San Francisco – Oakland Bay Bridge
East Span Seismic Safety Project

REVISED MARINE MAMMAL MONITORING PLAN

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REVISED MARINE MAMMAL MONITORING PLAN

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1.0 INTRODUCTION

The San Francisco-Oakland Bay Bridge (SFOBB) is a component of Interstate-80 that is one of the principal corridors linking the San Francisco Peninsula and the East Bay (Figure 1-1). The East Span Seismic Safety Project (East Span Project) will provide a seismically upgraded replacement bridge to the north of the existing bridge alignment between Yerba Buena Island (YBI), in the City and County of San Francisco, and the City of Oakland, in Alameda County. The construction of the new East Span will entail driving 259 large-diameter piles in San Francisco Bay to support the Skyway and Self-Anchored Suspension (SAS) components of the new side-by-side eastbound and westbound bridge structures. Pursuant to the Marine Mammal Protection Act (MMPA), the California Department of Transportation (Caltrans) requested and received an Incidental Harassment Authorization (IHA) from National Marine Fisheries Service (NMFS) to incidentally take, by harassment, small numbers of California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina richardsi*), and possibly gray whales (*Eschrichtius robustus*) in San Francisco Bay. This marine mammal monitoring plan has been prepared and submitted in compliance with NMFS's requirements for an IHA. This plan discusses construction activities for the East Span Project, potential impacts to marine mammals, and methods for monitoring and reporting the activity of marine mammals near the construction areas.

2.0 BACKGROUND

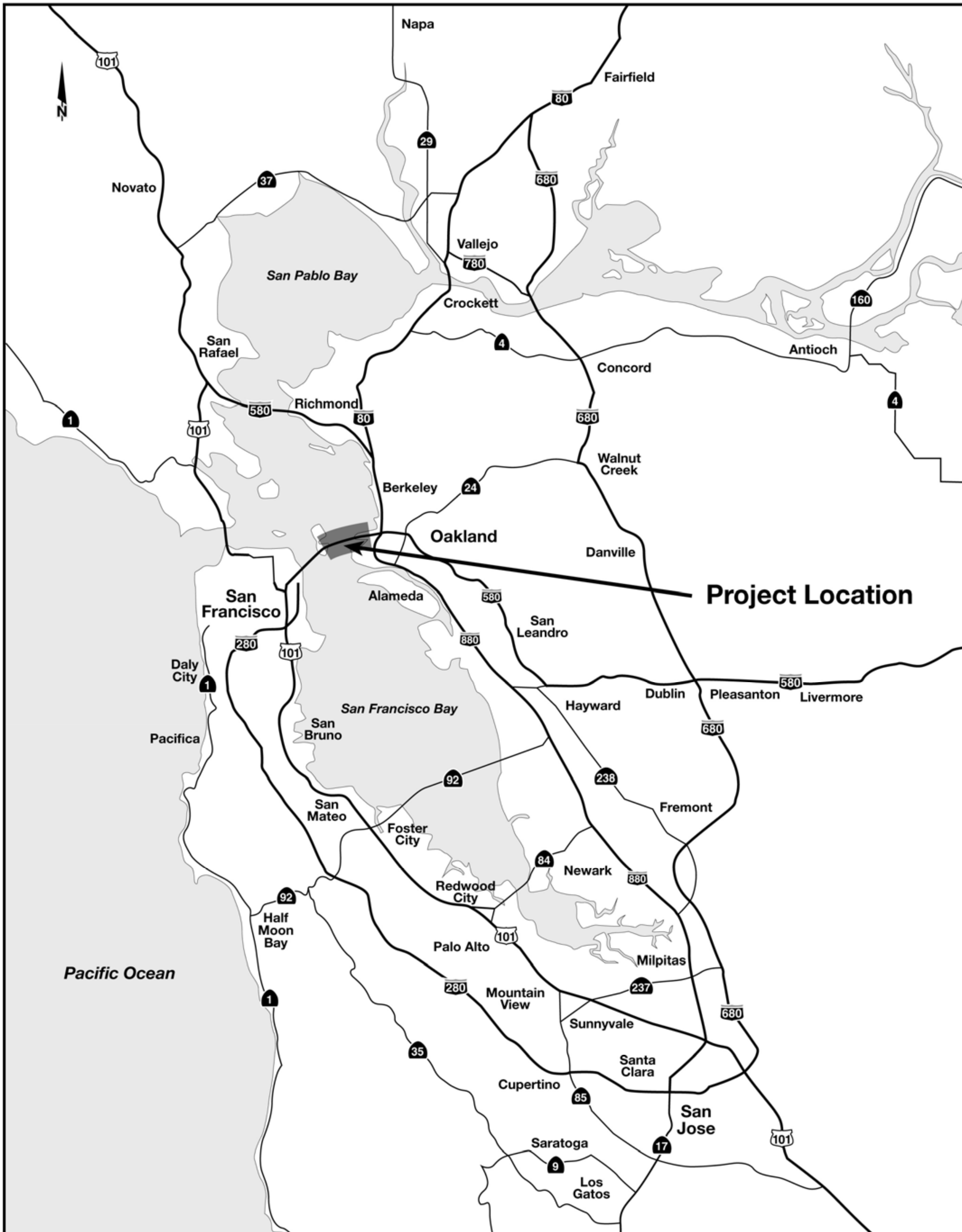
2.1 Pile-Driving Activities

The new East Span will be constructed in the eastern part of Central San Francisco Bay between YBI and the Oakland Touchdown (Figure 2-1). The bridge will be constructed in four separately contracted components (Figure 2-2):

- Geofill at the Oakland Touchdown
- Oakland Approach Structures
- Skyway
- Self-Anchored Suspension/Yerba Buena Island transition structure (SAS/YBI)

The new East Span will consist of two parallel bridge structures, an eastbound structure and westbound structure, separated by approximately 15 meters (m) [49 feet (ft)]. Each structure will be supported by a series of piers, with each pier supported by four to six piles. Current plans include driving a total of 189 2.5-m (8.2-ft) diameter piles and 70 1.8-m (5.9-ft) diameter steel pipe piles. All piles will be battered, that is, driven at an angle.

Each pile is expected to consist of two or more segments; the first segment will be driven to an established elevation, then the next segment(s) will be welded on and driven in succession until the pile is driven to its final or "tip" elevation. However, the contractor could choose to drive the piles in one piece. The larger piles will support the Skyway and SAS sections of the new bridge; they will be driven to depths ranging from about -66 m to about-108 m (about -256 ft to about -358 ft), with most being driven to about -95 m (312 ft). The smaller diameter piles will support the Oakland Approach structures; they will be driven to tip elevations ranging from about -41 m to about -65 m (-135 ft to about –213 ft).



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Project Location

Figure 1-1

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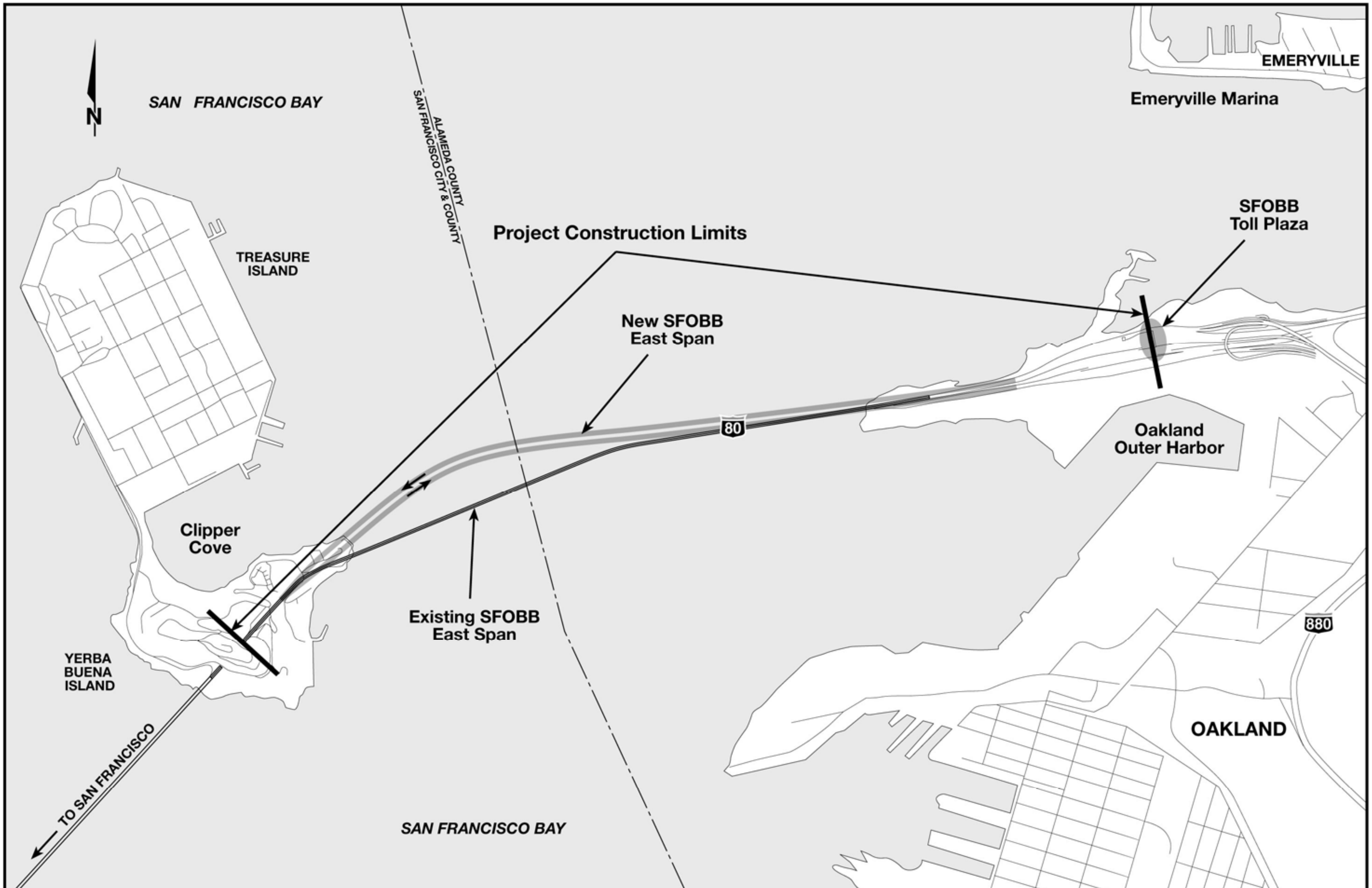

