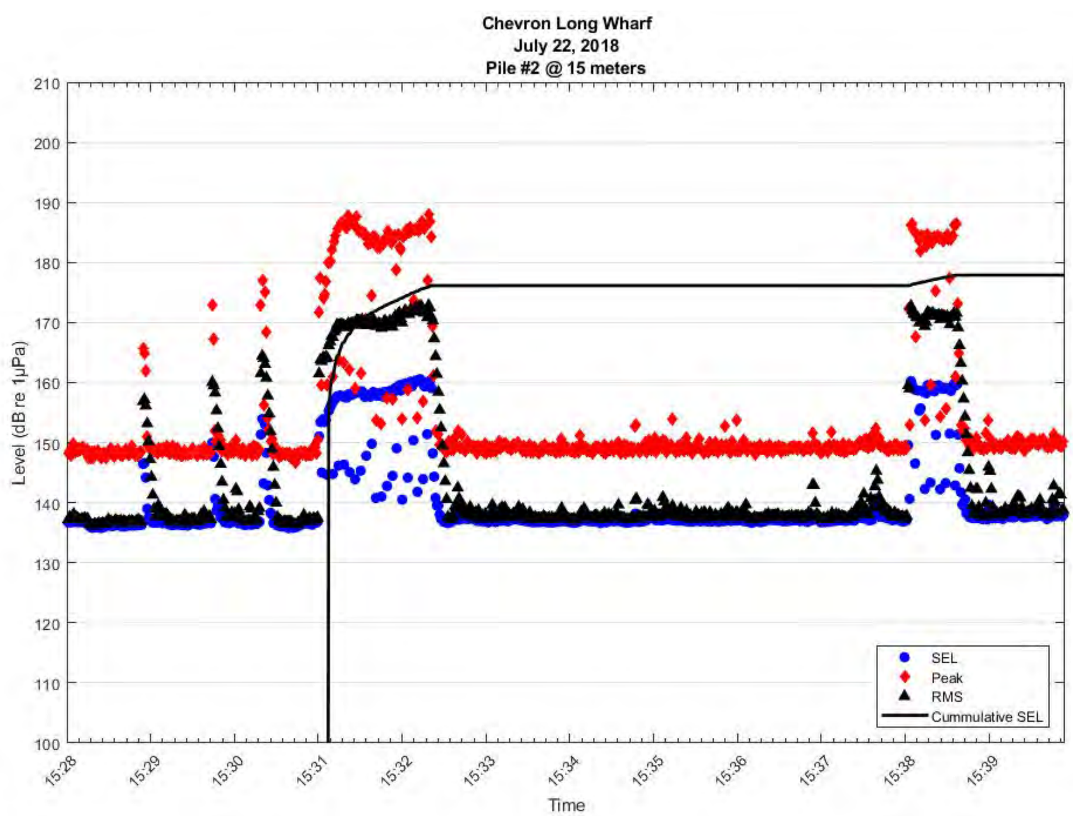


Figure 4



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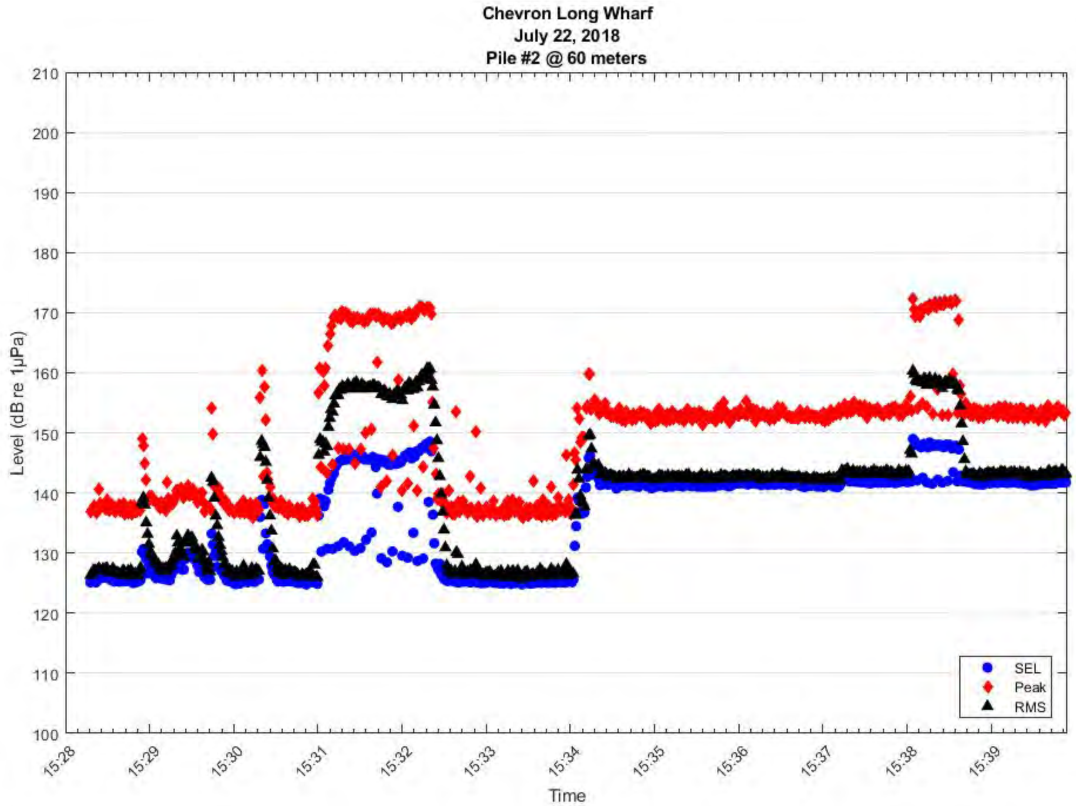


