# APPENDIX F

## Appendices Related to Biological Resources

- **F1: REGIONAL SPECIAL-STATUS SPECIES TABLES**
- **F2: SONGS UNITS 2 AND 3 OFFSHORE DISCHARGE CONDUITS UNDERWATER PHOTOS**
- **F3: NOISE IMPACTS ON MARINE WILDLIFE**

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# APPENDIX F1
# REGIONAL SPECIAL-STATUS SPECIES TABLES[1]



The tables above identify special-status plants and wildlife (terrestrial and marine) known in the region and summarize the species' habitat and distribution, conservation status, and their potential to occur. The potential to occur is based on the five criteria below.

| | |
|---|---|
| **Present** | Observed during surveys or recently documented and habitat conditions remain unchanged from the time of the record |
| **High** | Documented in Proposed Project study area vicinity and suitable habitat found in study area, but not detected during Project-specific surveys |
| **Moderate** | Either documented in Proposed Project study area vicinity or suitable habitat found in study area within species' known geographic range |
| **Low** | No records in Proposed Project study area vicinity, habitat is marginal, or the species is conspicuous and was not detected during biological surveys |
| **Unlikely** | No records in Proposed Project area, and the site lacks suitable habitat requirements |

Table Notes:

- Federal Rankings: FE = Federally Endangered; FT = Federally Threatened; BCC = USFWS Birds of Conservation Concern
- State Rankings: SE = State Endangered; ST = State Threatened; SSC = California Species of Special Concern; SR = State Rare; FP = California Department of Fish and Wildlife (CDFW) Fully Protected.
- California Rare Plant Ranks (CRPR)
  - CRPR 1A = Presumed extinct in California;
  - CRPR 1B = Rare or endangered in California and elsewhere;
  - CRPR 2 = Rare or endangered in California, more common elsewhere;
  - CRPR 3 = More information needed;
  - CRPR 4 = Limited distribution (Watch List).
  - CRPR Sub-categories: .1 = Seriously endangered in California (over 80 percent of occurrences threatened/high degree and immediacy of threat); .2 = Fairly endangered in California (20 to 80 percent occurrences threatened); .3 = Not very endangered in California (less than 20 percent of occurrences threatened or no current threats known).

[1] This document has been prepared for the California State Lands Commission by Aspen Environmental under Contract No. C2015046.

## Table F1-1. Regional Special-Status Plants

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Abronia maritima*[1] | Red sand-verbena | 4.2 | Feb. – Nov. | Coastal dunes; nearly extirpated in southern California. | **Present** – One plant observed during 2016 survey at the base of sea cliff in the south-eastern portion of the terrestrial study area (Figure 4.4-2). |
| *Acanthomintha ilicifolia*[2] | San Diego thornmint | FT<br>SE<br>1B.1 | Apr. – June | Clay openings in chaparral, coastal scrub, valley and foothill grassland, vernal pools. | **Unlikely** – Suitable habitat present but nearest reported occurrence is over 20 miles southeast of the Proposed Project in the vicinity of Carlsbad. |
| *Ambrosia pumila*[2] | San Diego ambrosia | FE<br>1B.1 | Apr. – Oct. | Sandy loam or clay, often in disturbed areas; sometimes alkaline. In chaparral, coastal scrub, valley and foothill grassland, and vernal pools. | **Unlikely** – Suitable habitat present but nearest reported occurrence is 25 miles northeast of the Proposed Project near Alberhill, Riverside County. |
| *Aphanisma blitoides*[1, 3] | Aphanisma | 1B.2 | Feb. – June | Sandy or gravelly soils; coastal bluff scrub, coastal dunes, and coastal scrub. | **High** – Suitable habitat present. One record from San Onofre State Park 2 miles southeast of Proposed Project site. |
| *Artemisia palmeri*[1] | San Diego sagewort | 4.2 | Feb. – Sept. | Sandy, mesic sites; chaparral, coastal scrub, riparian forest, riparian scrub, and riparian woodland. | **Unlikely** – Limited habitat present in coastal scrub. Nearest reported occurrence is 20 miles northwest of the Proposed Project in the San Joaquin Hills, Orange County. |
| *Atriplex coulteri*[1, 3] | Coulter's saltbush | 1B.2 | Mar. – Oct. | Alkaline or clay soils; coastal bluff scrub, coastal dunes, coastal scrub, valley and foothill grassland. | **High** – Suitable habitat present. One record from San Onofre State Park campground less than 0.5 mile southeast of Proposed Project site. |

**Table F1-1. Regional Special-Status Plants**

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Atriplex pacifica*[1, 3] | South coast saltscale | 1B.2 | Mar. – Oct. | Coastal bluff scrub, coastal dunes, coastal scrub, and playas. | **High** – Suitable habitat present. One record from San Onofre State Beach less than 0.5 mile northwest of Proposed Project site. |
| *Brodiaea filifolia*[1, 2, 3] | Thread-leaved brodiaea | FT<br>SE<br>1B.1 | Mar. – June | Often clay; chaparral (openings), cismontane woodland, coastal scrub, playas, valley and foothill grassland, and vernal pools. | **High** – Suitable habitat present. Numerous records within 3 miles of Proposed Project site. |
| *Calochortus weedii var. intermedius*[1, 3] | Intermediate mariposa lily | 1B.2 | May – July | Rocky, calcareous; chaparral, coastal scrub, valley and foothill grassland. | **Moderate** – Suitable habitat present. Records less than 6 miles north of Proposed Project site. |
| *Caulanthus simulans*[1] | Payson's jewelflower | 4.2 | Feb. – June | Sandy, granitic; chaparral, and coastal scrub. | **Moderate** – Suitable habitat present. Records less than 3 miles southeast of Proposed Project site. |
| *Chamaebatia australis*[1] | Southern mountain misery | 4.2 | Nov. – May | Chaparral (gabbroic or meta-volcanic). | **Unlikely** – No suitable habitat present. No reported records at Proposed Project site. |
| *Chorizanthe leptotheca*[1] | Peninsular spineflower | 4.2 | May – Aug. | Alluvial fan, granitic; chaparral, coastal scrub and lower montane coniferous forest. | **Moderate** – Suitable habitat present. Records less than 6 miles northwest of Proposed Project site. |
| *Chorizanthe polygonoides var. longispina*[1] | Long-spined spineflower | 1B.2 | Apr. – July | Often clay; chaparral, coastal scrub, meadows and seeps, valley and foothill grassland, and vernal pools. | **Moderate** – Suitable habitat present. Records less than 7 miles northwest of Proposed Project site. |

## Table F1-1. Regional Special-Status Plants

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Convolvulus simulans*[1] | Small-flowered morning-glory | 4.2 | Mar. – July | Clay, serpentinite seeps; chaparral (openings), coastal scrub, and valley and foothill grassland. | **Moderate** – Suitable habitat present. Records less than 7 miles northwest of Proposed Project site. |
| *Deinandra paniculata*[1] | Paniculate tarplant | 4.2 | Mar. – Nov. | Usually vernally mesic, sometimes sandy; coastal scrub, valley and foothill grassland, and vernal pools. | **Moderate** – Suitable habitat present. Records less than 7 miles northwest of Proposed Project site. |
| *Dichondra occidentalis*[1] | Western dichondra | 4.2 | Jan. – July | Chaparral, cismontane woodland, coastal scrub, and valley and foothill grassland. | **Moderate** – Suitable habitat present. Records less than 7 miles northwest of Proposed Project site. |
| *Dudleya blochmaniae ssp. blochmaniae*[1, 3] | Blochman's dudleya | 1B.1 | Apr. – June | Rocky, often clay or serpentinite; coastal bluff scrub, chaparral, coastal scrub, and valley and foothill grassland. | **High** – Suitable habitat present. Records less than 3 miles northwest of Proposed Project site. |
| *Dudleya multicaulis*[1, 3] | Many-stemmed dudleya | 1B.2 | Apr. – July | Often clay; chaparral, coastal scrub, valley and foothill grassland. | **High** – Suitable habitat present. Records less than 1 mile east of Proposed Project site. |
| *Dudleya viscida*[1, 3] | Sticky dudleya | 1B.2 | May – June | Rocky; coastal bluff scrub, chaparral, cismontane woodland, and coastal scrub. | **Moderate** – Suitable habitat present. Records less than 9 miles northeast and southeast of Proposed Project site. |
| *Eryngium aristulatum var. parishii*[1, 2, 3] | San Diego button-celery | FE<br>SE<br>1B.1 | Apr. – June | Mesic; coastal scrub, valley and foothill grassland, and vernal pools. | **Moderate** – Suitable habitat present. Records less than 7 miles southeast of Proposed Project site. |

**Table F1-1. Regional Special-Status Plants**

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Eryngium pendletonense* [1, 3] | Pendleton button-celery | 1B.1 | Apr. – July | Clay, vernally mesic; coastal bluff scrub, valley and foothill grassland, and vernal pools. | **Present** – Observed in vernal pool restoration area within northwestern portion of terrestrial study area (Figure 4.4-2). |
| *Ferocactus viridescens* [1] | San Diego barrel cactus | 2B.1 | May – June | Chaparral, coastal scrub, valley and foothill grassland, and vernal pools. | **Unlikely** – Suitable habitat present but the northernmost record in California is more than 11 miles south of Proposed Project site. |
| *Harpagonella palmeri* [1, 3] | Palmer's grappling-hook | 4.2 | Mar. – May | Clay, open grassy areas within shrubland; chaparral, coastal scrub, valley and foothill grassland. | **Moderate** – Suitable habitat is present. Records less than 6 miles northwest of Proposed Project site. |
| *Hordeum intercedens* [1] | Vernal barley | 3.2 | Mar. – June | Coastal dunes, coastal scrub, valley and foothill grassland (saline flats and depressions), and vernal pools. | **Present** – Reported from vernal pool restoration area within northwestern portion of terrestrial study area (Figure 4.4-2). |
| *Isocoma menziesii var. decumbens* [1, 3] | Decumbent goldenbush | 1B.2 | Apr. – Nov. | Chaparral, coastal scrub (sandy, often in disturbed areas). | **Moderate** – Suitable habitat present. Records less than 4 miles northwest of Proposed Project site. |
| *Juncus acutus ssp. leopoldii* [1] | South-western spiny rush | 4.2 | Mar. – June | Coastal dunes (mesic), meadows and seeps (alkaline seeps), coastal salt marshes. | **Low** – Marginally suitable habitat present. Records less than 1 mile northwest in San Onofre Creek. |
| *Lasthenia glabrata ssp. coulteri* [1, 3] | Coulter's goldfields | 1B.1 | Feb. – June | Coastal salt marshes, playas, and vernal pools. | **High** – **S**uitable habitat present. Records less than 1 mile east of Proposed Project site. |
| *Lepidium virginicum var. robinsonii* [1, 3] | Robinson's pepper-grass | 4.3 | Jan. – July | Chaparral and coastal scrub. | **Moderate** – Suitable habitat present. Records less than 2 miles southeast of Proposed Project site. |