SFOBB
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PROJECT

Project Construction Limits

Figure 2-1

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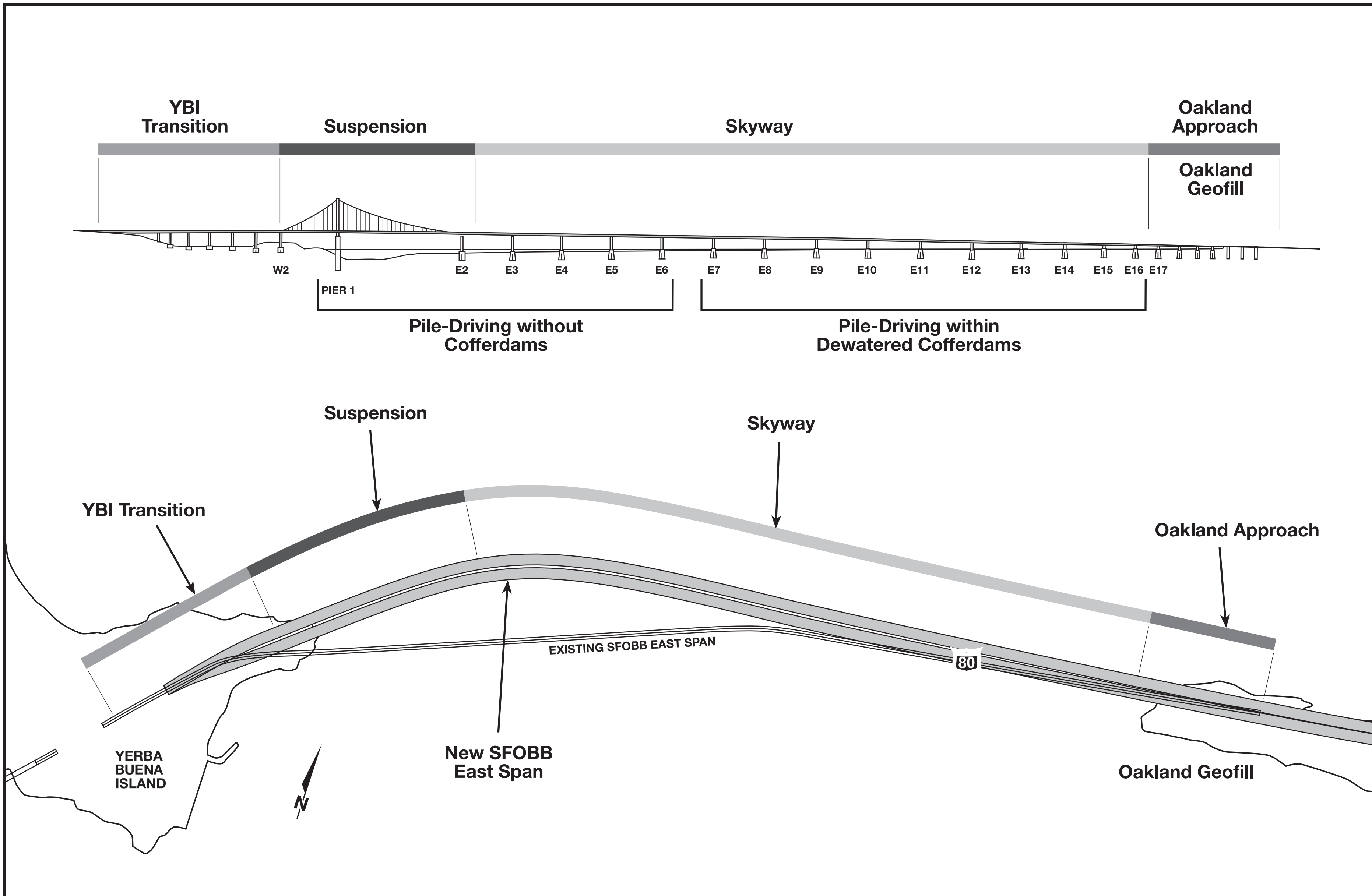

SFOBB EAST SPAN SEISMIC SAFETY PROJECT

Project Components

Figure 2-2

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Each pile is expected to require approximately five hours total driving time to reach the specified tip elevation; therefore, the 259 in-Bay piles could require about 1,300 hours of pile-driving. However, the contractor will be allowed to drive simultaneously at multiple locations. Furthermore, it is possible that all three contractors (the contractor for the SAS-YBI portion, the contractor for the Skyway, and the contractor for the Oakland approach structures) will drive piles simultaneously. Pile-driving will be allowed only from 7:00 AM to 8:00 PM, seven days a week.

If the contractor uses piles consisting of multiple segments, it is expected that the first segments driven will take less energy and drive faster than subsequent segments because the top Bay sediments are soft, with hard mud and soft rock at deeper levels. If the contractor uses a pile that is driven in one piece, early driving will take less energy and progress faster than later driving. The total time that the hammer is operating will be the same in both cases; however, the total placement time for multiple segments will be longer.

The depths of water where pile-driving will occur range from 18 m (59 ft), at piles for the SAS tower, to 0.3 m (1 ft), at footings located along the north shore of the Oakland Touchdown.

In addition to in-Bay pile-driving, the East Span Project will include pile-driving on YBI for construction of the YBI transition structures on the northeastern side of the island. The piles will be steel driven piles, which are conventionally used in building construction. Unlike in-Bay pile-driving, which may require hammer energy levels up to 1,700 kilojoules (kJ), pile-driving activity on YBI will require hammer energy levels less than 100 kJ. A total of approximately 2,950 piles will be needed to support the YBI transition structures. Each pile will require about 30 minutes of driving time; therefore, it is estimated that the East Span Project includes about 1,500 hours of driving time for piles on YBI.

Small, temporary piles will be driven to found temporary structures during construction, including: the temporary tower crane platforms (one at each pier), mooring platforms (one or two at each pier), template piles (two sets at each pier), cofferdam sheet-piles (two sets at each pier for Piers E7 through E16), the temporary trestle from the Oakland Touchdown area to the Skyway, and another access trestle near the Oakland Touchdown area. Since the temporary structures will be contractor designed, their exact nature (size, type, quantity, etc.) will not be known until the contractors submit their plans to Caltrans. While the number of piles placed to found the structures will be large, it is expected that they will be of a smaller size than the permanent structures, since they are temporary and are not designed for traffic or seismic loading. There may be 1,000 to 2,000 temporary piles. These piles are expected to be 0.5 m (18 inches [in]) to 1.1 m (42 in) in diameter and 12 m (40 ft) to 30 m (100 ft) long. A vibratory driver/extractor will be used to install and remove these temporary piles, with energy levels less than 100 kJ. Driving time for each temporary pile is likely to be three to five hours; therefore, the estimated range of driving time for the temporary structures varies from 3,000 to 10,000 hours.

2.1.1 Schedule

The eastbound structure of the Skyway will be built first. Once all the piles supporting the piers for the eastbound structure are driven, construction will start for the westbound structure of the Skyway. Construction of both bridge structures for the Skyway will begin at the Oakland Approach and progress west towards Yerba Buena Island, from Pier E16 to Pier E3.

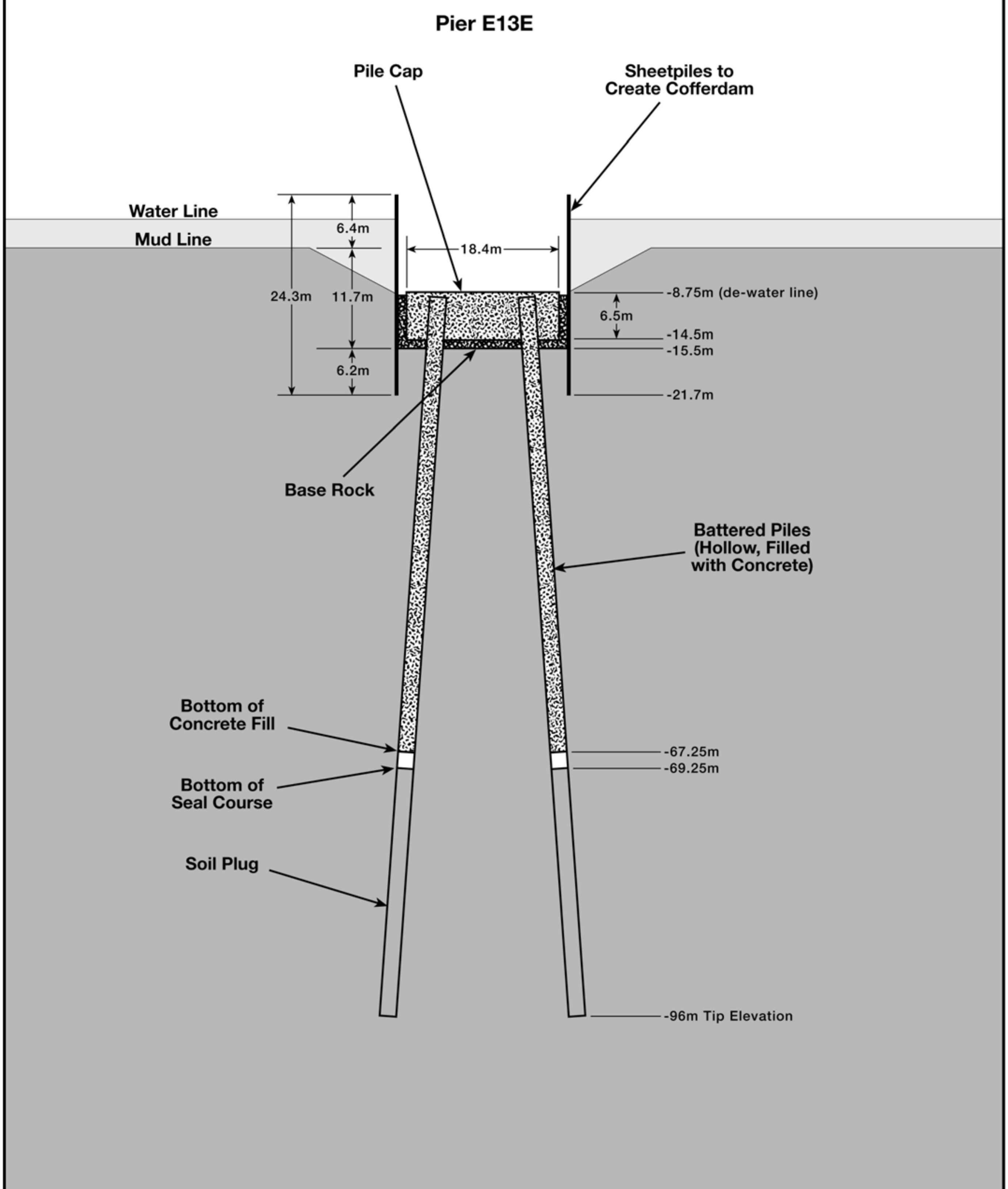
Piers E16 through E7 for both the eastbound and westbound structures of the Skyway will be surrounded by sheet-pile cofferdams that will be dewatered before the start of pile-driving (Figure 2-2). The sheet pile sections for the cofferdam will be 9.5-millimeter (mm) to 12.7-mm (3/8-in to 1/2-in) thick and will be driven by a vibratory hammer. The cofferdam dimensions will be approximately 25.6 m by 19.2 m (84 ft by 63 ft) for piers E15 and E16. The cofferdam dimensions for Piers E7 through E14 will be approximately 25.6 m by 20.7 m (84 ft by 68 ft).