Figure 6

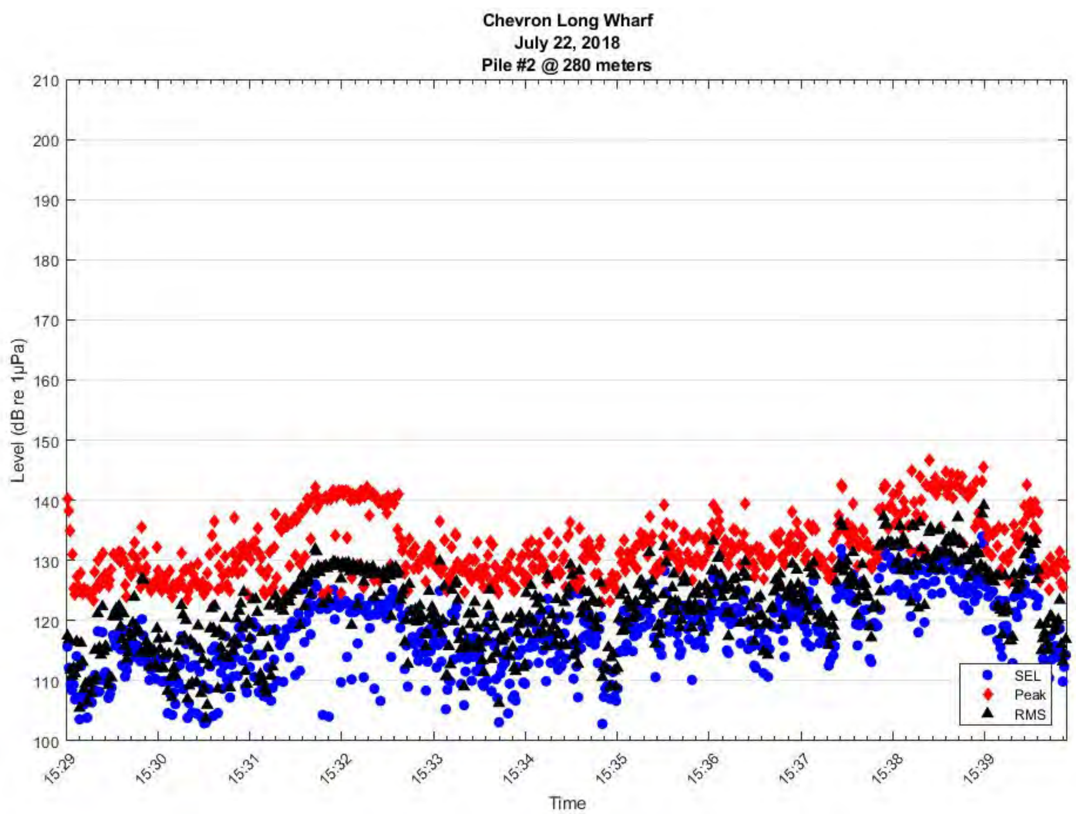


Figure 7