**Table F1-1. Regional Special-Status Plants**

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Leptosyne maritima*[1, 3] | Sea dahlia | 2B.2 | Mar. – May | Coastal bluff scrub and coastal scrub. | **Low** – Suitable habitat present but northern-most record is 7.5 miles southeast of Proposed Project site. |
| *Lycium brevipes var. hassei*[1] | Santa Catalina Island desert-thorn | 3.1 | June – Aug. | Coastal bluff scrub and coastal scrub. | **Moderate** – Suitable habitat present. Records less than 2.5 miles northwest of Proposed Project site. |
| *Lycium californicum*[1] | California box-thorn | 4.2 | Dec. – Aug. | Coastal bluff scrub and coastal scrub. | **Present** – Reported on coastal bluffs in terrestrial study area (Figure 4.4-2). |
| *Microseris douglasii ssp. platycarpha*[1] | Small-flowered microseris | 4.2 | Mar. – May | Cismontane woodland, coastal scrub, valley and foothill grassland, and vernal pools. | **Present** – Reported from vernal pool restoration area within terrestrial study area (Figure 4.4-2). |
| *Monardella hypoleuca ssp. intermedia*[1, 3] | Intermediate monardella | 1B.3 | Apr. – Sept. | Usually under-story; chaparral, cismontane woodland, lower montane coniferous forest. | **Unlikely** – No suitable habitat present and does not occur below 300 feet elevation. |
| *Myosurus minimus ssp. apus*[1, 3] | Little mousetail | 3.1 | Mar. – June | Valley and foothill grassland, vernal pools (alkaline). This subspecies is taxonomic-ally not recognized.[4] | **Present** – Reported from vernal pool restoration area within northwestern portion of terrestrial study area (Figure 4.4-2). |
| *Navarretia prostrata*[1,3] | Prostrate vernal pool navarretia | 1B.1 | Apr. – July | Mesic; coastal scrub, meadows and seeps, valley and foothill grass-land (alkaline), and vernal pools. | **High** – Suitable habitat is present. Records less than 2 miles from Proposed Project site. |
| *Nemacaulis denudata var. denudata*[1] | Coast woolly-heads | 1B.2 | Apr. – Sept. | Coastal dunes. | **Unlikely** – No suitable habitat present and no records for more than 8 miles from Proposed Project site. |

## Table F1-1. Regional Special-Status Plants

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Nolina cismontana*[1, 3] | Chaparral nolina | 1B.2 | Mar. – July | Sandstone or gabbro; chaparral and coastal scrub. | **Low** – Suitable habitat present, but no records for more than 7 miles from Proposed Project site. |
| *Piperia cooperi*[1] | Chaparral rein orchid | 4.2 | Mar. – June | Chaparral, cismontane woodland, coastal scrub, and valley and foothill grassland. | **Low** – Suitable habitat present, but no records for more than 12 miles from Proposed Project site. |
| *Polygala cornuta var. fishiae*[1] | Fish's milkwort | 4.3 | May – Aug. | Chaparral, cismontane woodland, riparian woodland. | **Unlikely** – No suitable habitat is present. Records less than 3 miles from Proposed Project site. |
| *Pseudog-naphalium leucocephalum*[1, 3] | White rabbit-tobacco | 2B.2 | July – Sept. | Sandy, gravelly; chaparral, cismontane woodland, coastal scrub and riparian woodland. | **Moderate** – Suitable habitat present. Records less than 1.3 miles from Proposed Project site. |
| *Quercus dumosa*[3] | Nuttall's scrub oak | 1B.1 | Feb. – Aug. | Sandy, clay loam; closed- cone coniferous forest, chaparral and coastal scrub. | **Moderate** – Suitable habitat present. Records less than 5 miles from Proposed Project site. |
| *Romneya coulteri*[1] | Coulter's Matilija poppy | 4.2 | Mar. – July | Often in burns; chaparral and coastal scrub. | **Moderate** – Suitable habitat present. Records less than 1.3 miles from Proposed Project site. |
| *Senecio aphanactis*[1, 3] | Chaparral ragwort | 2B.2 | Jan. – May | Chaparral, cismontane woodland and coastal scrub (sometimes alkaline). | **High** – Suitable habitat present. Records less than 3 miles from Proposed Project site. |
| *Suaeda esteroa*[1, 3] | Estuary seablite | 1B.2 | May – Jan. | Coastal salt marshes, wetlands, and riparian habitat. | **Low** – Marginally suitable habitat present. Records less than 10 miles from Proposed Project site along sea cliffs in San Clemente.[3] |

**Table F1-1. Regional Special-Status Plants**

| Scientific Name | Common Name | Status | Blooming | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|---|
| *Suaeda taxifolia*[1] | Woolly seablite | 4.2 | Jan. – Dec. | Coastal bluff scrub, coastal dunes, and margins of coastal salt marshes. | **Present** – Reported from vernal pool restoration area and along coastal bluffs in northwestern portion of terrestrial study area (Figure 4.4-2). |
| *Viguiera laciniata*[1] | San Diego County viguiera | 4.2 | Feb. – Aug. | Chaparral and coastal scrub. | **Moderate** – Suitable habitat present. Records from San Onofre State Beach less than 2 miles from Proposed Project site. |

Sources: [1] CNPS 2018; [2] USFWS 2016; [3] CDFW 2017a; [4].

## Table F1-2. Regional Special-Status Wildlife (Terrestrial)

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| **Invertebrates** | | | | |
| *Branchinecta sandiegonensis*[1, 2] | San Diego fairy shrimp | FE | Endemic to San Diego and Orange County mesas; vernal pools. | **Present** – Historic occurrences (as recent as 2012)[1] in San Onofre Vernal Pool Restoration Area (Figure 4.4-4). |
| *Streptocephalus woottoni*[1, 2] | Riverside fairy shrimp | FE | Endemic to San Diego, Orange, and western Riverside counties in tectonic swale/earth slump basin areas in grassland and coastal sage scrub. Inhabit seasonally astatic pools filled by winter/spring rains. | **High** – Potentially suitable habitat present in San Onofre Vernal Pool Restoration Area. Records within 3 miles (Figure 4.4-4). |
| **Fish** | | | | |
| *Oncorhynchus mykiss irideus*[1, 2] | Southern California steelhead | FE | Listing is for populations from Santa Maria River south to southern extent of range (San Mateo Creek). Southern steelhead likely have greater physiological tolerances to warmer water/variable conditions. | **Unlikely** – No suitable habitat present; known to occur over 1 mile north of Proposed Project site in San Mateo creek. |
| *Eucyclogobius newberryi*[1, 2] | Tidewater goby | FE<br>SSC | Brackish coastal waters, from Agua Hedionda Lagoon to the Smith River mouth. Shallow lagoons and lower stream reaches with slow (not stagnant) water and high oxygen levels. | **Unlikely** – No suitable habitat present; known to occur north of Proposed Project site in San Onofre and San Mateo creeks. |
| **Amphibians and Reptiles** | | | | |
| *Anaxyrus californicus*[1] | Arroyo toad | FE<br>SSC | Rivers with sandy banks, willows, cottonwoods, and sycamores; loose, gravelly areas of streams in drier parts of range. | **Unlikely** – No suitable breeding habitat present. Potentially suitable upland habitat on Proposed Project site isolated by I-5 freeway. Closest record more than 4 miles northwest. |

**Table F1-2. Regional Special-Status Wildlife (Terrestrial)**

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| *Spea hammondii*[1] | Western spadefoot | SSC | Occurs primarily in grassland habitats, but can be found in valley-foothill hardwood woodlands. Vernal pools are essential for breeding and egg-laying. | **Moderate** – Suitable breeding habitat present in vernal pool restoration area within northwestern portion of terrestrial study area. Records within 3 miles. |
| *Emys marmorata*[1] | Western pond turtle | SSC | Perennial ponds, marshes, rivers, streams and irrigation ditches, usually with aquatic vegetation and basking sites, below 6,000 feet elevation. | **Unlikely** – No suitable habitat present; known to occur over 1 mile from terrestrial study area in San Mateo creek. |
| *Phrynosoma blainvillii*[1] | Coast horned lizard | SSC | Most common in lowlands along sandy washes with scattered low bushes. Open areas for sunning, bushes for cover, loose soil for burial, and native ants for diet. | **Moderate** – Potentially suitable habitat present. Records within 1 mile of Proposed Project site. |
| *Plestiodon skiltonianus interparietalis*[1] | Coronado Island skink | SSC | Grassland, chaparral, pinon- juniper and juniper sage, woodland, pine-oak, and pine forests in coastal ranges of southern California. | **Moderate** – Potentially suitable habitat present. Records within 1 mile of Proposed Project site. |
| *Aspidoscelis hyperythra*[1] | Orange-throat whiptail | SSC | Low elevation coastal scrub, chaparral, and valley-foothill hardwood. Washes, and other sandy areas. | **Moderate** – Potentially suitable habitat present. Records within 1.3 miles of Proposed Project site. |
| *Crotalus ruber*[1] | Red-diamond rattlesnake | SSC | Chaparral, woodland, grassland, and desert areas from coastal San Diego County to eastern slopes of the mountains. Rocky with dense vegetation. Requires rodent burrows or cracks in the surface cover. | **Moderate** – Potentially suitable habitat present. records within 1.5 miles of Proposed Project site. |