Figure 2-3 shows an illustration of the cofferdam for Pier E13E (for the eastbound structure). The general order of work to install the cofferdam and piles includes: 1) excavate below the mud line to create work area, 2) drive sheet piles in a rectangular formation to create cofferdam, 3) dredge out bottom of cofferdam, 4) place base rock blanket at the bottom of the cofferdam, 5) place pile cap in cofferdam, 6) insert locking fill (base rock) around the pile cap, 7) dewater cofferdam, and lastly 8) drive battered piles through sleeves in the pile cap.

It is anticipated that the piles for Piers E3, E4, E5 and E6 of the Skyway, as well as for Piers T1 and E2 of the SAS span, will not be surrounded by cofferdams; therefore, a bubble curtain system will surround the piles. In compliance with the NMFS's Biological Opinion and the California Department of Fish and Game's (CDFG) 2081 Incidental Take Permit, a bubble curtain system is required to reduce impacts to endangered and threatened fish species during driving of permanent in-Bay piles, unless other equally effective methods to attenuate peak underwater sound pressure levels (SPLs) which can damage fish are used, such as cofferdams (NMFS, 2001, p. 7; CDFG, 2001, p.6). As summarized in the NMFS's Biological Opinion and CDFG's 2081 Incidental Take Permit, the contractor will design a bubble curtain system that consists of air compressors, air supply lines, distribution manifolds, and aeration pipelines. The aeration pipelines will consist of perforated pipes configured into concentric rings spaced no more than five vertical meters apart in all tide conditions. The lowest aeration pipeline layer will be designed to ensure contact with the mud line without sinking into Bay mud. Each aeration pipeline will have four adjacent rows of approximately 1.6-mm (1/16-in) diameter air holes spaced approximately 20 mm (3/4 in) apart. The bubble curtain system will provide a bubble flux of three cubic meters per minute, per linear meter of pipeline in each concentric ring.

2.1.2 Equipment

The contractor is likely to use two Menck hydraulic hammers to install the permanent in-Bay piles. The smaller hammer will probably be a 500-600 kJ hammer. The larger is likely to be a hammer with a 1,700 kJ capacity. Hammering typically starts with a few irregularly timed blows at less than full capacity for up to a minute. Then hammering picks up speed and force so that there are approximately 30 blows a minute continuously until the pile is near its "tip" elevation. Hammering may stop for a few minutes towards the end while measurements are made and then recommence until the target elevation is achieved.



SFOBB
EAST SPAN
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PROJECT

Cofferdam Schematic

Figure 2-3

3/29/02

2.2 Regulations Pertaining to Marine Mammals

Pursuant to the MMPA enacted in 1972 and last amended in 1994, it is forbidden to intentionally harass marine mammals. Harassment is defined as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment) or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption to behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment)." NMFS currently considers that underwater SPLs above 190 decibels referenced to 1 micropascal, root-mean-square (abbreviated as 190 dB re 1 μPa RMS [impulse])[1] could cause temporary hearing impairment (Level B harassment) in harbor seals and sea lions and SPLs above 180 dB re 1 μPa RMS (impulse) could cause temporary hearing impairment (Level B harassment) in whales (Fahy personal communication 2001). The effects of elevated SPLs on marine mammals may include avoidance of an area, tissue rupturing, hearing loss, disruption of echolocation, masking, habitat abandonment, aggression, pup/calf abandonment, annoyance, and helplessness.

In accordance with the MMPA, Caltrans requested authorization from NMFS for possible harassment of small numbers of two pinniped species, California sea lions and Pacific harbor seals, and one cetacean species, gray whales, incidental to conducting the East Span Project. Prior to issuance of an IHA, a marine mammal monitoring plan that incorporates mitigation, monitoring, and reporting requirements described in the IHA request must be prepared. NMFS specifies the following requirements for the marine mammal monitoring plan:

> "The complete monitoring plan must include: (1) a description of the proposed survey techniques that will be used to determine the movement and activity of marine mammals near the construction areas; and (2) scientific rigor that will allow NMFS to verify that any impacts on marine mammal populations from this specific activity are small in number and negligible." (Federal Register 2001)

2.3 Marine Mammal Species of Concern

Although numerous species of marine mammals exist along the central and northern California coasts, very few are regularly observed in San Francisco Bay. Only the California sea lion, the Pacific harbor seal, and gray whale are likely to occur in the vicinity of the project site. These species are protected from harassment under the Marine Mammal Protection Act of 1972, as amended.

Other pinnipeds, including northern elephant seals (*Mirounga angustirostris*), stellar sea lions (*Eumetopias jubata*), northern or Alaska fur seals (*Callorhinus ursinus*) and Guadalupe fur seals

[1] RMS (impulse): The root square of the energy divided by the duration. When presented as a level in dB re 1 μPa, the RMS pressure level is equivalent to the average square pressure level of the pulse. The 5 percent of the energy that occurs in the initial rise of the impulse and the 5 percent of energy that occurs at the final decay of the impulse are excluded from the average.

(*Arctocephalus phillippii townsendii*) appear in the Bay on rare occasions. There have been extremely rare cases of humpback whales (*Megaptera novaeangliae*) straying into the Bay and occasional sightings of harbor porpoises (*Phocoena phocoena*) in the Bay, including near the YBI haul-out site. Since these species are not common in the Bay, it is unlikely that these species will be present in the project vicinity during project construction.

2.3.1 California Sea Lions

The California sea lion is the most common eared seal on the California coast. Dominant males maintain a harem of females and can grow up to 2.5 m (8 ft) in length and weigh over 280 kilograms (kg) [600 pounds (lbs)]. Females attain a length of 2 m (6 ft) and generally weigh less than 90 kg (200 lbs). California sea lions breed and give birth in spring, primarily in the Channel Islands. Breeding aggregations begin in May and copulation and birth occur on land. Pups nurse for about four months or longer. After breeding season, about mid-August, the adult males, many subadult males, and a few subadult females disperse from the rookeries. Males travel northward while females travel south or remain near the rookeries (Schoenherr, 1995; Zeiner, 1990).

Molting season occurs from August to October for adult females and juveniles and from November to February for adult males. Feeding occurs mainly at night. California sea lions frequently forage in groups and prey opportunistically on schooling fish such as northern anchovy (*Engraulis mordax*), sardine (*sardinops asgax caerulrus*), whiting (*Theragra chalcogramma*), mackerel (*Scomber scombrus*), rockfish (*Sebastes caurinus*), and market squid (*Loligo opalescens*). The sea lions can live up to 24 years (Seal Conservation Society, 1998a).

The California sea lion's geographic range extends from southern Mexico to Vancouver Island, Canada. After a decrease earlier in the century, the U.S. population has been increasing in part due to the enactment of the MMPA (U.S. Geological Survey, 1997). Current population estimates of the U.S. stock, defined as beginning at the U.S./Mexico border and extending northward into Canada, range from 167,000 to 188,000. The annual growth rate for this population is estimated at around five percent for the years 1975 to 1999. This growth rate includes three El Niño events in 1983, 1992-93, and 1998 when the number of pups was lower than other years (NMFS, 2000). Sea lions are not listed under the Endangered Species Act or considered strategic under the MMPA.

<u>California Sea Lions in San Francisco Bay</u>

While California sea lions are known to have historically used San Francisco Bay to feed and sleep at the surface of the Bay's calmer waters, they were rarely observed hauling out in the Bay (Bauer, 1999). However, since at least 1987, sea lions have been observed occupying the docks near Pier 39 in San Francisco, about 5.7 kilometers (km) [3.5 miles (mi)] from the project site (Figure 2-4). According to the Marine Mammal Center in Sausalito, the number of sea lions hauled out at Pier 39 ranged from 63 to 737 in 1998 and from 5 to 906 in 1997. For both years,

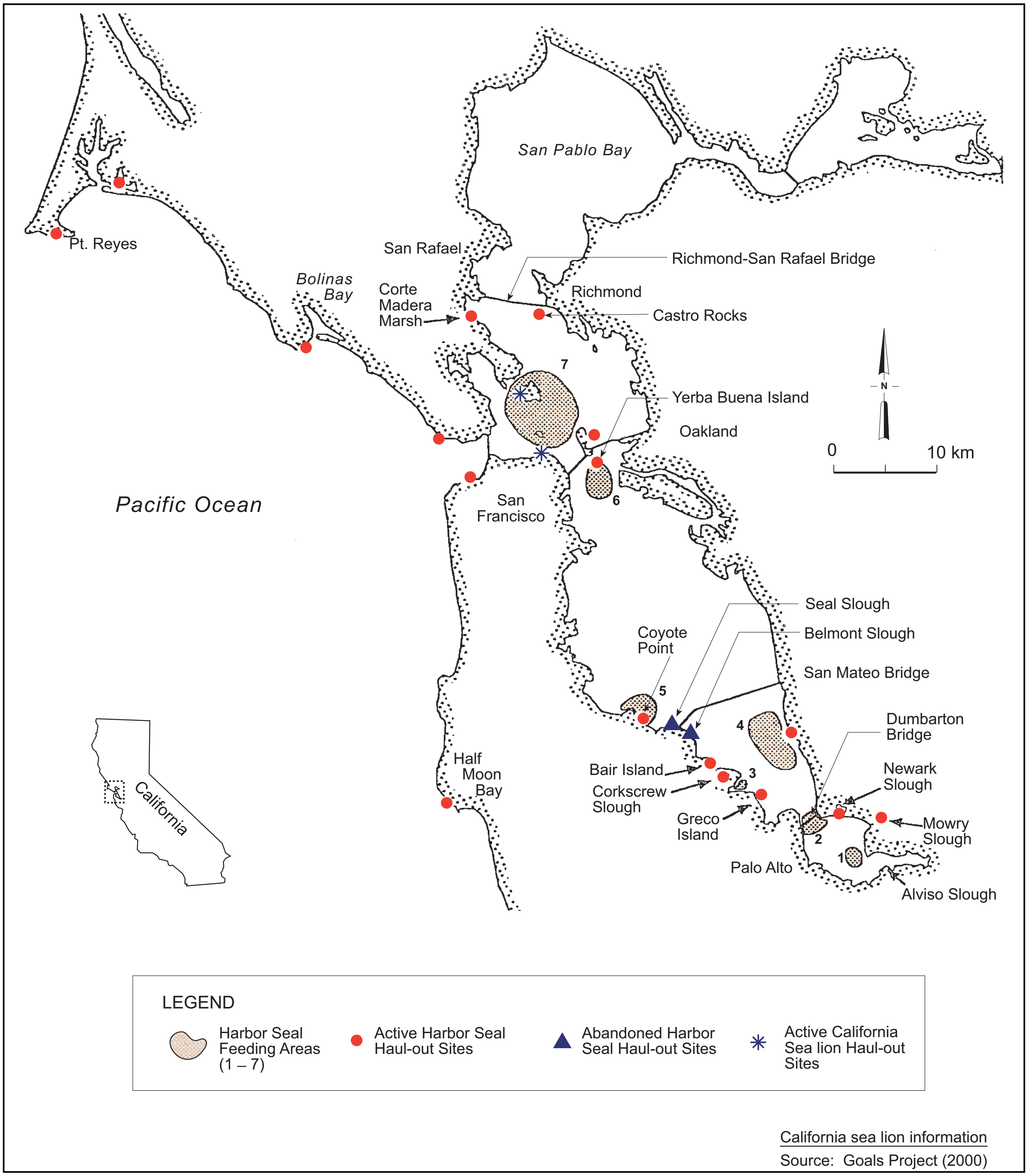

Figure 2-4 Harbor Seal and California Sea Lion Haul-out Sites and Feeding Areas in the San Francisco Bay Area

the lows occurred in June and the highs occurred in August. On September 1, 2001, approximately 1,105 sea lions were observed on K dock at Pier 39. Pier 39 has now become a regular haul-out site for sea lions.