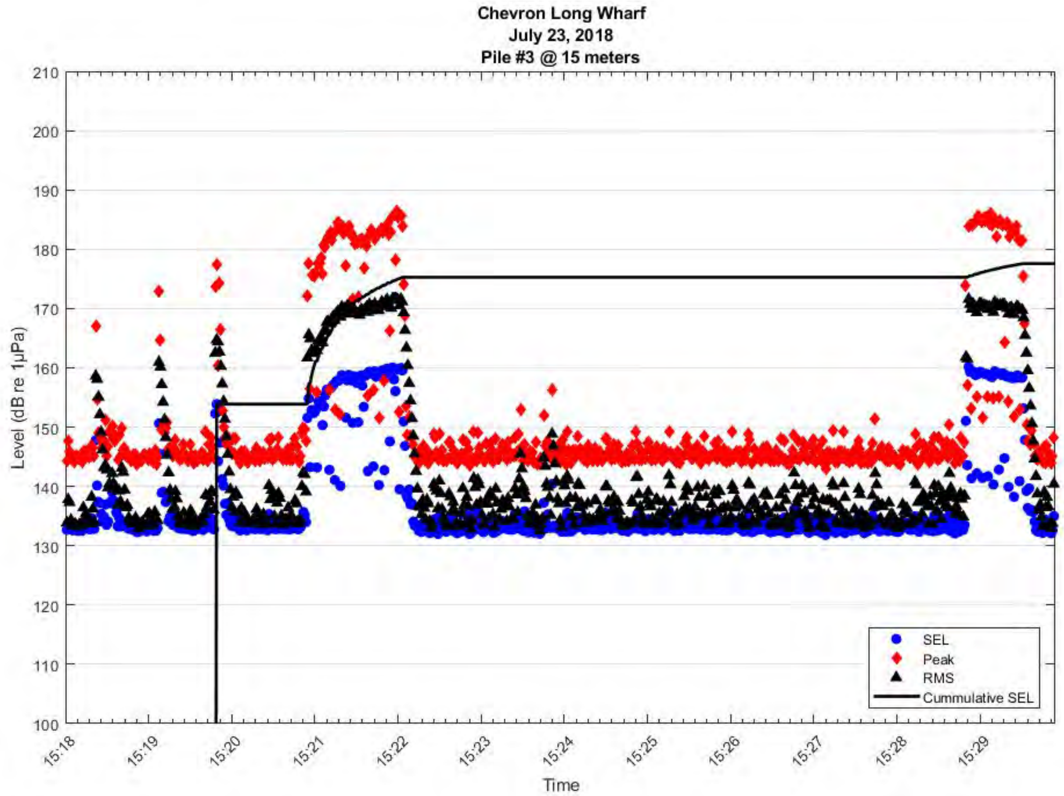


Figure 8

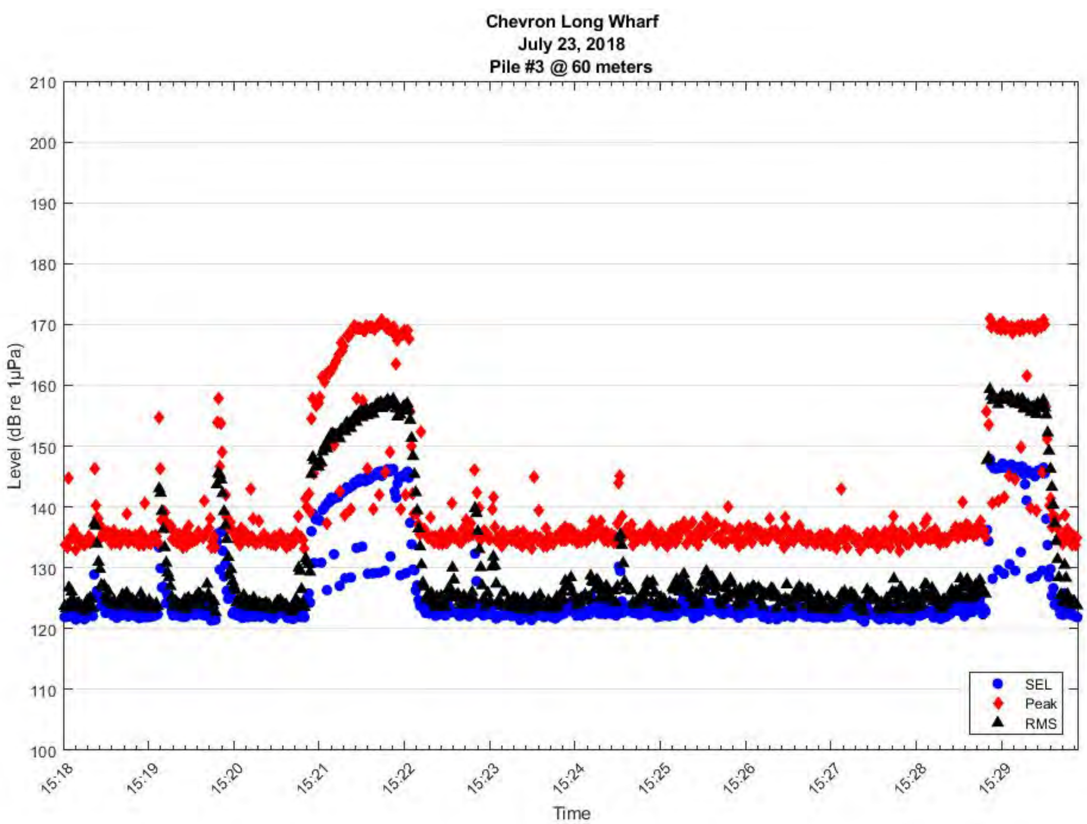