**Table F1-2. Regional Special-Status Wildlife (Terrestrial)**

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| **Birds** | | | | |
| *Pelecanus occidentalis californicus* | California brown pelican | FP | Roosts communally on natural or man-made structures in or adjacent to the ocean. Colonial nester on coastal islands just above the surf line. | **Low** – May occasionally roost on Proposed Project structures but not expected to nest in terrestrial study area. |
| *Falco peregrinus anatum* | American peregrine falcon | FP | Found near water, forages for shorebirds and ducks on shorelines and mudflats. Nests on buildings, water towers, cliffs, power pylons, and other tall structures. | **Moderate** – Suitable foraging and nesting habitat present within terrestrial study area; known to occur in MCBCP.[3] |
| *Elanus leucurus*[1] | White-tailed kite | FP | Open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees. | **Unlikely** – No potentially suitable nesting habitat present. |
| *Charadrius alexandrines nivosus* | Western snowy plover | FT<br>SSC | Sandy beaches, salt pond levees, and shores of large alkali lakes. Needs sandy, gravelly, or friable soils for nesting. | **Low** – Marginally suitable nesting habitat present. Nearest nesting record is less than 10 miles south of Proposed Project site. |
| *Sternula antillarum browni*[1, 2] | California least tern | FE<br>SE<br>FP | Nests along the coast from San Francisco Bay to northern Baja California. Colonial breeder on bare or sparsely vegetated, flat substrates, sand beaches, alkali flats, landfills, or paved areas. | **Low** – Marginally suitable nesting habitat present. Nearest nesting record is more than 7 miles south of Proposed Project site. |
| *Athene cunicularia*[1] | Burrowing owl | BCC<br>SSC | Open, dry annual, or perennial grasslands, deserts, and scrublands with low-growing vegetation. Subterranean nester. Dependent on California ground squirrel. | **Moderate** – Suitable habitat present. One 2004 wintering record from terrestrial study area within SSA. |
| *Empidonax traillii extimus*[1, 2] | Southwestern willow flycatcher | FE<br>SE | Riparian woodlands in southern California. | **Unlikely** – No potentially suitable nesting habitat present. |

**Table F1-2. Regional Special-Status Wildlife (Terrestrial)**

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| *Campylorhynchus brunneicapillus sandiegensis*[1] | Coastal cactus wren | BCC SSC | Southern California coastal sage scrub. Wrens require tall opuntia cactus for nesting and roosting. | **Unlikely** – No potentially suitable nesting habitat present. |
| *Polioptila californica californica*[1, 2] | Coastal California gnatcatcher | FT SSC | Obligate, permanent resident of coastal sage scrub below 2,500 feet in southern California. Low coastal sage scrub in arid washes, on mesas, and slopes. | **Present** – Multiple nest records (as recent as 2014)[3] within 500 feet of terrestrial study area, including one within SSA (Figure 4.4-3). |
| *Vireo bellii pusillus*[1, 2] | Least Bell's vireo | FE SE | Summer resident of southern California in low riparian in vicinity of water or in dry river bottoms below 2000 feet. Nests in margins of twigs and bushes protruding on to pathways. Usually willows, baccharis, and mesquite. | **Unlikely** – No potentially suitable nesting habitat present. |
| *Rallus obsoletuslevipes*[2] | Ridgway's rail | FE SE | Found in salt marshes traversed by tidal sloughs, where cordgrass and pickleweed are the dominant vegetation. Requires dense growth of either pickleweed or cordgrass for nesting or escape cover; feeds on mollusks and crustaceans. | **Unlikely** – No potentially suitable nesting habitat present. No records within 5 miles of Proposed Project site. |
| **Mammals** | | | | |
| *Choeronycteris mexicana*[1] | Mexican long-tongued bat | SSC | Occasionally found in San Diego County, which is on periphery of their range. Feeds on nectar and pollen of night-blooming succulents. Roosts in relatively well-lit caves, and in and around buildings. | **Low** – Potentially suitable roosting habitat present but at edge of range. |
| *Antrozous pallidus*[1] | Pallid bat | SSC | Deserts, grasslands, shrublands, woodlands, and forests. Most common in open, dry habitats with rocky areas for roosting. | **Low** – Marginally suitable roosting habitat present. |

## Table F1-2. Regional Special-Status Wildlife (Terrestrial)

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| *Eumops perotis californicus*[1] | Western mastiff bat | SSC | Open, semi-arid to arid habitats, including conifer and deciduous woodlands, coastal scrub, grasslands, and chaparral. Roosts in crevices in cliff faces, high buildings, trees, tunnels. | **Moderate** – Potentially suitable roosting habitat present. |
| *Nyctinomops femorosaccus*[1] | Pocketed free-tailed bat | SSC | Arid areas in southern California including pine-juniper woodlands, desert scrub, palm oasis, desert wash, and desert riparian. Roosts in rocky areas with high cliffs. | **Moderate** – Potentially suitable roosting habitat present. |
| Perognathus longimembris pacificus[1, 2] | Pacific pocket mouse | FE<br>SSC | Narrow coastal plains from the Mexican border to El Segundo, Los Angeles County. Alluvial sands near the ocean. | **Unlikely** – Records 1 mile inland in alluvial habitat of San Mateo Creek. Limited, marginally suitable habitat at Proposed Project site isolated by I-5 freeway and surface streets. |
| *Dipodomys stephensi*[1, 2] | Stephens' kangaroo rat | FE<br>ST | Primarily annual and perennial grasslands; also sparse coastal scrub. | **Unlikely** – All known records at least 4.5 miles inland. |
| *Chaetodipus californicus femoralis*[1] | Dulzura pocket mouse | SSC | Coastal scrub, chaparral, and grassland in San Diego County. Attracted to grass-chaparral edges. | **Moderate** – Potentially suitable habitat present. Records within 1 mile of Proposed Project site. |
| *Chaetodipus fallax fallax*[1] | North-western San Diego pocket mouse | SSC | Coastal scrub, chaparral, grasslands sagebrush, etc. in western San Diego County. Sandy, herbaceous areas with rocks and coarse gravel. | **Moderate** – Potentially suitable habitat present. Records within 1 mile of Proposed Project site. |
| *Neotoma lepida intermedia*[1] | San Diego desert woodrat | SSC | Coastal scrub from San Diego to San Luis Obispo Counties. Moderate to dense canopies preferred. Also like rocky cliffs and outcrops. | **Moderate** – Potentially suitable habitat present. Records within 1 mile of Proposed Project site. |

Sources: [1] CDFW 2017a; [2] USFWS 2016; [3] Marine Corps Installations West 2016.
Acronyms: MCBCP = Marine Corps Base Camp Pendleton; SSA = supplemental support areas.

**Table F1-3. Regional Special-Status Marine Mammals**

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| *Enhydra lutris nereis* | Southern sea otter | FT, FP | Occurs from near Half Moon Bay south to Gaviota and San Nicolas Island. Typically occurs in coastal waters within 0.6 mile of shoreline; often associated with kelp beds | **Unlikely** – South of known inhabited range. |
| *Arctocephalus townsendii* | Guadalupe fur seal | FT, ST, FP | Occurs primarily in Baja California, Mexico, but occasionally found on San Miguel and San Nicolas Islands. Prefers rocky insular shorelines and sheltered coves. | **Unlikely** – Suitable habitat absent in Proposed Project area. |
| *Balaenoptera musculus* | Blue whale | FE | In the eastern North Pacific Ocean, ranges from the Gulf of Alaska south to Costa Rica. Winters off of Mexico and Central America, and feeds during summer off the U. S. west coast. | **Low** – Low potential for occurrence within Proposed Project area given population density/habitat preferences,. |
| *Balaenoptera physalus* | Fin whale | FE | One of the four stocks identified in U.S. waters occurs off California/ Oregon/ Washington. The species is migratory and moves seasonally into and out of high-latitude feeding areas. | **Low** (see above) |
| *Balaenoptera borealis* | Sei whale | FE | Cosmopolitan distribution; occur in subtropical, temperate, and subpolar waters around the world. Usually observed in deeper waters of oceanic areas far from the coastline | **Low** (see above) |
| *Eschrichtius robustus* | Gray whale | Delisted; protected under the Marine Mammal Protection Act | The eastern North Pacific gray whale population summers and feeds mainly in the Chukchi, Beaufort, and the northwestern Bering Seas. Migrates south along the coast in the autumn to wintering grounds on the west coast of Baja California, Mexico and the southeastern Gulf of California to breed, and bear/nurse their young before returning to the Arctic. | **Moderate** – May occur in nearshore coastal waters during migratory periods. |

**Table F1-3. Regional Special-Status Marine Mammals**

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| *Megaptera novaeangliae* | Humpback whale | FE | One of the three populations identified in the North Pacific is the California/Oregon/Washington stock that winters in coastal Central America and Mexico and migrates to areas ranging from the coast of California to southern British Columbia in summer/fall. Prefer shallow waters while feeding and calving. Feeding grounds are in cold, productive coastal waters. | **Low** (see above) |
| *Physeter macrocephalus* | Sperm whale | FE | Inhabit all oceans of the world. Distribution is dependent on their food source and suitable conditions for breeding. | **Low** (see above) |

Sources: CDFW 2017b; Tinker and Hatfield 2016; NMFS 2018a-l.

## Table F1-4. Regional Special-Status Marine Birds

| Scientific Name | Common Name | Status |
|---|---|---|
| **Shorebirds** | | |
| *Charadrius alexandrines nivosus* | Western snowy plover (coastal) | FT, BCC, SSC (nesting) |
| *Haematopus bachmani* | Black oystercatcher | BCC (nesting) |
| *Numenius americanus* | Long-billed curlew | BCC (nesting) |
| **Seabirds** | | |
| *Cerorhinca monocerata* | Rhinoceros auklet | No listing (nesting colony) |
| *Gavia immer* | Common Loon | SSC (nesting) |
| *Gelochelidon nilotica* | Gull-billed tern | BCC, SSC (nesting colony) |
| *Hydroprogne caspia* | Caspian tern | BCC (nesting colony) |
| *Larus californicus* | California Gull | SSC (nesting colony) |
| *Oceanodroma homochroa* | Ashy storm-petrel | BCC, SSC (nesting colony) |
| *Oceanodroma melania* | Black storm-petrel | SSC (nesting colony) |
| *Pelecanus occidentalis* | California brown pelican | FP (nesting colony/communal roosts) |
| *Ptychoramphus aleuticus* | Cassin's auklet | BCC, SSC (nesting colony) |
| *Sternula antillarum browni* | California least tern | FE, SE, FP (nesting colony) |
| *Thalasseus elegans* | Elegant tern | SSC (nesting colony) |
| *Synthliboramphus scrippsi* | Scripps's murrelet | ST, BCC |
| *Phalacrocorax auritus* | Double-crested cormorant | SSC (Nesting colony) |
| *Rynchops niger* | Black skimmer | BCC, SSC (Nesting colony) |

Sources: CDFW 2017b; Shuford and Gardali 2008; Baird 1993.