Approximately 85 percent of the animals hauled out on Pier 39 were males. No pupping has been observed at this site or any other site in San Francisco Bay (Lander personal communication, 1999). No other sea lion haul-out sites have been identified in the Bay. About 90 percent of the U.S. stock breeds on the southern California Channel Islands, most notably on San Nicolas and San Miguel Islands, approximately 93 km (58 mi) west of Santa Barbara and over 483 km (300 mi) from the project site (Schoenherr, 1995).

The sea lions appear at Pier 39 after returning from the Channel Islands at the beginning of August (Bauer, 1999). Around late winter, sea lions start to disperse down the coast, and numbers at Pier 39 decline. The lowest numbers of sea lions are usually observed from May through July. Numbers of sea lions at the haul-out site fluctuate throughout the year and even from one week to the next. For example, in June of 1998, a maximum of 574 sea lions was observed on June 7th while a low count of 63 was observed on June 25th (Lander personal communication, 1999).

While little information is available on the foraging patterns of the California sea lion in the Bay, individual sea lions have been observed feeding in the shipping channel to the south of YBI on a fairly regular basis (Grigg personal communication, 1999). Foraging by sea lions that utilize the Pier 39 haul-out site primarily occurs in the Bay, where they feed on Pacific herring (*Clupea harengus*), northern anchovy, and sardines, and other prey (Hanni, 1995).

2.3.2 Pacific Harbor Seals

The Pacific harbor seal is a subspecies of the most widely distributed pinniped inhabiting both temperate and sub-arctic coastal areas on both sides of the north Atlantic and north Pacific oceans (Seal Conservation Society, 1998b). Male and female harbor seals are similar in appearance. Males are slightly larger, measuring up to 2 m (6 ft) in length and weighing up to 126 kg (300 lbs). Unlike California sea lions, male harbor seals do not preside over harems. Males will mate with any female in estrus and females may mate with more than one male. Harbor seals generally mate in water but give birth on land (Schoenherr, 1995). Female harbor seals live longer than males; females live up to 30-35 years and males live up to 20-25 years (Seal Conservation Society, 1998b).

Pacific harbor seals inhabit near-shore coastal and estuarine areas from Baja California, Mexico to the Pribilof Islands in Alaska. The estimated population of this subspecies is 285,000 (Seal Conservation Society, 1998b). There are approximately 400 to 500 haul-out sites in California alone. Harbor seals generally do not make extensive pelagic migrations although they have been known to travel 300-500 km (186-311 mi) to find food or suitable breeding habitat. The estimated population of harbor seals in California is approximately 30,300 and the population has been growing annually at an estimated rate of 3.5 percent between 1982 and 1995. This growth rate includes declines in population during two El Niño events in 1983 and 1992 (Barlow et al., 1997). Despite increases in harbor seal populations throughout their range, in some areas, including San Francisco Bay, their numbers have not been significantly increasing (Kopec and Harvey, 1995). Harbor seals are not listed under the Endangered Species Act or considered strategic under the MMPA.

<u>Harbor Seals in San Francisco Bay</u>

Pacific harbor seals are the only species of marine mammal that breed and bear young in the Bay. There are 12 haul-out sites and rookeries in the Bay (Figure 2-4) and of those, only eight are used by more than a few animals at a time. Only three sites in the Bay are regularly host to more than 40 harbor seals at any one time; these are Mowry Slough in the South Bay, YBI, and Castro Rocks in the Central Bay (Spencer, 1997). The three closest haul-out sites to the project location are at YBI, Alameda Breakwater Gap, Angel Island and Castro Rocks. An aerial harbor seal count conducted by the California Department of Fish and Game in 1999, found 477 individuals in San Francisco Bay (Greene personal communication, 1999). It is important to note that not all harbor seals were counted as some may have been under water during the survey.

Harbor seals are present in the Bay year-round and use it for foraging, resting, and reproduction. Peak numbers of hauled-out harbor seals vary by haul-out site depending on the season. Results of a study of 39 radio-tagged harbor seals in San Francisco Bay found that most active diving occurred at night and a majority of the diving time was spent in seven feeding areas in the Bay. These areas are shown in Figure 2-4. The two feeding areas located closest to the project site are areas 6 and 7. Area 6 is located just to the south of YBI and area 7 is to the north of Treasure Island. Feeding areas 1, 2, 6, and 7 were frequented by most of the radio-tagged seals. This same study found that the seals dove for a mean time of 0.50 minutes to 3.33 minutes. Mean surface intervals or the mean time the seals spent at the surface between dives ranged from 0.33 minutes to 1.04 minutes. Mean haul-out periods ranged from 80 minutes to 24 hours (Harvey and Torok, 1994).

Pacific harbor seals are opportunistic feeders, eating the most abundant prey species available, especially small schooling species. In the Bay, yellowfin goby (*Acanthogobius flavimanus*), an introduced species, is the most common species in the harbor seal diet. Also important are the northern anchovy, Pacific staghorn sculpin (*Leptocottus armatus*), plainfin midshipman (*Porichthys notatus*), white croaker (*Genyonemus lineatus*), and Pacific herring (Harvey and Torok, 1994).

Pupping season in San Francisco Bay begins in mid-March and continues until about mid-May. Pups nurse for only four weeks and mating begins after pups are weaned. In the Bay, mating occurs from April to July and molting season is from June until August (Schoenherr, 1995; Kopec and Harvey, 1995).

Haul-Out Sites in the Vicinity of the East Span Project

YBI is located in central San Francisco Bay, adjacent to man-made Treasure Island. The SFOBB passes through a tunnel on YBI. An important harbor seal haul-out site is located on a rocky beach on the southeast side of YBI, immediately to the west of the lighthouse on the southernmost tip of the island (Figure 2-4) (Kopec and Harvey, 1995). Pile-driving activity for the East Span Project will be performed on the northeast side of YBI and in the San Francisco Bay, between the northeast side of the island to the Oakland Touchdown area. The harbor seal haul-out site is located about 450 m (1,476 ft) from the closest planned pile-driving activity on land (bent 10A on YBI) and about 950 m (3,117 ft) from the closest planned pile-driving activity in the Bay (piles for the SAS tower).

Although seals haul out year-round on YBI, it is not considered a pupping site for harbor seals because no births have been observed at the site. However, there is recent evidence that a few births may actually have occurred at the haul-out site, including observations of a stillborn and afterbirth at the site (Grigg personal communication, 2001). Occasionally, pups have been seen at an average of one pup per year, though more recently, nine pups were observed at one time in May, 2001 (San Francisco State University unpublished records, 2001). In a study of the haul-out site conducted between 1989 and 1992, males comprised 83.1 percent of the seals whose gender could be determined (Spencer, 1997). Peak numbers of harbor seals at this haul-out site have been observed from November to February. The maximum reported number of seals hauled out at one time is 344, counted in January 1992 (Kopec and Harvey, 1995). The number of seals counted at YBI ranged from 0 to 296 for the period May 1998 through research conducted in 1999. The maximum count of 296 was recorded in January 1999. Mean monthly counts for the same period range from 14.5 in September 1998 to 107.3 in June 1999 (San Francisco State University, unpublished records 1998-9). The abundance of harbor seals at this site during the winter months likely coincides with the presence of spawning pacific herring near the island. Re-sightings at the haul-out site indicate long-term usage of the site (Spencer, 1997).

A new haul-out site has been identified in recent years at the Alameda Breakwater Gap located approximately 5.8 km (3.6 mi) southeast of the project site (Grigg personal communication, 2001). A total of 73 harbor seals were counted in January 1997 and 20 were observed hauled-out on April 4, 1998 (U.S. Fish and Wildlife Service [USFWS], 1998). A small pup was observed in May 1997 at this location (Feeney, personal communication, as cited in USFWS, 1998); however, site characteristics are not ideal for the island to be a major pupping area (Kopec, personal communication, as cited in USFWS, 1998). Between 1984 and 1997, counts of ten or fewer seals present at any one time were recorded during this period (Kopec, personal communication, as cited in USFWS, 1998).

Angel Island is a small haul-out site located approximately 7.4 km (4.6 mi) from the project site. A maximum count of 15 seals was observed in the 1980s and most recently, six harbor seals were seen in 1989. No pupping has been observed at the site.

The next closest haul-out site is approximately 14 km (8.7 mi) away at Castro Rocks, near the Richmond touchdown of the Richmond-San Rafael Bridge. The Castro Rocks haul-out site is a recognized pupping site. A maximum of 212 harbor seals were observed at Castro Rocks in November 2000 (San Francisco State University unpublished records, 2001).

2.3.3 Gray Whales

Gray whales reach lengths of up to about 14 m (45 ft), with the males being slightly smaller. Unlike other baleen whales, gray whales have no dorsal or back fin, instead they have a raised dorsal area or back. The whales are gray, with a characteristic white mottling resulting from attached barnacles. Gray whales are baleen whales that feed on bottom-dwelling invertebrates by stirring up and straining bottom sediments, so that local turbidity plumes can be observed when they forage. The vast majority of all gray whales are found in the Pacific Ocean along the western coastline of North America. Here, they spend their winters in the waters off Baja California and migrate more than 9,000 km (5,600 mi) north to spend their summers north of Alaska. They are typically seen off the California coastline from December through May as they migrate northward to the Bering and Chukchi Seas, and again in the return trip to Baja California.

Gray Whales in San Francisco Bay

Gray whales have been uncommon in San Francisco Bay during historic times but have been sighted more frequently in recent years. There are a number of possible reasons sightings in the Bay may be more frequent. These reasons include poor ocean conditions, which are thought to be cyclic with changing El Nino conditions. Poor ocean conditions translate to poor food supply and increased search area into the Bay. The gray whale population size has been increasing and this could also be a reason for more frequent sightings.

Since gray whales are so uncommon in the Bay, it is difficult to predict the number of gray whales that may be present in the Bay during the construction period. Early indicators in the equatorial Pacific suggest ocean conditions are improving. Current reports regarding this year's migrating whales indicate that whales have more fat reserves than in the past few years, suggesting that feeding conditions in the ocean have improved. If this is the case, search areas for food may decrease and the likelihood of seeing gray whales in the Bay may decrease. Feeding during migration is relatively rare and is better characterized as fasting. If feeding occurs, it is more likely during the spring northern migration.