Figure 9

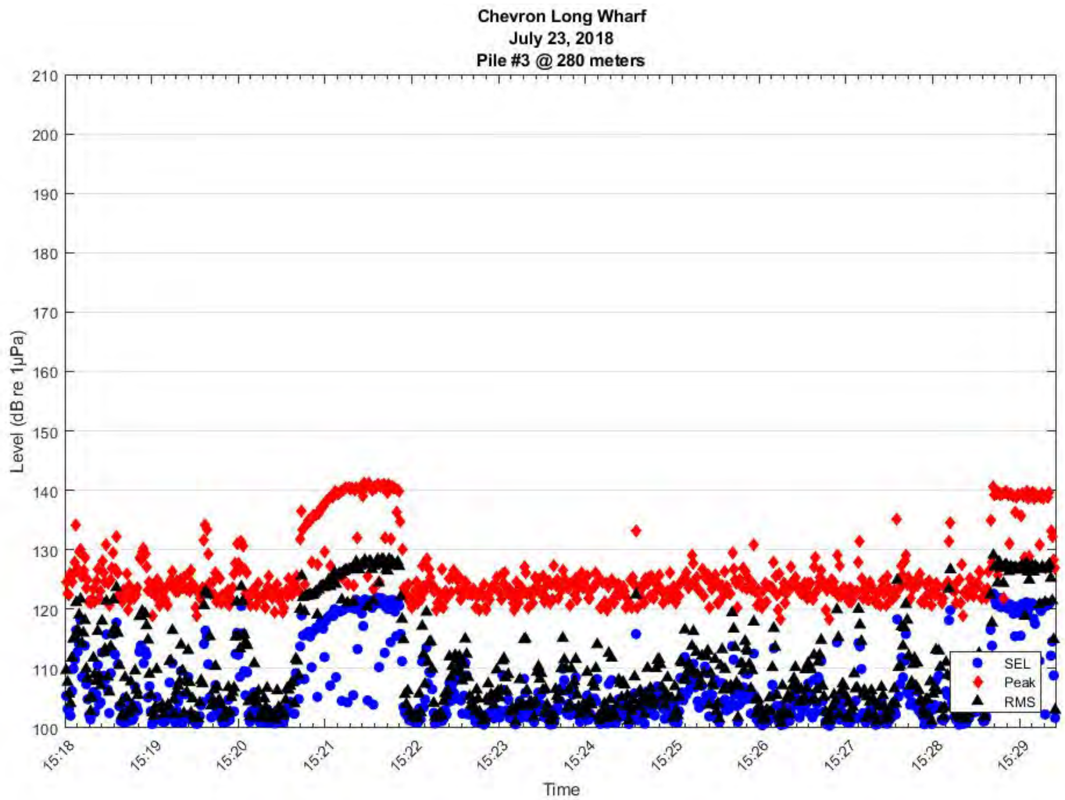