## Table F1-5. Regional Special-Status Sea Turtles

| Scientific Name | Common Name | Status | Habitat | Likelihood of Occurrence |
|---|---|---|---|---|
| *Caretta caretta* | Loggerhead sea turtle | FE | Circumglobal distribution throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Loggerheads are the most abundant species of sea turtle found in U.S. coastal waters. Have been reported as far north as Alaska, and as far south as Chile. Most records along U.S. west coast are of juveniles off the California coast, with occasional sightings from Washington and Oregon coasts. | **Low** – No known nesting areas on southern California beaches. Low potential for occurrence within Proposed Project site due to generally low population densities. |
| *Chelonia mydas* | green sea turtle | FE, SSC | Globally distributed and generally found in tropical and subtropical waters along continental coasts and islands. In the eastern North Pacific, green sea turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south. | **Low** (see above) |
| *Lepidochelys olivacea* | Olive ridley sea turtle | FT | Globally distributed in tropical waters. Occurs in the eastern Pacific from southern California to northern Chile. Infrequent occurrences documented off southern, central, and northern California. | **Low** (see above) |
| *Dermochelys coriacea* | Leatherbac k sea turtle | FE | Sighted with some regularity in coastal waters off the west coast of the U.S. Sighting frequency is greatest off central California. Nearly all sightings in southern California occur in deeper waters seaward of the Channel Islands. | **Low** (see above) |

Sources: CDFW 2017b; Tinker and Hatfield 2016; NMFS 2018a-l; CalHerps 2017.

## Table F1-6. Essential Fish Habitat Federal Fishery Management Plan – Covered Fishes

| Taxa in Area[1,2] | Fishery Management Plan | | | | Likelihood of Occurrence[3] |
|---|---|---|---|---|---|
| | HMS | PCG | CPS | PCS | |
| **Nearshore – Benthic** | | | | | |
| Ratfish (*Hydrolagus colliei*) | | x | | | ~~**High**~~Low |
| Rock sole (*Lepidopsetta bilineata*) | | x | | | Low |
| **Nearshore – Benthic and Pelagic** | | | | | |
| Leopard shark (*Triakis semifasciata*) | | x | | | **High** |
| Spiny dogfish (*Squalus suckleyi*) | | x | | | **High** |
| Smelts (*Osmeridae*) | | x | x | | **High** |
| **Nearshore Benthic – Hard Substrate** | | | | | |
| Cabezon (*Scorpaenichthys marmoratus*) | | x | | | **High** |
| Rockfishes (*Sebastes spp.*) | | x | | | **High** |
| Lingcod (*Ophiodon elongates*) | | x | | | **High** |
| Kelp greenling (*Hexagrammos decagrammus*) | | x | | | Low |
| **Nearshore Benthic – Soft Substrate** | | | | | |
| Curlfin sole (*Pleuronichthys decurrens*) | | x | | | **High** |
| English sole (*Parophrys vetulus*) | | x | | | **High** |
| Pacific sanddab (*Citharichthys sordidus*) | | x | | | **High** |
| Sand sole (*Psettichthys melanostictus*) | | x | | | **High** |
| Starry flounder (*Platichthys stellatus*) | | x | | | **High** |
| Big skate (*Raja binoculata*) | | x | | | **High** |
| California skate (*Raja inornata*) | | x | | | **High** |
| All other skates (endemic species in the family *Arhynchobatidae*) | | x | | | **High** |
| Dover Sole (*Microstomus pacificus*) | | x | | | Low |
| **Nearshore – Pelagic/Water Column** | | | | | |
| Pacific sardine (*Sardinops sagax*) | | | x | | **High** |
| Pacific (chub) mackerel (*Scomber japonicas*) | | | x | | **High** |
| Northern anchovy (*Engraulis mordax*) | | | x | | **High** |
| Jack mackerel (*Trachurus symmetricus*) | | | x | | **High** |
| Jacksmelt (*Atherinopsis californiensis*) | | | x | | **High** |
| Market squid (*Doryteuthis opalescens*) | | | x | | **High** |
| Silversides (Atherinopsidae) | | x | x | | **High** |
| Pacific whiting (hake) (*Merluccius productus*) | | x | | | **High** |
| Sablefish (*Anoplopoma fimbria*) | | x | | | ~~**High**~~Low |
| Round herring (*Etrumeus teres*) | x | x | x | x | **High** |
| Mesopelagic fishes. Families: Myctophidae, Bathylagidae, Paralepididae, Gonostomatidae | x | x | x | x | **High** |
| Great white shark (*Carcharodon carcharias*) | x | | | | **High** |
| Common thresher shark (*Alopias vulpinus*) | x | | | | **High** |
| Soupfin shark (*Galeorhinus zyopterus*) | | x | | | **High** |

## Table F1-6. Essential Fish Habitat Federal Fishery Management Plan – Covered Fishes

| **Taxa in Area[1,2]** | **Fishery Management Plan** | | | | **Likelihood of Occurrence[3]** |
|---|---|---|---|---|---|
| | **HMS** | **PCG** | **CPS** | **PCS** | |
| Basking shark (*Cetorhinus maximus*) | x | | | | Low |
| Megamouth shark (*Megachasma pelagio*) | x | | | | Low |
| Chinook salmon (*Oncorhynchus tshawytscha*) | x | | | x | Low |
| North Pacific albacore (*Thunnus alalunga*) | x | | | | Low |
| Yellowfin tuna (*Thunnus albacares*) | x | | | | Low |
| Bigeye tuna (*Thunnus obesus*) | x | | | | Low |
| Skipjack tuna (*Katsuwonus pelamis*) | x | | | | Low |
| Northern bluefin tuna (*Thunnus orientalis*) | x | | | | Low |
| Shortfin mako or bonito shark (*Isurus oxyrinchus*) | x | | | | Low |
| Blue shark (*Prionace glauca*) | x | | | | Low |
| Striped marlin (*Tetrapturus audax*) | x | | | | Low |
| Swordfish (*Xiphias gladius*) | x | | | | Low |
| Dorado or dolphinfish (*Coryphaena hippurus*) | x | | | | Low |
| Thread herring (*Opisthonema libertate*, *O. medirastre*) | x | x | x | x | Low |
| Pacific saury (*Cololabis saira*) | x | x | x | x | Low |
| Pelagic squids. Families: *Cranchiidae, Gonatidae, Histioteuthidae, Octopoteuthidae, Ommastrephidae* (except Humboldt squid [*Dosidicus gigas*]), *Onychoteuthidae*, and *Thysanoteuthidae* | x | x | x | x | Low |
| Krill or euphausiids | | | x | | Low |

Sources: PFMC 2016a, b, c, and d; Love 2011; Miller and Lea 1972; Allen 2006; MBC 2007.
Acronyms: HMS = Highly Migratory Species; PCG = Pacific Coast Groundfish ; CPS = Coastal Pelagic Species; PCS = Pacific Coast Salmon.
Notes:
[1] By broad habitat use (constituting essential fish habitat [EFH]) listed under FMPs.
[2] Includes both Fishersy Management Unit and Ecosystem Component taxa.
[3] Likelihood of occurrence is relative to the taxa population distribution. If the species is less common in the Proposed Project area than other parts of its range, likelihood of occurrence is classified as low.

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# SONGS Units 2 and 3

# Offshore Discharge Conduits Underwater Photos

**December 2016**

## INTRODUCTION

The following document includes underwater photographs taken by biologist-divers in October 2016 as part of a diffuser port characterization survey of the SONGS offshore discharge conduits performed by MBC Applied Environmental Sciences. The purpose of the characterization survey was to observe and document the biological conditions on and around the vertical components of the offshore conduits, including type and degree of plant growth, fish and invertebrate communities, and seafloor characteristics (MBC 2017).

Unit 2 and Unit 3 each have one intake and one discharge conduit, both of which are buried under the seafloor. However, the discharge conduits each have 63 diffuser ports that extend above the seafloor (see Figure 1 below). During plant operations, to minimize thermal impacts, the discharge conduits released water through the diffuser ports, mounted on top of each conduit at approximately 40-foot intervals from the seaward end (SCE 2018). The diffuser sections of the discharge conduits are approximately 2,500 feet in length, ranging in water depth from approximately 30 to 50 feet. Each diffuser port is approximately 12.5 feet high, 8.5 feet long, and 6 feet wide, and contains a 3-foot diameter diffuser nozzle.

The photos included here illustrate conditions at three areas surveyed along the 2,500-foot long diffuser sections of each of the Units 2 and 3 discharge conduits (see Figures 3 and 4 for surveyed sections). To select the survey areas, MBC reviewed side-scan sonar data (CE 2016) which indicated that along the Unit 2 diffuser section, the inshore area is predominately sandy, the middle area has variably scattered rock reef, and the offshore area has a mixture of sand and low cobble reef structure. For Unit 3, side-scan sonar data indicated all of the diffusers are surrounded by sand (CE 2016). MBC therefore selected an inshore, mid-point, and offshore area along each diffuser section to survey to capture representative information for the varied biota, substrate, and water depths found along the 2,500-foot diffuser sections.

The next page is a reference map of the offshore conduits (Figure 2), followed by a figure depicting the Unit 2 discharge conduit diffuser section (Figure 3). The Unit 2 diffuser photos labeled with their associated diffuser port number follow and they are organized from shoreward-most photos to seaward-most. After the Unit 2 photos, there is a Unit 3 diffuser section reference map followed by the Unit 3 diffuser port photos.