Gray whales have been sighted in the Bay in areas off Sausalito in Richardson Bay and the tip of the Tiburon Peninsula (approximately 11 km or 7 mi northwest of the project area) and as far south as the San Bruno Shoals area (approximately 23 km or 14 mi southwest of the project area). Gray whales have been observed foraging in these areas. Observations in San Francisco Bay have typically been made from December through May, during the whales' coastal migration. In February 2001, a pod of gray whales was observed near the Dumbarton Bridge in the South Bay during the whales' migration to and from Alaska and the Bering Straits.

Gray whales heading to the San Bruno Shoals area will pass beneath the SFOBB. It is likely that some of the whales that enter the Bay will swim through the two deep-water shipping channels beneath the West Span of the bridge. Though the number of sightings of gray whales to the east of YBI and in the immediate vicinity of the SFOBB are low, they are not precluded from swimming there to reach the San Bruno Shoals area or foraging near or in these areas in the future.

3.0 POTENTIAL IMPACTS

NMFS considers that underwater SPLs above 190 dB re 1 μPa RMS (impulse) could cause temporary hearing impairment (Level B harassment) in harbor seals and sea lions and SPLs above 180 dB re 1 μPa RMS (impulse) could cause temporary hearing impairment (Level B harassment) in whales (Fahy personal communication, 2001). The in-Bay pile-driving outlined in Section 2.1 has the potential to harass harbor seals, sea lions, and gray whales that may be swimming, foraging, or resting in the project vicinity.

3.1 Noise from Pile-Driving

There is very little in the available literature about underwater SPLs generated by pile-driving; however, there is literature available about SPLs from other sound sources within the range generated by pile-driving. Most underwater sound measurements and consequent impacts on marine mammals have been recorded during activities involving underwater explosives and sonar.

The propagation of noise underwater is affected by various environmental conditions, including bathymetry, sea state, currents, temperature, presence of fish schools and/or phytoplankton blooms/algae, and other physical or biological factors. Attenuation of underwater noise in the San Francisco Bay is complex due primarily to the relatively shallow waters, soft Bay mud, and complex topography at the bottom.

3.1.1 Pile Installation Demonstration Project

In the fall and winter of 2000, Caltrans conducted a Pile Installation Demonstration Project (PIDP) to assess the use of large hammers to install large-diameter piles at the project site. This demonstration project gave Caltrans an opportunity to assess the SPLs from driving large-diameter piles, monitor marine mammal behavior, and test the operation and effectiveness of sound attenuation devices.

The PIDP involved driving three piles, with two different sizes of hammers and the use of two different methods of underwater sound attenuation. The test piles (labeled Piles 1, 2 and 3) were made of steel and were 2.4 m (8 ft) in diameter. Pile 1 was driven straight down and did not use any sound attenuation. Pile 2 was a battered pile angled to the east and used an air bubble curtain system that deployed air bubbles from a ring of perforated pipes surrounding the pile and template system (used for holding the pile in place). Pile 3 was a battered pile angled to the west and used a system that supplied air bubbles adjacent to and between two layers of fabric surrounding the pile.

The piles were installed at two locations adjacent to the existing SFOBB East Span. Piles 1 and 2 were installed north of the existing bridge near Pier E6, where the water is approximately 9 m (30 ft) deep. Pile 3 was installed north of existing bridge near Pier E8, where the water depths range between approximately 7 m (25 ft) to the west of the pile and 5 m (17 ft) deep to the east of the pile.

Caltrans obtained an IHA for the PIDP, which included several stipulations about pile-driving operations, marine mammal monitoring and collection and reporting of data. The IHA required that a safety zone including all areas where the underwater SPLs were anticipated to equal or exceed 190 dB re 1 μPa RMS (impulse) be established around the pile-driving work. An initial underwater safety zone of 500 m (1,640 ft) was set until SPL measurements could be made to determine the 190 dB re 1μPa RMS (impulse) contour. Before pile-driving of a pile segment began, NMFS-approved observers on boats were required to survey the PIDP safety zone to ensure that no marine mammals were found within the area. If marine mammals were found within the safety zone, pile-driving of the segment was to be delayed until they moved out of the area. If the observed marine mammal seen above water then dove below, pile-driving was to be delayed for 15 minutes to allow time for the marine mammal to move out of the area. If no marine mammal was observed during that time, it could be assumed that the animal had moved out of the area and pile-driving could commence. If a marine mammal entered the safety zone after pile-driving of a segment already began, hammering could continue unabated and observers were to monitor and record the number and behavior of the marine mammals.

Results of the Pile Installation Demonstration Project

During the two-month PIDP construction period, sound measurements were taken during pile-driving and marine mammals were monitored at both the project site and at the YBI harbor seal haul-out site. A total of 68 pinnipeds (55 harbor seals and 13 sea lions) were sighted in the project area during monitoring activities. Of this total, fifty-seven pinnipeds (47 harbor seals and 10 sea lions) were seen during times when there were no pile-driving activities. Only eight harbor seals and three sea lions were observed near the PIDP site during actual pile-driving, which totaled 12 hours and 51 minutes. In addition, up to 85 harbor seals per monitoring period hauled out at the semi-protected cove on the southwestern side of YBI, approximately 1,500 m (4,920 ft) from the pile-driving area. No gray whales were observed.

Harbor seals did not seem to be affected by pile-driving noise, and typical responses included head alerts or watching the activity near the barge while swimming calmly in or out of the established 500-m (1,640-ft) safety zone around the pile-driving site. Harbor seals at YBI increased in number during low tide, and responded to activities unrelated to pile-driving activities such as helicopter noise, boat traffic and kayakers, with head alerts or flushing of the site when startled or disturbed. The three sea lions seen within and beyond the safety zone, on the other hand, responded to pile-driving noise by swimming rapidly out of the area, regardless of whether the small or large hammer was used or whether sound attenuation devices were in operation.

Acoustic data for the PIDP were reported in linear peak and RMS (fast) or Lmax (both A- and C-weighted) for airborne noise measurements, and both linear peak and RMS (impulse) for underwater noise measurements. The linear peak sound level indicates the maximum instantaneous SPL during the pile-driving period and is the highest SPL within that period that may be damaging to marine mammals. RMS (impulse) is the unit requested and reported by

NMFS to identify the underwater safety zone, and is typically the maximum SPL in water averaged over the duration of the impulse, but in the PIDP, a 35-millisecond (msec) time constant was used. This value represents the time over which most of the impulse energy specific to this study occurred for a more conservative estimate of the NMFS criterion.

Based on the results of the PIDP, the estimated extent of the 190 dB safety zone during pile-driving without sound attenuation is approximately 285 meters (935 feet) for a hammer energy level of 1,750 kJ. This estimate represents the maximum distance likely for the 190 dB safety zone under pile-driving conditions without sound attenuation. But since all permanent, in-Bay piles will be driven within cofferdams or surrounded by a bubble curtain system, the 190 dB safety zone for the East Span Project is expected to be smaller. The estimate also assumes no excess attenuation. In reality, numerous factors in the environment, such as water conditions and irregularities in the bottom, would tend to attenuate underwater sound propagation in shallow water. Estimated excess attenuation was approximately 0.02 dB per meter (Illingworth & Rodkin 2001).

3.1.2 East Span Project

The SPLs that will be generated by pile-driving for the East Span Project may result in temporary threshold shifts or disturbance of marine mammal behavioral patterns. Other project-associated activities such as vessel operation are not expected to result in noise levels that will qualify as harassment; however, their presence in the project area may cause free-swimming pinnipeds or cetaceans to leave or avoid the area.

Several construction phases may be occurring at the same time during construction, which could result in a scenario where multiple piles are driven at the same time. Despite this fact, it is estimated that there will not be a cumulative effect as a result of more than one pile being driven at the same time. The drop-off rates for SPLs measured during the PIDP were substantial. Unless hammers are very close to one another and struck at the same time, there will be no measurable difference in peak or RMS (impulse) levels. It is very unlikely that the hammers will strike at the same time.

3.2 Effects of Sound Pressure Levels on Marine Mammal Hearing

Sound pressure is measured in micropascals (μPa), a unit of pressure. These measurements are usually presented as a ratio of pressures and therefore a standard reference is adopted as the denominator. This reference pressure is 1 μPa in water and 20 μPa in air. Acoustic intensity is defined as the power per unit area in the direction of sound propagation and is often expressed in decibels (dB), denoting a logarithmic scale. Acoustic instruments normally measure sound pressure and not intensity. Intensity levels are derived from pressure measurements, as intensity is proportional to the average of the pressure squared. “Sound pressure levels” imply a value in dB derived from sound pressure ratios where a reference pressure was used as the denominator. More specifically,

$$\text{Sound Pressure Level (dB)} = 20 \log (P/P_0)$$

where P_0 is the reference pressure. Frequency is the rate at which sound waves oscillate or vibrate and is measured in cycles per second or hertz (Hz). A marine mammal's sensitivity to sound varies with frequency and therefore its response to a sound depends on the presence of the range of frequencies to which the marine mammal is sensitive (Richardson et al., 1995).

Being amphibious, California sea lions and Pacific harbor seals must be able to respond to sound both in air and in water. In water, harbor seals are sensitive to sounds ranging from about 1 kHz to 60 kHz with thresholds between 60 and 85 dB re 1 µPa. The threshold is the minimum received SPL that a marine mammal can detect at a specified frequency. Thresholds are generally high at low frequencies, and low within the range of frequencies that a marine mammal detects best (best frequencies). As frequencies rise above this "best" range, thresholds increase too, meaning that SPLs must be higher in order to be detected. Data from individual harbor seals showed detection limitations below 1 kHz, but detection of sounds was noted in one harbor seal at 100 Hz where a threshold of 96 dB re 1 µPa was recorded. Sound can be detected in frequency ranges of up to 180 kHz if the sound is sufficiently intense, and resulting thresholds are subsequently higher at 130-140 dB. As mentioned above, sensitivity above 60 kHz is therefore typically poor (Møhl, 1968a,b; Terhune, 1988; Kastak and Schusterman, 1995 *in* Richardson et al., 1995; Howorth and Abbott, 1999).

California sea lions are sensitive to sounds ranging from 2 kHz to 36-40 kHz with a threshold of 80 dB re 1 µPa. Within that range sea lions are most sensitive to frequencies between 2 and 16 kHz. At a frequency of 1 kHz the threshold increases to approximately 85 dB re 1 µPa and further deteriorates to 116 to 120 dB re 1 µPa at a lower frequency of 100 Hz. Similarly, above 40 kHz, sea lion hearing thresholds also deteriorates to above 90-100 dB (Schusterman et al., 1972; Schusterman, 1981; Kastak and Schusterman, 1995 as cited in Richardson et al., 1995).