Figure 10

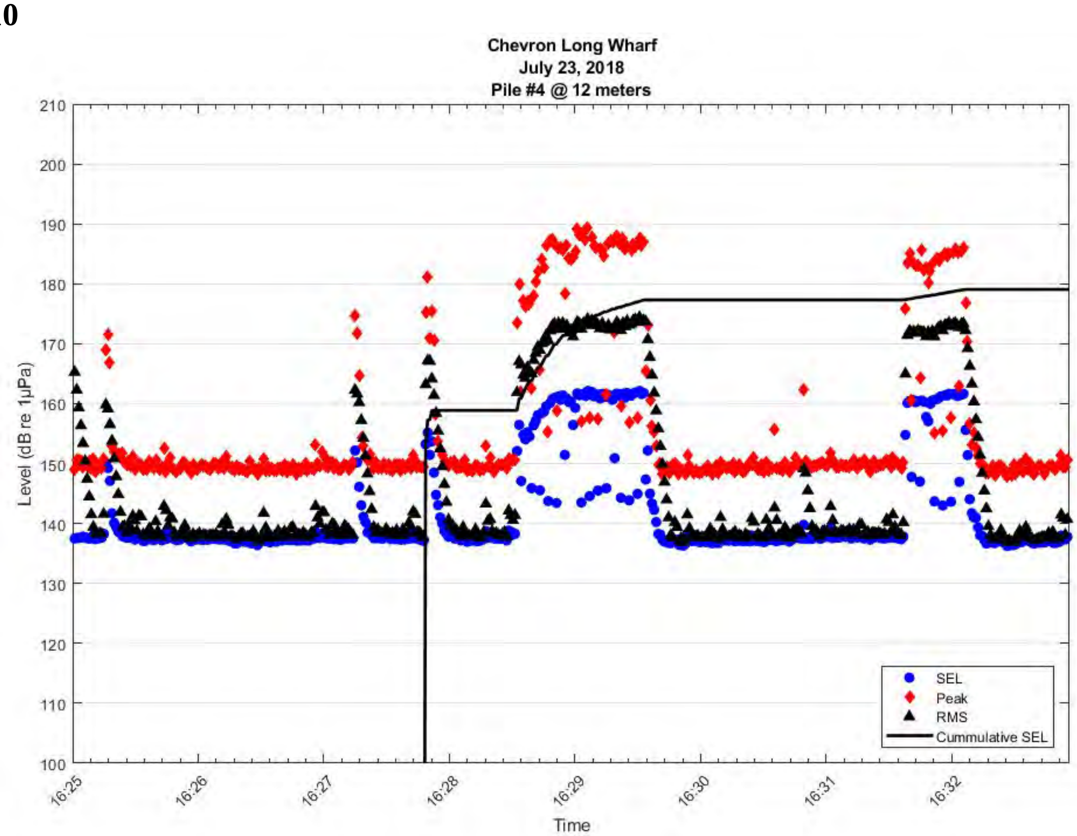


Figure 11