**FIGURE 1**
**Diffuser Port – Side View**

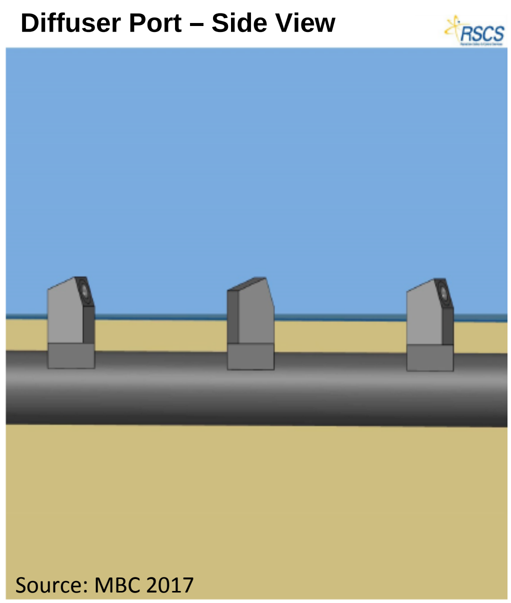
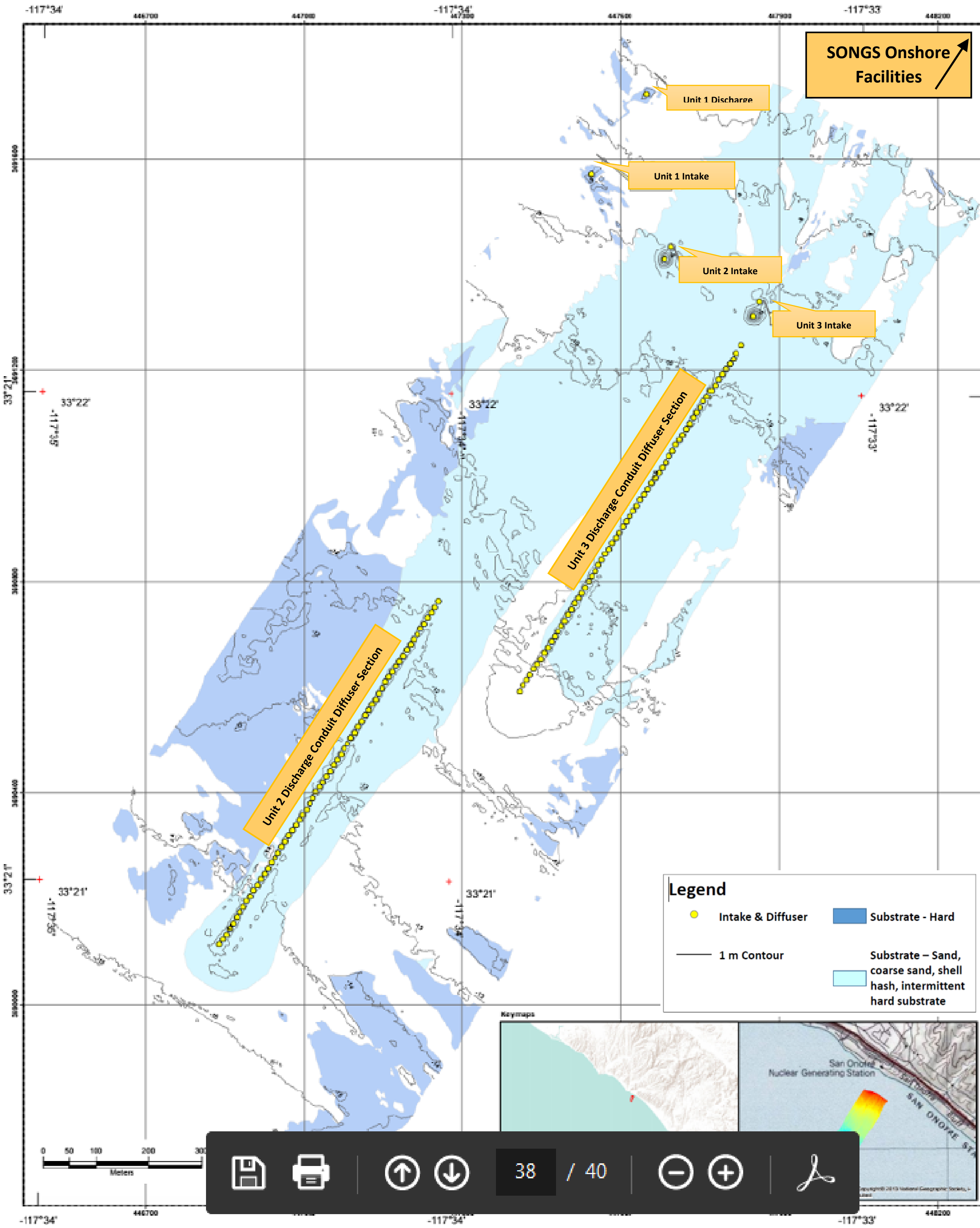


**FIGURE 2**

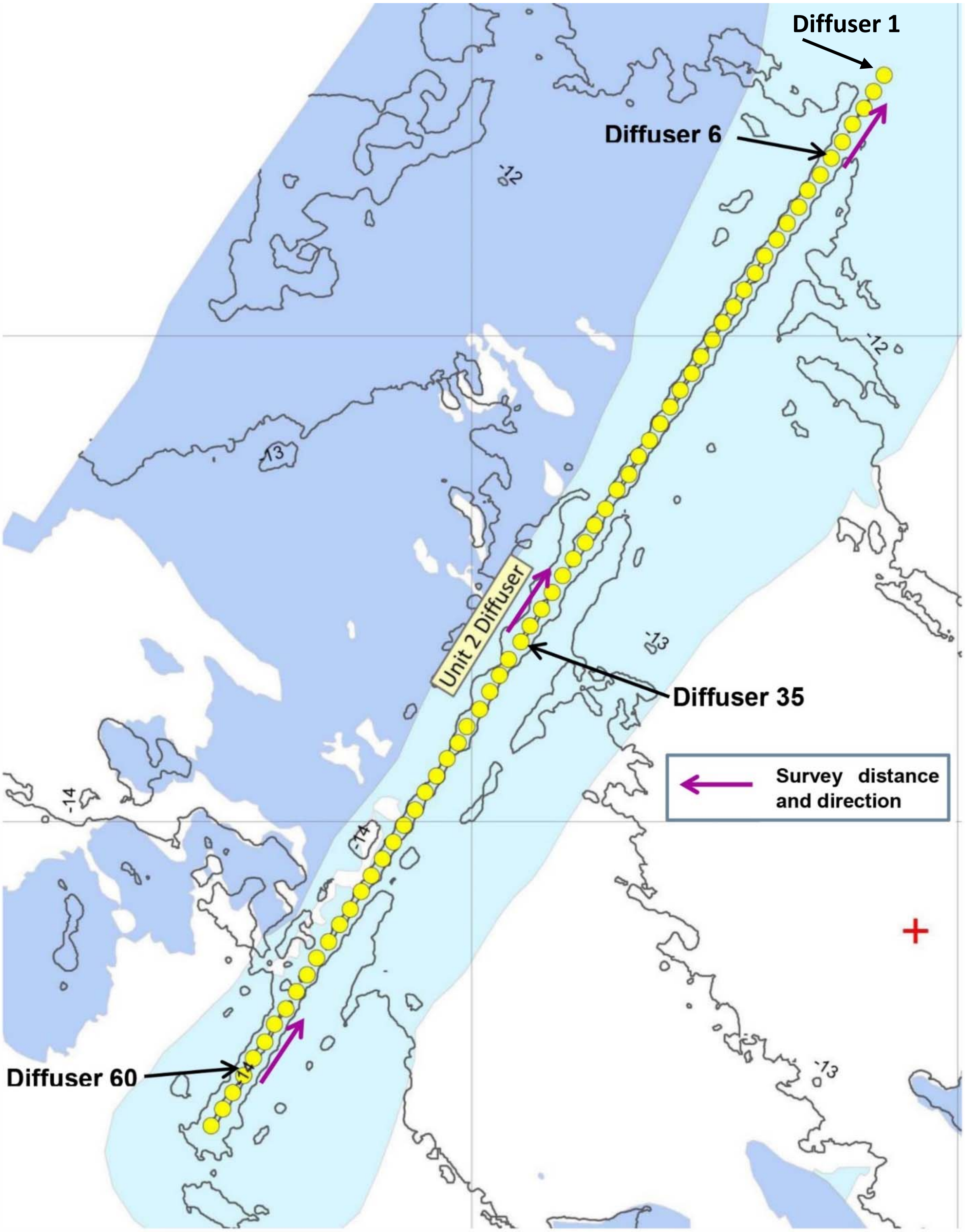
**Side-scan survey map showing SONGS overall offshore structure array, February 2016**




Source: CE 2016

# SONGS Unit 2 Discharge Conduit

**FIGURE 3**
**Unit 2 diffuser ports (yellow dots) and diffuser reference numbers (from Coastal Environments 2016)**




Source: SONGS Units 2 and 3 Diffuser Characterization Study (MBC 2017)