Pinnipeds as a group appear to be considerably less sensitive to airborne sounds below 10 kHz than humans. In air, harbor seals are sensitive to sounds between 2-20 kHz with thresholds between 40 and 65 dB re 20 µPa (Møhl, 1968a; Kastak and Schusterman, 1995; Terhune and Turnbull, 1995 *in* Richardson et al., 1995). In contrast, sea lions are sensitive to sounds in the same frequency as for water (1 to 32-36 kHz) with thresholds between 40 and 65 dB re 20 µPa. Within that range, they are most sensitive to frequencies between 2-10 kHz with a threshold of approximately 45 dB re 20 µPa (Moore and Schusterman, 1987; Kastak and Schusterman, 1995 as cited in Richardson et al., 1995). In air, sensitivity to sound by both species decreases as frequency declines below 2 kHz. Note that airborne SPLs are assumed to be referenced to 20 µPa. Even if both air and water SPLs are referenced to 1 µPa, direct comparisons between in-air and underwater SPLs cannot be made due to differences in acoustic impedance between the two mediums.

Available data comparisons between underwater and aerial hearing of both hair seals (i.e. harbor seals) and eared seals (i.e. California sea lions) show that they are more sensitive to sounds in water rather than in air (Richardson et al., 1995). Sea lions are more sensitive than harbor seals in water (higher threshold of hearing), but both pinnipeds have similar hearing thresholds in air. According to Kastak and Schusterman (1998) and Richardson et al. (1995), sea lions have a slightly greater sensitivity to airborne noise and higher high-frequency threshold than harbor seals at the sound frequencies typical for pile-driving activities. They also report that sea lions are more sensitive than harbor seals to underwater noise at low frequencies.

No hearing audiograms for baleen whales have been reported. All evidence regarding thresholds, hearing sensitivities and the shape of the hearing audiogram are indirect. Though reactions were noted at frequencies below 1 kHz, the reaction threshold was typically high. Gray, humpback, and bowhead whales are able to hear sounds in the 50 to 500 Hz range, i.e., low frequencies. Baleen whales have reacted to sounds in this range at SPLs as low as 90 dB re 1 μPa. Ranges of hearing include from below 1 to up to or above 28 kHz. Therefore, it is uncertain whether whales are more sensitive to low or high frequency noise (Richardson et al., 1995). Though hearing sensitivities and thresholds of whales are unknown, sound levels from the PIDP were generated within their hearing range and at levels above which reactions have been previously observed (90 dB re 1 μPa). It is therefore likely that the mammals will avoid the pile-driving area during construction for the East Span Project due to the frequency range of sound generated by pile-driving, presence of equipment and consequent human disturbance (Richardson et al., 1995).

3.3 Incidental Harassment of Marine Mammals

Loud sounds, both in air and under water, could possibly have adverse impacts on marine mammals by causing stress, increasing the risk of mortality by altering the delicate balance of predator-prey detection and avoidance, and by interfering with the use of sounds in communication, especially in relation to reproduction and navigation (Gisiner, 1998). Currently, very little direct information exists regarding what frequency-intensity combinations damage pinniped hearing or tissue, no information is available on hearing or tissue damage to whales, and there are insufficient data to accurately determine acoustic exposure criteria for any marine mammal (Ketten, 1998). However, for pulsed sounds such as pile-driving, the available evidence suggests that temporary hearing loss, also known as a temporary threshold shift (TTS), may occur at received levels of 180-190 dB re 1μPa or higher in pinnipeds and about 180 dB re 1μPa or higher in whales (Greene, 1999; NMFS, personal communication 1999).

A TTS occurs when a sound damages hearing by causing decreased sensitivity. The extent and duration of this temporary loss in sensitivity depends on, among other things, the interactions of frequency, intensity, and duration of exposures (Ketten, 1998). At higher SPLs, a permanent threshold shift (PTS) can occur if a marine mammal is too close to a high intensity sound. Deafness can be life-threatening for pinnipeds and for echolocating cetaceans. No data are available to assess the levels at which permanent threshold shifts occur in marine mammals. Any estimates of ranges and levels at which PTS can occur are speculative.

Loss of hearing, whether temporary or permanent, can affect behavior by altering the ability of a marine mammal to process acoustic signals providing information about reproductive behavior, parental care, feeding, predator avoidance, navigation, and migration (Gisiner, 1998). Another impact of sound on marine mammal hearing is the occurrence of masking, whereby ambient or man-made noise masks the ability of marine mammals to detect other competing sound, even if the sound is within their hearing range (Richardson et al., 1995).

Behavioral responses of marine mammals to noise can range from something as innocuous as a pinniped raising or turning its head, to permanent abandonment of an area by whales and pinnipeds. Noise may also elicit short-term disruptions of normal activities, startle responses, agitation, and stress. Noise disturbance has been known to cause hauled-out pinnipeds to flush into the water. On rare occasions, pinniped pups may be trampled, maimed, or permanently separated from their mothers as a result of a mass exodus from a haul-out site. On the other hand, marine mammals may become habituated to elevated sound levels and develop a certain tolerance of them. Noise could also influence the distribution of prey species. For example if prey species such as fish move away from the area of construction, the likelihood of a fish-eating marine mammal foraging in the safety zone would be decreased.

Long-term displacement such as the abandonment of areas and haul-out sites by pinnipeds and of areas by whales has also been known to occur, although it is less clear whether this is a direct result of noise or a combination of disturbance factors (Richardson et al., 1995). Cetaceans have been known to reduce swimming speeds, divert from travel paths, and otherwise avoid the source of noise. In contrast to pinnipeds, cetaceans typically dive to deep water to avoid humans or traveling boats. Mother-calf pairs are particularly sensitive. The mother gray whale moves over the calf for protection (Ljungblad et al., 1993, J.T. Clarke et al., 1989 as cited in Richardson et al., 1999). Gray whale pods have dispersed with aircraft presence. Hasty dives, turns, and other changes have been noted. During snorkeling near construction sites, gray whales have been observed to expose only the blowhole to the surface. Abandonment has been observed in San Diego Bay due to ship traffic (Rice and Wolman, 1971). However, gray whales often re-occupy disturbed areas once activity subsides (Bryant et al., 1984, as cited in Richardson et al., 1999)

3.3.1 Underwater Sound Pressure Levels

As previously mentioned, it is difficult to predict underwater SPLs that will be generated by the East Span Project. Judging from the few comparable studies cited above, it is possible that California sea lions, harbor seals, and gray whales swimming in the project vicinity may be subject to elevated SPLs that could produce a temporary hearing threshold shift in those mammals.

Pile-driving noise could also potentially result in behavioral impacts. Marine mammals, such as harbor seals and sea lions, may temporarily cease normal activities such as feeding or swimming or come up to the surface in response to the noise. Gray whales may reduce swimming speeds or may dive and avoid the area in response to abnormal noise. Pinnipeds may prove to be curious and investigate the project site. However, existing evidence shows that most marine mammals tend to avoid loud noises (Richardson, personal communication 1999). It is likely then that harbor seals, sea lions, and gray whales in the water in the project vicinity may be temporarily displaced if they avoid high SPLs due to pile-driving in the area. Pile-driving for permanent, in-Bay piles will require a total of approximately 1,300 hours over the construction period.

3.3.2 Airborne Sound Pressure Levels

Based on the in-air hammer noise measurements conducted for the PIDP, the maximum root mean square (RMS) noise levels received by instrumentation were 96 to 105 dBA (or 101 to 108 dBC) re 20 μPa measured at 100 m (328 ft) from the pile. The peak SPLs at 100 meters (328 ft) ranged from 115 to 124 dB re 20 μPa. The range in SPLs was the result of pile orientation. A battered pile that was tilted away from the measurement location (top further away than bottom) resulted in higher noise levels than the opposite condition. For a vertical pile, the RMS SPLs were 97 dBA (or 103 dBC) and the peak SPLs were 120 dB re 20 μPA for a similar distance. SPLs were not noticeably different between the large and small hammer.

Distant SPL measurements indicated excess attenuation (over spherical spreading) of 0 to 8 dB at distances up to 500 m (1,640 ft). At Treasure Island (distance of 1,200 to 1,500 m or 3,937 to 4,921 ft from pile-driving), RMS SPLs ranged from less than 60 dBA to a maximum of 72 dBA re 20 μPa. When westerly winds occurred, which are common to the area, SPLs at Treasure Island were less than 65 dBA re 20 μPa. The background SPLs in the vicinity of the SFOBB are typically 60 to 75 dBA, depending on proximity to the bridge. Although measurements were not made at the Yerba Buena Island seal haul-out site, the PIDP measurements indicate that the highest in-air SPLs will be less than 70 dBA re 20 μPa. The haul-out site will be shielded by terrain from most pile-driving activity during construction of the East Span Project.

NMFS considers in-air noise levels below 85 dB re 20 μPa RMS to be safe for marine mammals (Fahy, personal communication 2001). A level of 85 dBA re 20 μPa or less is also considered safe for human workers. Seals have hearing that is 20 to 30 dB less sensitive than humans in the frequency range of noise from pile-driving (Richardson et al., 1995). Consequently, it is possible that hauled-out harbor seals will hear the pile-driving activities, but noise from this activity is not expected to adversely affect them. Close to pile-driving activities, elevated noise levels may impact harbor seals. Potential impacts on these seals may be similar to those discussed above, including temporary threshold shifts and changes to behavioral patterns.

During the PIDP, hauled-out harbor seals on YBI showed only initial evidence of sound recognition during the first few minutes of driving of Pile 1A; no further response was noted for the duration of the project. Based on these results, piles driven at the distance of Pile 1 or further from YBI during the East Span Project are unlikely to result in long-term behavioral impacts at the haul-out site. It is unknown whether in-Bay piles driven closer to YBI will show the same results. It is possible that harbor seals at YBI may show behavioral effects to in-Bay pile-driving at closer distances; however, the in-Bay piles closest to YBI will be located along the new bridge alignment, with the island providing a direct barrier between in-Bay pile-driving noise and the haul-out site.

A noise model was developed to calculate noise levels from piles being driven on YBI. Typical land-based pile-driving activities produce a noise level of 100 dBA at 31 m (100 ft). During the East Span Project, land-based piles could be driven at distances of 300 to 700 meters from the haul-out site. However, YBI is a solid barrier between the land-based pile-driving on the northeast end of the island and the haul-out site on the southeast side; there is no direct acoustical path between the two locations. This contrasts with the location of the haul-out site in relationship to the pile-driving for the PIDP's Piles 1 and 2, in which YBI provided only a partial barrier to the acoustical path. The noise modeling, which takes into account terrain and atmospheric conditions, indicates that noise levels from land-based pile-driving activities would be 60 dBA or less. These levels would be lower than ambient levels or those received at the haul-out site during the PIDP, and therefore, are not expected to disturb marine mammals at the haul-out site.

3.4 Potential Impact on Habitat

The East Span Project is not expected to result in any significant impacts to marine mammal habitat. Short-term impacts will include the minimal disturbance of the sediment where the channels are dredged for barge access and where individual bridge piers are constructed. Long-term impacts to marine mammal habitat will be limited to the footprint of the piles and the obstruction they will create following installation. However, this impact is not considered significant as marine mammals can easily swim around the piles of the new bridge, as they currently swim around the existing bridge piers.