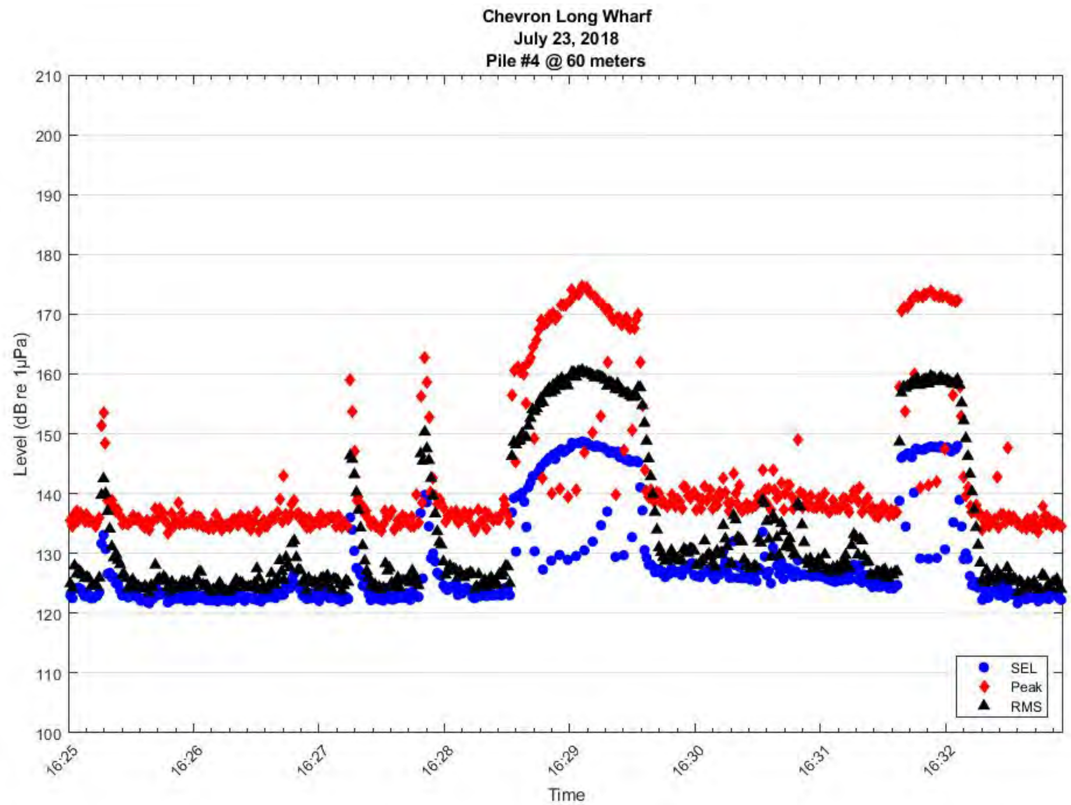
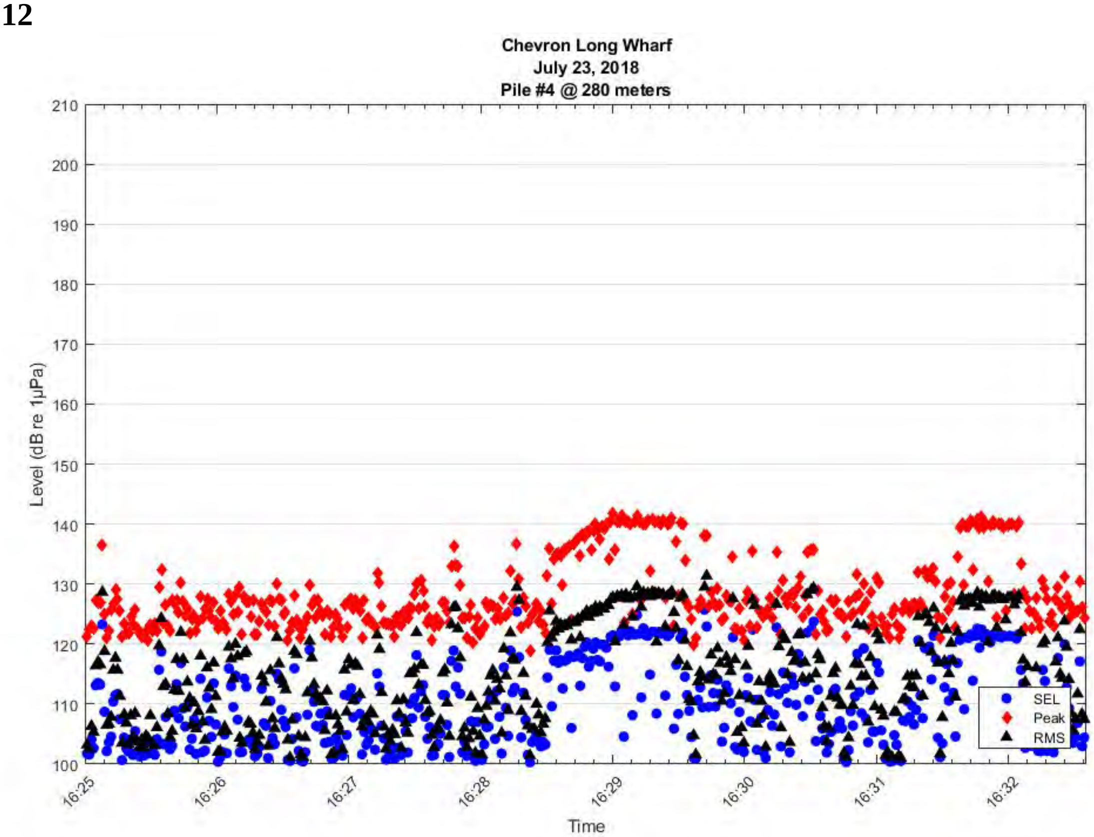