# Unit 2 Discharge Conduit
# Diffuser Port #1 (both images)


## Unit 2 Discharge Conduit
## Diffuser Port #4

## Unit 2 Discharge Conduit
## Diffuser Port #6

## Unit 2 Discharge Conduit
## Diffuser Port #30

## Unit 2 Discharge Conduit
## Diffuser Port #33

## Unit 2 Discharge Conduit
## Diffuser Port #34

## Unit 2 Discharge Conduit
## Diffuser Port #35 (image 1 of 2)

## Unit 2 Discharge Conduit
## Diffuser Port #35 (image 2 of 2)

## Unit 2 Discharge Conduit
## Diffuser Port #56

## Unit 2 Discharge Conduit
## Diffuser Port #57

## Unit 2 Discharge Conduit
## Seafloor adjacent to Diffuser Port #57

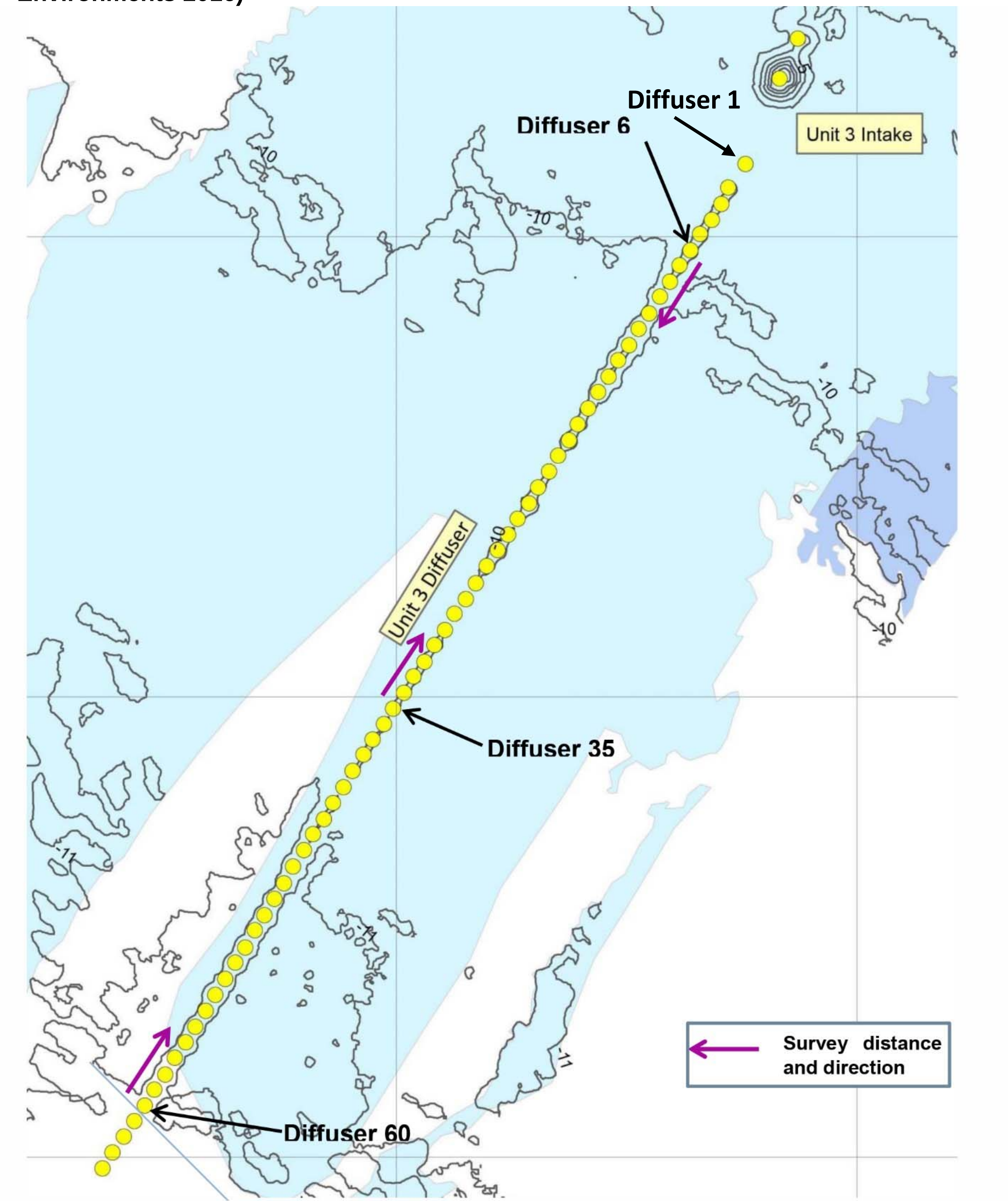
**Unit 2 Discharge Conduit**
**Diffuser Port #59**

**Unit 2 Discharge Conduit**
**Diffuser Port #60 (image 1 of 2)**

# Unit 2 Discharge Conduit
# Diffuser Port #60 (image 2 of 2)

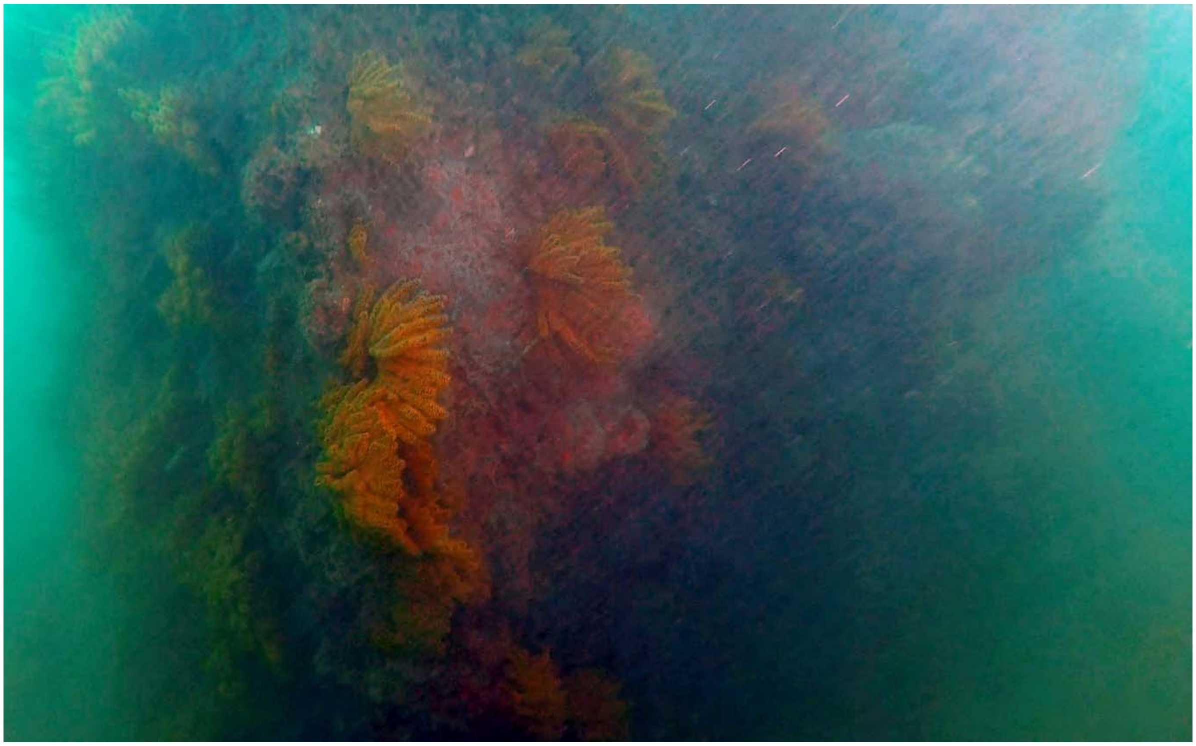
# SONGS Unit 3 Discharge Conduit

**FIGURE 4**
**Unit 3 diffuser ports (yellow dots) and diffuser reference numbers (from Coastal Environments 2016)**



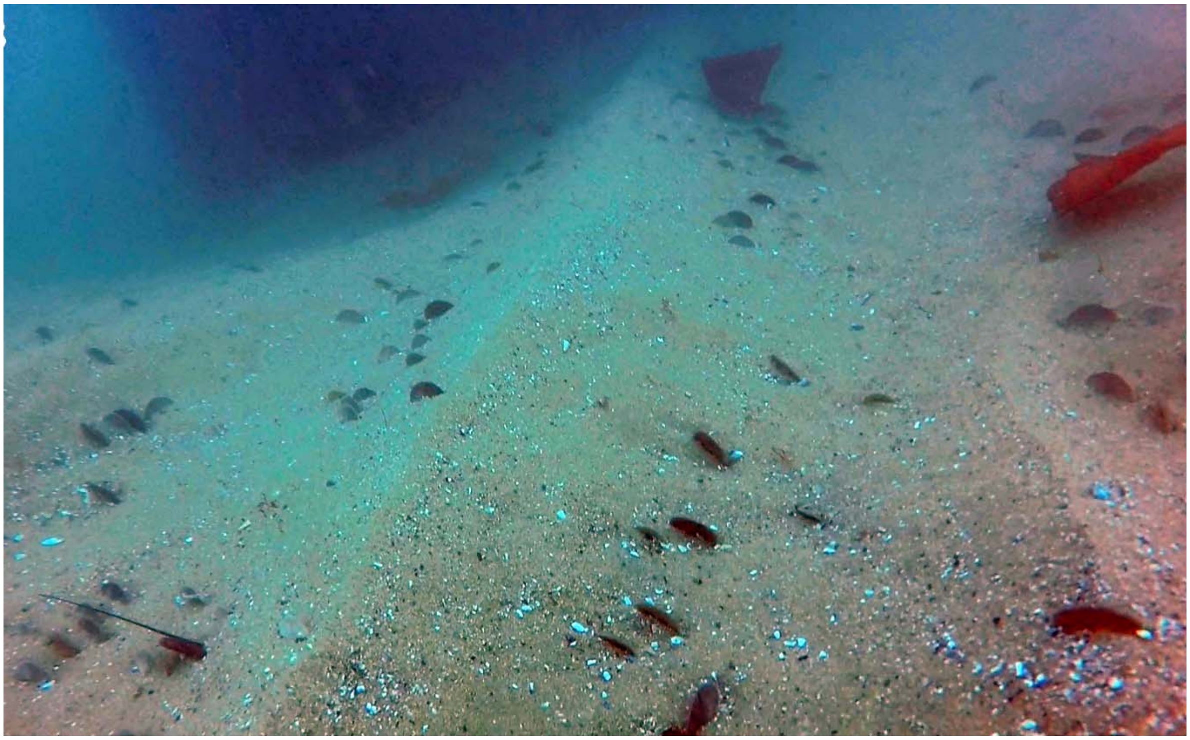

Source: SONGS Units 2 and 3 Diffuser Characterization Study (MBC 2017)

## Unit 3 Discharge Conduit
## Diffuser Port #6



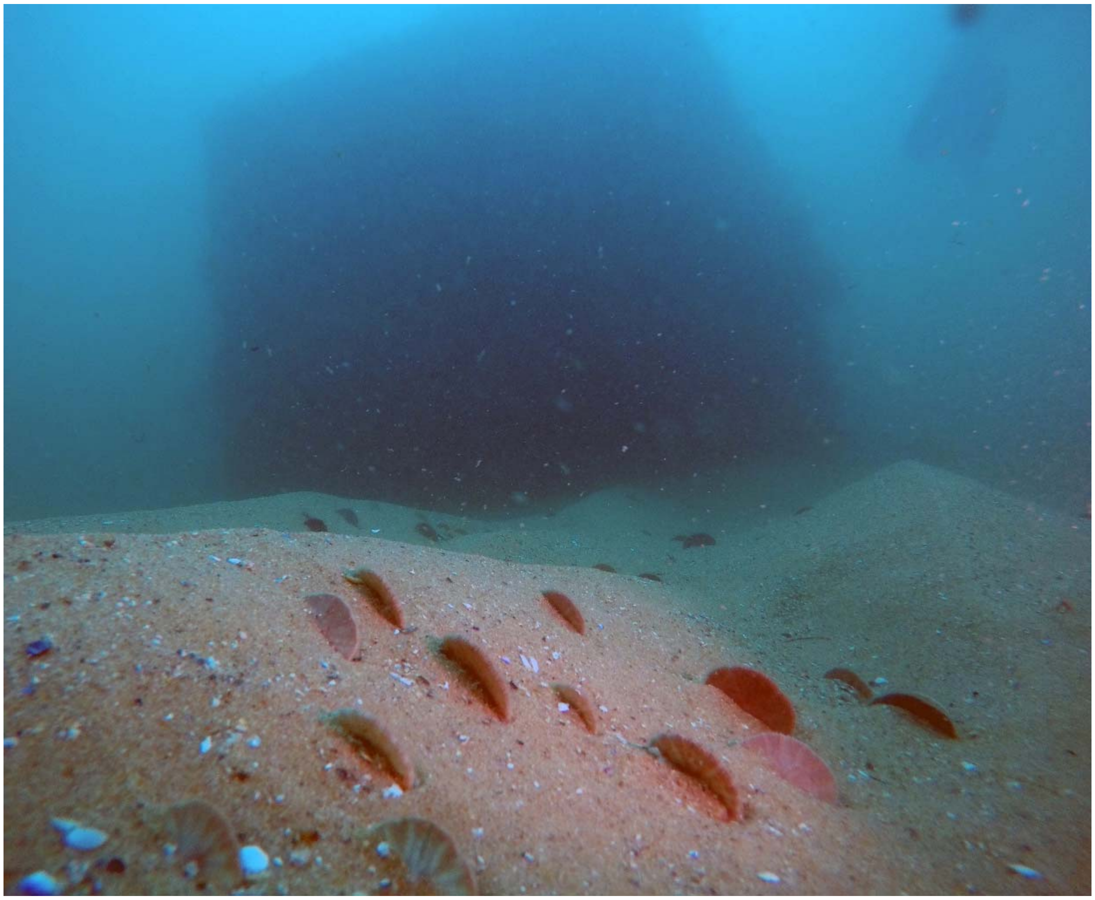
## Unit 3 Discharge Conduit
## Diffuser Port #7