Harbor seals on YBI are commonly subjected to high levels of disturbance, primarily from watercraft. This is particularly true during the summer, when the numbers of small boats, jet skis, kayaks, etc., in San Francisco Bay increase (San Francisco State University, 1999b). Abandonment of the haul-out site is not anticipated as sound levels from pile-driving, both in water and in air, are expected to attenuate sufficiently by the time they reach the site. Although harbor seal pups have been observed at the YBI haul-out site, it is not a recognized pupping site and therefore, no significant impacts on species recruitment are anticipated. Other haul-out sites for sea lions and harbor seals area are at a sufficient distance from the project site that they will not be affected.

4.0 MITIGATION PLAN

4.1 Compliance with Equipment Noise Standards

To mitigate noise levels and therefore impacts to harbor seals, California sea lions, and gray whales, all construction equipment will comply as much as possible with applicable equipment noise standards of the U.S. Environmental Protection Agency, and all construction equipment will have noise control devices no less effective than those provided on the original equipment.

4.2 Briefings

Prior to the start of pile-driving activity for the Skyway Contract, a briefing will be held between the construction supervisors and crews, the marine mammal monitoring team, acoustical monitoring team, and Caltrans staff. The purpose of the briefing will be to establish responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures. The Resident Engineer will have the authority to stop or delay any construction activity, if deemed necessary.

Additional briefings will be conducted prior to the start of the YBI/SAS and Oakland Approach Structures contracts and as necessary. New personnel will be briefed before they join the work in progress.

4.3 Establishment of Safety/Buffer Zones

Prior to commencement of driving of any open water (i.e., no cofferdam is used), permanent piles, a preliminary 500-m (1,640-ft) radius safety zone for pinnipeds (harbor seals and California sea lions) will be established around the pile-driving site. The safety zone is intended to include all areas where the underwater SPLs are anticipated to equal or exceed 190 dB re 1 μPa RMS (impulse). Once pile-driving begins, SPLs will be recorded at the 500-m (1,640-ft) contour. The safety zone radius for pinnipeds will then be enlarged or reduced, depending on the actual recorded SPLs. A preliminary radius of 500 m (1,640 ft) was established in consultation with NMFS. A 180-dB re 1 μPa RMS (impulse) safety zone for gray whales will be established for pile-driving occurring during the gray whale migration season from December through May.

Observers on boats, existing bridge piers and/or the construction barge will survey the safety zone to ensure that no marine mammals are seen within the zone before pile-driving of a pile segment begins. If marine mammals are found within the safety zone, pile-driving of the segment will be delayed until the marine mammals have moved beyond the MMSZ, either verified through sighting by an observer or by waiting until enough time has elapsed without a sighting (15 minutes) to assume that the animal has moved beyond the MMSZ. As mentioned in Section 2.1.2, initial hammering is expected to begin with taps of the hammer at less than full capacity, which may serve to alert marine mammals to leave the area. Due to the limitations of monitoring from a boat, there can be no assurance that the zone will be devoid of all marine mammals.

If marine mammals enter the safety zone after pile-driving of a segment has commenced, hammering will continue unabated and marine mammal observers will monitor and record their numbers and behavior. NMFS's Southwest Regional Office will also be notified within 48 hours. Once the pile-driving of a segment begins it cannot be stopped until that segment has reached its predetermined depth due to the nature of the sediments underlying San Francisco Bay. If hammering stops and then resumes, it will potentially have to occur for a longer time and at increased energy levels. In sum, this will amplify impacts to marine mammals, as they will endure potentially higher SPLs for longer periods of time. Pile segment lengths and wall thickness have been specially designed to accommodate this situation so that when work is stopped between segments, the pile tip is never resting in highly resistant sediment layers.

A 500-m (1,640-ft) no-entry buffer zone will be established around the haul-out site on YBI to minimize the impact of project-related vessel traffic during the East Span Project on marine mammals. This buffer zone will be established in coordination with the U.S. Coast Guard (USCG). Caltrans will establish strict standards on vessel speed for all project-related crafts traveling in the Bay.

4.4 Marine Mammal Monitoring

Safety zone monitoring will be conducted during driving of all open water, permanent piles. Monitoring of the pinniped and cetacean safety zones will be conducted by a minimum of three qualified NMFS-approved observers. One three-observer team will be required for the safety zones around each pile-driving site, so that multiple teams will be required if pile-driving is occurring at multiple locations at the same time. The observers will begin monitoring at least 30 minutes prior to startup of the pile-driving. Observers will likely conduct the monitoring from small boats, existing bridge piers or construction barges, as observations from a higher vantage point (such as the SFOBB) may not be practical. As discussed previously, pile-driving will delayed if any marine mammals are observed in the safety zone prior to the start of pile-driving. Once driving a pile segment begins, operations will continue uninterrupted until the segment has reached its predetermined depth. Monitoring will continue through the pile-driving period and will end approximately 30 minutes after pile-driving has been completed.

Observations will be made using binoculars during daylight hours. Marine mammal observers will have night-time infrared scopes to conduct monitoring during low-light conditions. Each member of the monitoring team will have a marine radio for contact with other observers and work crews if necessary. In addition to monitoring from boats, monitoring of the YBI haul-out will be conducted during pile-driving activity, in coordination with the Richmond Bridge Harbor Seal survey team. Point Bonita will be designated as a control site (a harbor seal haul-out site that has no potential impacts from the East Span Project's pile-driving activities) and monitored for comparison. Monitoring will be conducted twice a week at both YBI and the control site. Data on all observations will be recorded and will include items such as species, numbers, sex and age class, behavior, time of observation, location, time that the pile-driving begins and ends, and other acoustic or visual disturbances. The reactions of marine mammals will be recorded based the following classifications (consistent with the Richmond Bridge Harbor Seal survey methodology): 1) no response, 2) head alert (looks towards the source of disturbance), 3) approach water (but does not leave), and 4) flush (leaves haul-out site). The number of marine mammals under each disturbance reaction will be recorded, as well at the time when seals re-haul after a flush.

Baseline monitoring will be conducted for a period of 14 days prior to the beginning of open water pile driving for the Skyway contract. Baseline monitoring will be conducted in the general project area (before pile-driving begins) and at the YBI haul-out site. The 14-day monitoring period is expected to be an appropriate time frame to assess baseline conditions in the project area and to account for the potential variability in environmental factors, such as tide level, water current, air temperature and other factors that may influence the presence and activity of marine mammals. The information collected from baseline monitoring will be used for comparison with results of monitoring during pile-driving activities.

4.4.1 Seasonal Considerations

Although harbor seal pupping and mating season will be occurring in the Bay, typically from mid-February through June, YBI is not a known pupping site. The closest recognized pupping site is at Castro Rocks, approximately 14 km (8.7 mi) from the project site. The period of peak abundance at the YBI harbor seal haul-out site is November through February. Molting season in the Bay begins in June. If pile-driving for the East Span Project occurs during molting season, a greater proportion of harbor seals will be hauled out and therefore not subject to the potentially elevated underwater SPLs of pile-driving which could affect marine mammals.

California sea lions are not known to breed or give birth in San Francisco Bay. Molting season is from August to October for adult females and juveniles and from November to February for adult males.
If gray whales enter San Francisco Bay, this would occur from December through May during their winter migration to and from Alaska and the Bering Straits. Calves may accompany pods during the spring return to the north. Casual foraging occurs during the northern migration, but is relatively rare compared to the summer and fall feeding in the northern oceans.

4.5 Acoustical Monitoring

Both airborne and underwater environmental noise levels will be measured as part of the East Span Project. During open water pile driving with utilization of the bubble curtain, monitoring will be conducted for one pile in every other pair of piers. The measurements will be conducted during the driving of the last half (deepest segment) for any given pile. During pile driving with utilization of the cofferdam, preliminary hydroacoustic monitoring will occur as needed to ensure that the safety zone does not need to be implemented.

4.5.1 Underwater Sound Monitoring

The purpose of the underwater sound monitoring is to establish the safety zone of 190 dB re 1 μPa RMS (impulse) for pinnipeds and the safety zone of 180 dB re 1 μPa RMS (impulse) for gray whales. One reference location will be established at a distance of 100 m (328 ft). Noise levels will be measured during the entire driving session at this reference location. Measurements will be conducted at two depths: approximately mid water column and a depth near the bottom of the water column but at least 1 m (3 ft) above the bottom. Two additional in-water spot measurements generally 500 m (1,640 ft) in two directions either west, east, south, or north of the pile-driving site will be conducted at the same two depths as the reference location measurements. In cases where such measurements cannot be obtained due to obstruction by land mass, structures or navigational hazards, measurements will be conducted at alternate spot measurement locations. Measurements will be made at other locations either nearer or farther as necessary to establish the approximate distance for the safety zones.

The underwater noise measurement system shall provide tape-recorded data for subsequent analysis. The measuring system shall include a hydrophone or pressure transducer, along with signal conditioning equipment and signal amplifier (see Figure 4-1). The conditioned and amplified signal will be recorded on a calibrated digital audio tape (DAT) recorder or a recorder with an equivalent frequency response and dynamic range. The measurement system will have the capability to provide a real time readout display. Signal output to an integrating sound level

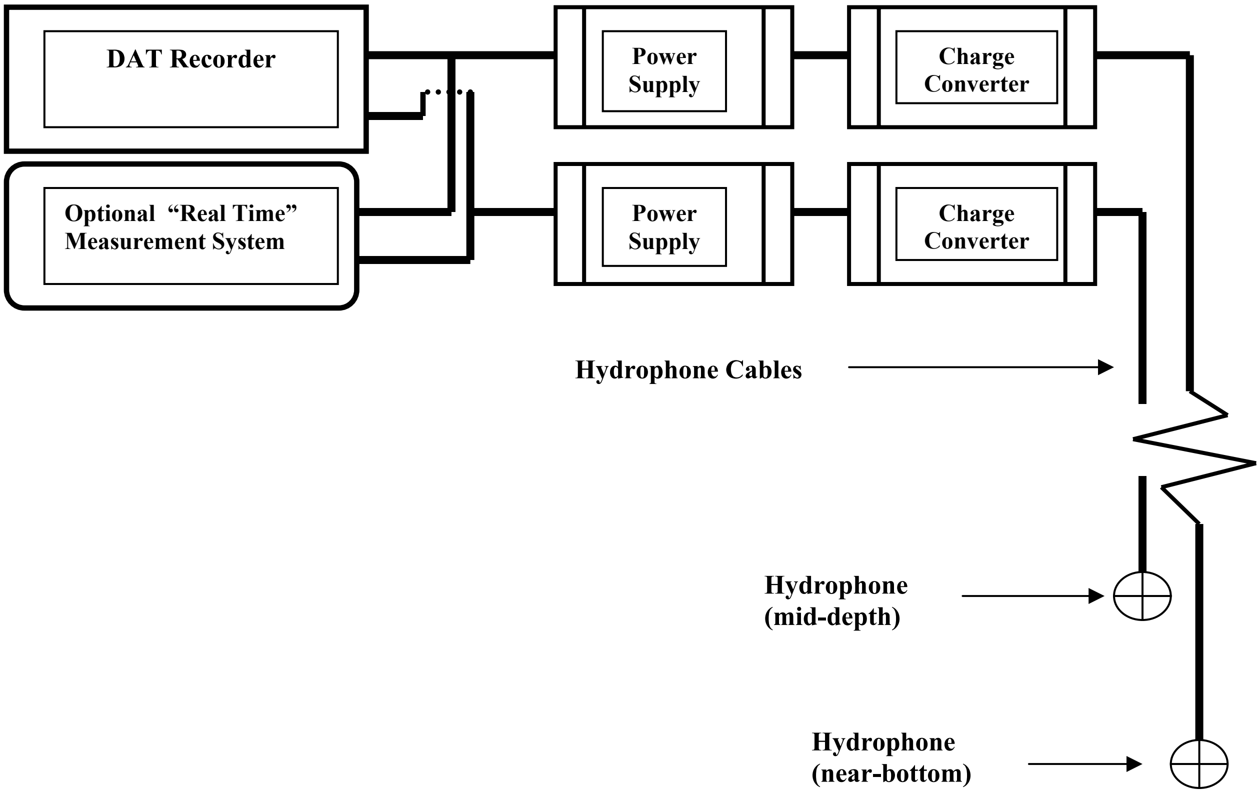

Figure 4-1. Schematic of Underwater Noise Measurement System

meter or similar device will provide a real time readout display of the measured underwater sound levels.