Figure 12



Appendix B PTS Calculation Spreadsheets

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Appendix B- PTS Calculations: Impact Driving of 60-inch Steel Piles

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

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	Summary Table I.2-1 values for 60-inch pile: Peak of 210, RMS of 195, SEL of 185. LWMEP pile driving monitoring in 2018 found a 20 log transmission loss for impact driving with a bubble curtain. 7 dB of attenuation assumed from bubble curtain.
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment[¥]	2	Default value for impact driving

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	188
Activity Duration (h) within 24-h period OR Number of piles per day	1
Pulse Duration[Δ] (seconds)	0.035
Number of strikes in 1 h OR Number of strikes per pile	2400
Activity Duration (seconds)	84
10 Log (duration)	19.24
Propagation (xLogR)	15
Distance of source level measurement (meters)	10

ΔWindow that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	412.7	14.7	491.5	220.8	16.1

E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)

$SEL_{cum} = SEL_{ss} + 10 \text{ Log (\# strikes)}$	211.8

Source Level (Single Strike/shot SEL)	178
Number of strikes in 1 h OR Number of strikes per pile	2400
Activity Duration (h) within 24-h period OR Number of piles per day	1
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)	10

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	830.9	29.6	989.7	444.7	32.4

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

Appendix B- PTS Calculations: Impact Driving of 24-inch Concrete Piles

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

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	LWMEP pile driving monitoring on 6/6 2018 with bubble curtain attenuation found a 20 log transmission loss, a peak of 191 dB, mean RMS of 173 and a mean SEL of 161. The 20 log transmission loss was recorded on other days as well.
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment¥	2	Default value for impact driving

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	173
Activity Duration (h) within 24-h period OR Number of piles per day	2
Pulse Duration^Δ^ (seconds)	0.05
Number of strikes in 1 h OR Number of strikes per pile	300
Activity Duration (seconds)	30
10 Log (duration)	14.77
Propagation (xLogR)	20
Distance of source level measurement (meters)	10

ΔWindow that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	17.3	1.4	19.7	10.8	1.5

E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)

$SEL_{cum} = SEL_{ss} + 10 \text{ Log (\# strikes)}$	188.8

Source Level (Single Strike/shot SEL)	161
Number of strikes in 1 h OR Number of strikes per pile	300
Activity Duration (h) within 24-h period OR Number of piles per day	2
Propagation (xLogR)	20
Distance of single strike SEL measurement (meters)	10