## Unit 3 Discharge Conduit
## Diffuser Port #32



## Unit 3 Discharge Conduit
## Diffuser Port #34

## Unit 3 Discharge Conduit
## Diffuser Port #35

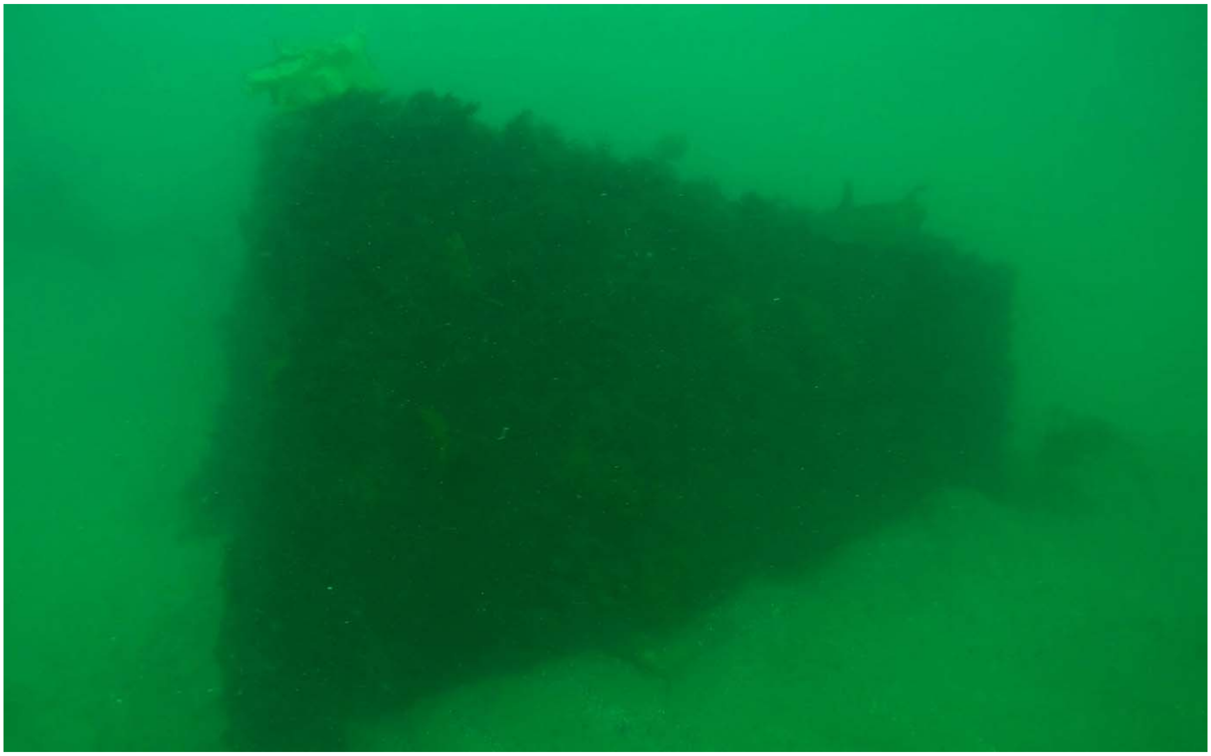


## Unit 3 Discharge Conduit
## Diffuser Port #54

# Unit 3 Discharge Conduit
# Diffuser Port #55


# Unit 3 Discharge Conduit
# Diffuser Port #56

# Unit 3 Discharge Conduit
# Diffuser Port #60



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# APPENDIX F3
# NOISE IMPACTS ON MARINE WILDLIFE[1]

This appendix provides background on the potential effects of increased noise levels on marine wildlife including marine mammals, sea turtles, fish, and diving seabirds for the Proposed Project and the Full Conduit Removal Alternative (Alternative). The information in this appendix supplements information provided in Section 4.4, *Biological Resources*, Section 4.12, *Noise*, and Section 5, *Project Alternatives Analysis*, and provides background on the fundamentals of noise, acoustic thresholds used by regulatory agencies to assess effects of noise on marine wildlife, and the types of noise-generating activities that may occur under the Proposed Project and Alternative. The three types of noise-generating activities characterized and analyzed in this appendix include vessel operations, concrete sawing, and pile driving. Although the Proposed Project does not include the use of pile driving, that activity would produce the highest levels of noise underwater; therefore, this analysis focuses on pile driving as the worse-case scenario.

## F3.1 NOISE FUNDAMENTALS

Sound is a pressure variation consisting of minute vibrations that travel through a medium such as air or water, and generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of a sound and is measured in hertz (Hz), while intensity describes the loudness of a sound and is measured in decibels (dB), which are measured using a logarithmic scale (e.g., a 10-dB increase represents a 10-fold increase in sound intensity). Sound intensity for underwater applications is typically expressed in dB referenced to (re) 1 micropascal (μPa); in air, sound intensity is expressed in dB re 20 μPa. Sound may be measured as either an instantaneous value (in this context, peak sound pressure level [SPL] or root-mean-square [RMS] SPL) or as the total sound energy present in a sound event (i.e., sound exposure level [SEL]). Resource agencies use these measurements—peak SPL, RMS SPL, and SEL—to assess potential effects of underwater and airborne noise on marine wildlife.

- Peak SPL is the maximum absolute value of the instantaneous sound pressure (which can be positive or negative) during a specified time interval. Peak SPL is expressed in dB referenced to 1 μPa.
- RMS SPL is the average of the squared pressure over some duration. Instantaneous sound pressures (positive or negative) are squared, averaged, and the square root of the average is taken. For non-pulse sounds, the averaging time is any convenient period sufficiently long to permit averaging the variability inherent in the type of sound. RMS SPL is expressed in dB referenced to 1 μPa.

[1] This document has been prepared for the California State Lands Commission by Aspen Environmental under Contract No. C2015046.

- The SEL is the total sound energy in an impulse that accumulates over the duration of that pulse normalized to 1 second (s). SEL is expressed in dB referenced to 1 $\mu Pa^2 s$.

The acoustic thresholds used by resource agencies, and the types of noise-generating equipment and underwater and airborne acoustic analyses, are discussed below.

## F3.2 ACOUSTIC THRESHOLDS FOR MARINE WILDLIFE

### F3.2.1 Marine Mammals

The National Marine Fisheries Service (NMFS) has identified acoustic threshold (received sound level) criteria above which marine mammals are predicted to experience changes in their hearing sensitivity, either permanent or temporary hearing threshold shifts (PTS or TTS, respectively). Physiological responses such as auditory or non-auditory tissue injuries are known as Level A harassment[2] under the Marine Mammal Protection Act (MMPA). Level A Harassment becomes a concern when sound levels from human-made sounds reach or exceed the acoustic thresholds associated with auditory injury in marine species. PTS is a permanent, irreversible increase in an animal's auditory threshold within a given frequency band or range of the animal's normal hearing, while TTS is a temporary, reversible increase in the threshold of audibility at a specific range of frequencies. While TTS is not an injury, it is considered Level B harassment[3] under the MMPA. Level B harassment also includes behavioral disturbance (e.g., avoidance, vocalization changes, alarm responses), which can cause indirect effects (e.g., reduced foraging success).

In July 2016, NMFS published *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (Guidance) and adopted new guidelines for the assessment of underwater noise impacts for marine mammals (NMFS 2016). The Guidance updates and provides a new method for calculating the onset of PTS, or Level A harassment, for various marine mammal groups based on the groups' hearing characteristics (i.e., high-, mid-, and low-frequency cetaceans, and otariid and phocid pinnipeds) and whether a sound is considered impulsive (e.g., impact pile driving) or non-impulsive (e.g., vibratory pile driving, vessel noise, concrete sawing). Table F3-1 provides a summary of marine mammal groups and hearing ranges, as well as PTS onset thresholds for impulsive and non-impulsive sounds. At the Proposed Project site (i.e., San Onofre Nuclear Generating Station [SONGS]), low-frequency cetaceans (humpback and gray whales), high-frequency cetaceans (harbor porpoises), phocid pinnipeds (harbor seals), and otariid pinnipeds (California sea lions) are most likely to occur.

[2] Level A harassment is defined as "[a]ny act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild."
[3] Level B harassment is defined as "[a]ny act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering."

**Table F3-1. Summary of Marine Mammal Hearing Groups and Underwater Acoustic Thresholds (Received Level) for Impulsive and Non-Impulsive Sounds[1]**

| | | Impulsive | | Non-Impulsive |
|---|---|---|---|---|
| **Hearing Group[2]** | **Generalized Hearing Range[3]** | **Peak SPL[4] (dB re 1 μPa)** | **Cumulative SEL[5] (dB re 1 μPa²s)** | |
| Low-Frequency (LF) Cetaceans | 7 Hz to 35 kHz | 219 dB | 183 dB | 199 dB |
| Mid-Frequency (MF) Cetaceans | 150 Hz to 160 kHz | 230 dB | 185 dB | 198 dB |
| High-Frequency (HF) Cetaceans | 275 Hz to 160 kHz | 202 dB | 155 dB | 173 dB |
| Phocid Pinnipeds (PW) (underwater) | 50 Hz to 86 kHz | 218 dB | 185 dB | 201 dB |
| Otariid Pinnipeds (OW) (underwater) | 60 Hz to 39 kHz | 232 dB | 203 dB | 219 dB |

Source: NMFS 2016.