The hydrophone and DAT recording systems shall have a frequency response of ±1 dB from 10 Hz to 20,000 Hz over the anticipated measurement range of 100 dB to 220 dB Linear Peak re: 1 *u*Pa. Note that hydrophones with differing sensitivities may be required depending upon the acoustic environment.

The hydrophones will be positioned at two depths: mid-water column depth and near bottom depth. The depth of the hydrophone will be measured and documented. This will be accomplished by measuring the lead while taking into account the effect of the current or collocating pressure devices to measure the depth during the pile-driving event. The accuracy of the depth measurement will be to within 1 meter.

The recorded data will be analyzed to determine the amplitude, time history and frequency of acoustical impulses from pile-driving activity. The marine mammal safety zone will be identified using measured SPLs that are reported in dB re 1 μPa RMS (impulse). Specific acoustical data that will be reported include:

- The RMS (impulse) level, or criterion used to identify the MMSZ, is the maximum root mean square SPL measured over the duration of the impulse. The underwater noise measurement results obtained during the PIDP indicated that 90 percent of the acoustic energy for most pile-driving impulses occurred over a 50 to 100 msec period with the energy concentrated in the first 30 to 50 msec. Analysis of underwater acoustic data gathered during the PIDP for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard "impulse exponential-time-weighting" (35 msec rise time) or a 1/32 second (31 msec) averaging time correlated to the NMFS RMS (impulse) level measured over the duration of the impulse. The maximum averaging time and representative range of impulse SPLs will be reported.

- The representative range of frequency spectra, $1/3^{rd}$ octave band center frequency SPLs dB re 1 μPa measured over the frequency range of 10 Hz to 20,000 Hz will be reported for each monitored pile.

- The Peak SPL dB re 1 μPa – the largest absolute value of the instantaneous sound pressure over the minimum frequency range of 10 Hz to 20,000 Hz – will be recorded. The maximum and representative range of peak SPLs will be reported for each monitored pile.

- The distance between the measurement location and the pile will be measured with an accuracy of ±10 percent. Methods to accomplish this should include an infrared range finder or global positioning system.

4.5.2 Airborne Sound Monitoring

Airborne sound levels will be measured at times and locations that are coincidental to the underwater measurement sites. In addition, airborne sound will also be measured at the YBI haul-out site. The measurements will be made at a height of about 1 m (3.3 ft) above the water surface.

Each measurement system will consist of an integrating sound level meter (SLM) connected to a DAT recorder (see Figure 4-2). Microphones will be fitted with windscreens. The instrumentation will meet the American National Institute of Standards (ANSI) S1.4 requirements for a Type 1 (Precision) SLM. The instrument will be set to the fast (125 msec) time setting. The expected total allowable error is ± 1.5 dB.

Real time amplitude measurement of airborne sound levels will be reported in dB re 20 µPa. This will include the reporting of linear peak and RMS using a 125 msec exponential-time-constant or SLM "fast" setting (C-weighted) SPLs. It is anticipated that the recorded data will be analyzed to determine the amplitude, time history and frequency content of the impulse. Specific acoustical data that will be reported include:

- The RMS "fast" C-weighted level, which is the maximum root mean square SPL measured using a 125-msec exponential-time-constant and the C-weighting filter.

- The representative range of frequency spectra, 1/3rd octave band center frequency SPLs dB re 20 µPa measured over the frequency range of 25 Hz to 20,000 Hz**.**

Peak SPL dB re 20 µPa, which is the largest absolute value of the instantaneous sound pressure over the minimum frequency range of 25 Hz to 20,000 Hz.

4.5.3 Quality Control

The acoustic measurement program for both underwater and airborne noise measurements will include regular calibration and calibration checks in the field. At a minimum, field verification will be performed on every underwater and in-air sound level monitoring system at the beginning and end of each field use or at least on a daily basis. Calibration or calibration checks will be conducted in the field by checking the system response to a known acoustic quantity. At a minimum, calibration tones will be recorded on DAT systems prior to and at the end of each measurement day.

Since underwater blast transducers cannot be field-calibrated, annual factory calibration certification will be required. All hydrophones, microphones, integrating measurements systems, and calibrators will be certified on an annual basis.

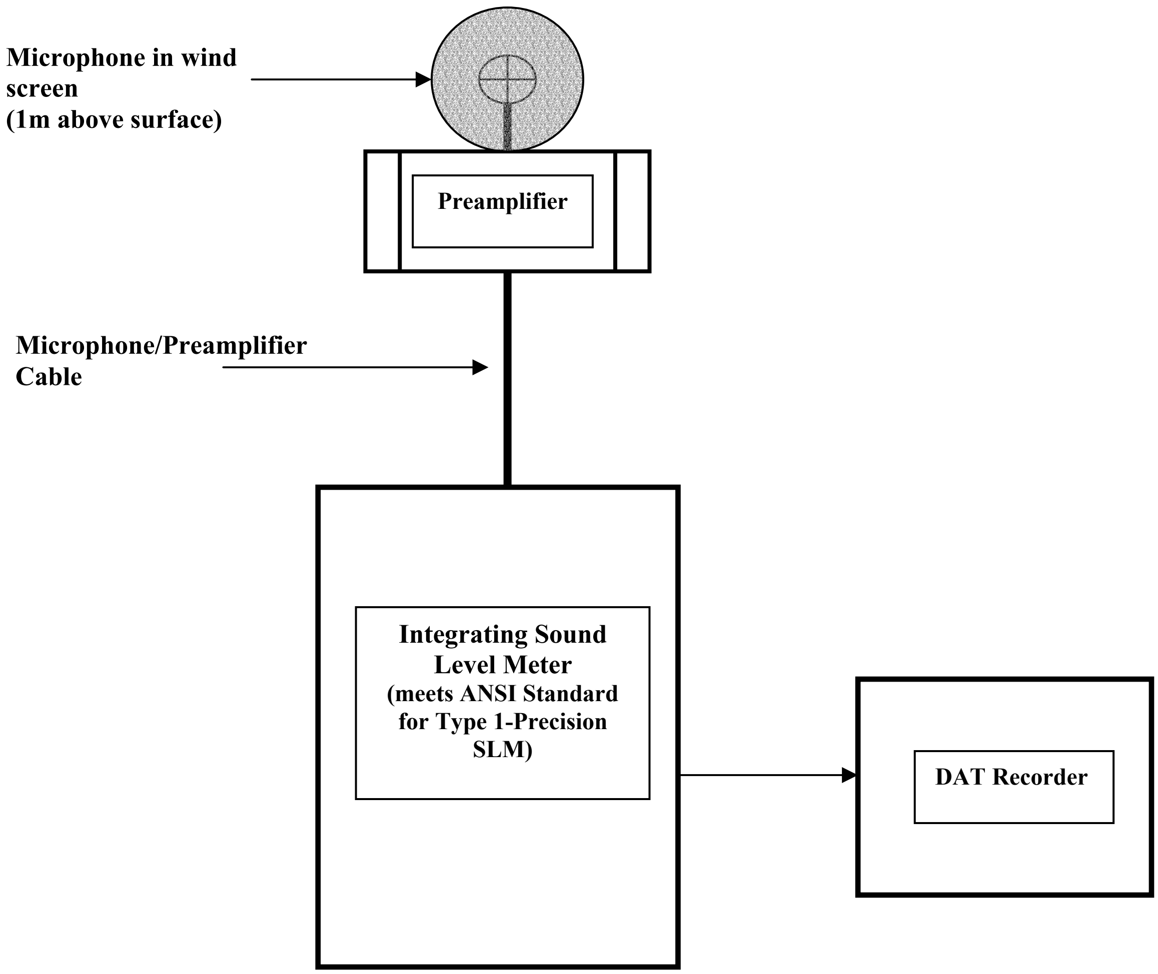

Figure 4-2. Schematic of Airborne Noise Measurement System

Calibration of tape recordings will include the recording of calibration tones at the beginning and end of each tape recording or at least on a daily basis. Calibration will be accomplished through subsequent analysis of these recordings. The frequency response of each recording system will be tested and records will be maintained.

All calibration activities will be documented in the final project monitoring report.

4.6 Reporting

NMFS' Southwest Regional Administrator will be notified prior to the initiation of pile-driving for the East Span Project, and coordination with NMFS will occur on a weekly basis, or as often as necessary. NMFS will be informed of the initial SPL measurements taken at the 500-m (1,640-ft) distance and the radius of adjusted safety-zones based on SPL measurements. As part of the Fisheries and Hydroacoustic Monitoring Program (FHMP) conducted for the East Span Project, acoustic measurements will be conducted during a bubble curtain on/off control study. Results of the study will be made available to NMFS to provide an indication of the amount of attenuation achieved from the cofferdam and bubble curtains during pile-driving.

Monitoring reports will be emailed to NMFS on a weekly basis during pile-driving activity. In addition, the monitoring reports will be available at the biological mitigation website (www.biomitigation.org). The weekly report will include species and numbers of marine mammals observed, time and location of observation, behavior, and other recorded data. In addition, the report will include an estimate of the number of California sea lions, Pacific harbor seals, and gray whales that may have been harassed as a result of the pile-driving activities. Relevant information from the Richmond Bridge Harbor Seal survey team will also be included in monitoring reports to NMFS.

Caltrans will provide NMFS with a final report detailing:

- the monitoring protocol
- a summary of the data recorded during monitoring
- an estimate of the numbers of marine mammals that may have been harassed due to pile-driving

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