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	19.4	1.6	22.2	12.2	1.7

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

Appendix B- PTS Calculations: Impact Proofing of 36-inch Steel Piles

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

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	Summary Table I.2-1 values for 36-inch pile in shallower water: Peak of 210, RMS of 193, SEL of 180. No attenuataion system will be used for proofing.
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment[¥]	2	Default value for impact driving

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	193
Activity Duration (h) within 24-h period OR Number of piles per day	2
Pulse Duration[Δ] (seconds)	0.035
Number of strikes in 1 h OR Number of strikes per pile	30
Activity Duration (seconds)	2.1
10 Log (duration)	3.22
Propagation (xLogR)	15
Distance of source level measurement (meters)	10

ΔWindow that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	76.0	2.7	90.5	40.7	3.0

E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)

$SEL_{cum} = SEL_{ss} + 10 \text{ Log } (\# \text{ strikes})$	197.8

Source Level (Single Strike/shot SEL)	180
Number of strikes in 1 h OR Number of strikes per pile	30
Activity Duration (h) within 24-h period OR Number of piles per day	2
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)	10

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	96.6	3.4	115.0	51.7	3.8

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

Appendix B- PTS Calculations: Vibratory Driving of 12-inch Composite Piles

A: STATIONARY SOURCE: Non-Impulsive, Continuous

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	Anacortes Ferry Terminal in Washington State - RMS noise levels produced during this installation varied from 138 to 158 dB RMS at 43 meters (141 feet) from the pile (Laughlin 2012).
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

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

Weighting Factor Adjustment¥	2.5	Default value for vibratory driving

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	168
Activity Duration (hours) within 24-h period	0.83333
Activity Duration (seconds)	2999.988
10 Log (duration)	34.77
Propagation (xLogR)	15
Distance of source level measurement (meters)	10

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	17.7	1.6	26.2	10.8	0.8

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

Appendix B- PTS Calculations: Vibratory Driving and Extraction of 36-inch Steel Piles

A: STATIONARY SOURCE: Non-Impulsive, Continuous

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	Explosive Handling Wharf-2 (EHW-2) project at the Naval Base Kitsap in Bangor, Washington, the peak was 180 and the RMS was approximately 170 dB at a 10 meter distance (Caltrans 2015). LWMEP pile driving monitoring in 2018 found a 20 log transmission loss for vibratory driving steel piles.
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment¥	2.5	Default value for vibratory driving

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Activity Duration (hours) within 24-h period	0.6666667
Activity Duration (seconds)	2400.00012
10 Log (duration)	33.80
Propagation (xLogR)	20
Distance of source level measurement (meters)	10

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	17.3	2.8	23.2	11.9	1.6

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

Appendix B- PTS Calculations: Vibratory Driving and Extraction of 20-inch Steel Piles

A: STATIONARY SOURCE: Non-Impulsive, Continuous

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	Explosive Handling Wharf-2 (EHW-2) project at the Naval Base Kitsap in Bangor, Washington, the peak was approximately 180 dB and RMS was approximately 163 dB at a 10 meter distance for 24-inch piles (Caltrans 2015a).
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment[¥]	2.5	Default value for vibratory driving

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	163
Activity Duration (hours) within 24-h period	0.6666667
Activity Duration (seconds)	2400.00012
10 Log (duration)	33.80
Propagation (xLogR)	20
Distance of source level measurement (meters)	10

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	7.7	1.3	10.4	5.3	0.7

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60

Appendix B- PTS Calculations: Vibratory Extraction of Wood and Concrete Piles

A: STATIONARY SOURCE: Non-Impulsive, Continuous

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Chevron Long Wharf Maintenance and Efficiency Project (LWMEP)
PROJECT/SOURCE INFORMATION Please include any assumptions	RMS 152 Provided by NMFS, cited Seattle Pier 62/63.
PROJECT CONTACT	Bill Martin - bill.h.martin@aecom.com

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment[¥]	2.5	Default value for vibratory driving

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	152
Activity Duration (hours) within 24-h period	1.333
Activity Duration (seconds)	4798.8
10 Log (duration)	36.81
Propagation (xLogR)	15
Distance of source level measurement (meters)	10

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	2.1	0.2	3.1	1.3	0.1

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.05	-16.83	-23.50	-1.29	-0.60