Acronyms: dB = decibel; Hz = Hertz; kHz = kilohertz; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.

Notes:

[1] Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the larger isopleth for calculating PTS onset. If a non-impulsive sound may exceed peak SPL thresholds associated with impulsive sounds, these thresholds should also be considered.

[2] LF cetaceans = baleen whales; MF cetaceans = dolphins, toothed whales, beaked whales, bottlenose whales; HF cetaceans = true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger, L. australis*; PW pinnipeds = true seals; OW pinnipeds = sea lions and fur seals.

[3] Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans and PW pinnipeds (approximation).

[4] Peak SPL thresholds are not weighted.

[5] All cumulative SEL acoustic threshold levels incorporate marine mammal auditory weighting functions and the recommended accumulation period of 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds would be exceeded.

The Guidance, however, does not make any changes with respect to the behavioral disruption thresholds, which trigger the onset of Level B harassment; therefore, NMFS's previous acoustic thresholds for impulsive (160 $dB_{rms}$) and non-impulsive (120 $dB_{rms}$) noise sources are still applicable. The application of the 120 $dB_{rms}$ threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As a result, NMFS Northwest Region has provided guidance for reporting RMS SPLs: (a) for continuous noise, RMS levels are based on a time constant of 10 seconds, and those RMS levels should be averaged across the entire event; and (b) for impact pile driving, the overall RMS level should be 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.

Regarding in-air acoustic thresholds for pinnipeds that could be hauled out on nearby rocks, NMFS does not provide in-air injury acoustic thresholds for pinnipeds. For multiple pulses, Southall et al. (2007) proposed in-air PTS and TTS threshold levels for pinnipeds (with phocids and otariids as one group), which are 149 $dB_{peak}$ and 144 dB (cumulative SEL), respectively. Based on information available specifically for California sea lions, Southall et al. (2007) suggested in-air PTS-onset values of 172.5 dB (cumulative SEL) for non-impulsive sources. NMFS does, however, provide airborne behavioral harassment thresholds for harbor seals (90 $dB_{rms}$) and pinnipeds other than harbor seals (100 $dB_{rms}$), which are used in the analysis below.

There are no underwater or in-air acoustic thresholds established for sea otters, which are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). In the absence of sufficient data on which to base thresholds, but in light of experimental evidence suggesting that sea lion and sea otter hearing sensitivities are generally comparable, the USFWS (2017) uses the thresholds, guidelines, and criteria applicable to sea lions as proxies. Although sea otters are not likely to occur in or near the Proposed Project area, which is south of their known habitable range, this analysis uses NMFS's underwater acoustic thresholds for otariids to determine underwater acoustic impacts to sea otters.

### F3.2.2 Sea Turtles

Very few hearing studies have been conducted involving sea turtles. Based on limited research, sea turtles appear to be sensitive to low frequency sounds with a functional hearing range of approximately 100 Hz to 1.1 kHz (Ridgeway et al. 1969; Bartol et al. 1999; Ketten and Bartol 2006; Martin et al. 2012). It has been suggested that sea turtle hearing thresholds should be equivalent to TTS thresholds for low-frequency cetaceans when animals are exposed to impulsive and non-impulsive anthropogenic sounds (Southall et al. 2007; Finneran and Jenkins 2012). More recently, however, the Acoustical Society of America standards committee suggested that turtle hearing was probably more similar to that of fishes than marine mammals (Popper et al. 2014). In Table F3-2, sea turtles were presumed to have the same thresholds as those fishes with swim bladders not involved in hearing. Thus, sea turtle mortality and mortal injury would be expected at pile driving sound levels greater than 210 dB (cumulative SEL) and 207 $dB_{peak}$. In the absence of behavioral impact thresholds, NMFS's Level B harassment thresholds for impulsive (160 $dB_{rms}$) and non-impulsive (120 $dB_{rms}$) sound are used in this analysis. There is low potential for sea turtles to occur at the Proposed Project site due to low population densities and no known nesting areas on southern California beaches.

**Table F3-2. Underwater Acoustic Thresholds for Sea Turtles**

| Noise Source | Mortality and Potential Mortal Injury | Impairment | | | Behavior |
|---|---|---|---|---|---|
| | | Recoverable Injury | TTS | Masking | |
| Impulsive[1] | 210 dB $SEL_{cum}$ or >207 $dB_{peak}$ | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low | (N) Moderate<br>(I) Low<br>(F) Low |
| Continuous[2] | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) Low<br>(I) Low<br>(F) Low | (N) High<br>(I) Moderate<br>(F) Low | (N) Moderate<br>(I) Moderate<br>(F) Low |

Source: Popper et al. 2014.
Acronyms: dB = decibel; $SEL_{cum}$ = cumulative sound expsure level; TTS = temporary threshold shift.
Notes:
[1] Peak SPL has a reference value of 1 µPa; SEL has a reference value of 1 µPa2s. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).
[2] Defined in terms of RMS SPLs dB re 1 µPa. All criteria are presented as sound pressure. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

As presented in Table F3-2, where insufficient data exist to make a recommendation for guidelines, a subjective approach is presented in which the relative risk of an effect is placed in order of rank at three distances from the source: near (N), intermediate (I), and far (F) (top to bottom within each cell of Table F3-2, respectively). While it would not be appropriate to ascribe particular distances to effects because of the many variables in making such decisions, "near" might be considered to be in the tens of meters from the source, "intermediate" in the hundreds of meters, and "far" in the thousands of meters. The relative risk of an effect is then rated as being "high," "moderate," and "low" with respect to source distance and animal type. No assumptions are made about source or received levels because there are insufficient data to quantify these distances. In general, the nearer the animal is to the source, the higher the likelihood of high energy and a resultant effect. In specifying these distances and potential effects, regulators and others need to consider actual source and received levels and the sensitivity to the sources by the animals of concern. The rating for effects in these tables is highly subjective, and represents a general consensus within the NMFS working group. However, these ratings are not hard and fast, and they are presented as the basis for discussion.

### F3.2.3 Fish

Hearing capabilities vary considerably between fish species and within fish groups. Fish species within a group may also differ substantially in terms of their hearing structures. Fish hear when hair cells are directly stimulated by particle motion in the water. Some fishes also have swim bladders or other air sacs that can detect and convert the pressure component of a sound field into particle motion, which directly stimulates the inner ear, allowing the fishes to detect sound. The majority of fishes are hearing generalists, which usually only hear sounds up to 1.5 kHz. Hearing specialists, some of which can hear sounds up to 3 to 4 kHz or more, have adaptations that lower their hearing threshold, thereby enhancing their ability to detect sounds in their hearing range (Popper 2003; Hastings and Popper 2005).

In 2008, the Fisheries Hydroacoustic Working Group (FHWG)[4] issued interim threshold criteria based on best available science for the onset of injury to fish from noise generated during impact pile driving (FHWG 2008). These thresholds are shown in Table F3-3. For behavioral changes in fish, NMFS and USFWS generally have used 150 $dB_{peak}$ as the threshold for behavioral effects, citing that SPLs in excess of 150 $dB_{peak}$ can cause temporary behavioral changes (startle and stress) that could decrease a fish's ability to avoid predators (Buehler et al. 2015).

**Table F3-3. Underwater Acoustic Thresholds for Fish[1]**

| Effect | Metric | Fish Mass | Threshold |
|---|---|---|---|
| Onset of Physical Injury | Peak SPL (re 1 μPa) | All | 206 dB |
| | Cumulative SEL (re 1 μPa2s) | ≥ 2 grams | 187 dB |
| | | < 2 grams | 183 dB |
| Adverse Behavioral Effects | RMS SPL (re 1 μPa) | N/A | 150 dB |

Sources: FHWG 2008; Buehler et al. (2015).

Acronyms: N/A = not applicable; RMS = root-mean-square; SEL = sound exposure level; SPL = sound pressure level.

Note: [1] There are no formal criteria for continuous noise. The impulsive noise thresholds are commonly applied for continuous noise in the absence of a specific threshold.

The FHWG determined that noise at or above the 206 $dB_{peak}$ threshold can cause barotrauma to auditory tissues, the swim bladder, or other sensitive organs. Noise levels above the cumulative SEL may cause temporary hearing thresholds shifts in fish. Behavioral effects (e.g., fleeing the area or temporary cessation of feeding or spawning behaviors) are not covered under these criteria, but could occur at these levels or lower. Although these criteria are not formal regulatory standards, they are generally accepted as viable criteria to evaluate the potential for injury to fish from pile driving. Because these criteria were developed for impact pile driving only, and there are no established criteria for vibratory pile driving (Buehler et al. 2015), the interim criteria for impact pile driving will be used for both pile driving methods in this analysis.

### F3.2.4 Seabirds

Compared to other vertebrates, birds have relatively consistent auditory structures and hearing capabilities regardless of size. The center- and high-frequency limits of bird

[4] FHWG members are: NMFS Southwest and Northwest Divisions; California, Washington and Oregon Departments of Transportation; California Department of Fish and Wildlife; and U.S. Federal Highway Administration.

hearing, however, are inversely proportional to the bird's size and weight. On average, a bird's hearing ranges from 500 Hz to 6 kHz, with some exceptions, and no birds are known to hear over 15 kHz. While there are no official thresholds for airborne noise, Dooling and Popper (2007) recommended interim in-air guidelines to assess noise effects on birds, as shown in Table F3-4.

**Table F3-4. Recommended Interim In-Air Acoustic Thresholds for Birds[1]**

| Noise Source | Hearing Damage | TTS |
|---|---|---|
| Multiple Impulse | 125 dBA | N/A[2] |
| Non-Strike Continuous | N/A[3] | 93 dBA |

Source: Dooling and Popper 2007.

Acronyms: dBA = A-weighted decibels; N/A = not applicable; TTS= temporary threshold shift.

Notes:

[1] In-air sound pressure has a reference value of 20 $\mu Pa^2 s$.

[2] No data avilable on TTS in birds caued by impulsive noise.

[3] Noise levels from these sources do not reach levels capable of causing auditory damage or permanent threshold shifts based on empirical data on hearing loss in birds from the laboratory.

There are also no underwater acoustic or in-air or underwater behavioral harassment thresholds for seabirds. However, the U.S. Navy (2011) convened the Marbled Murrelet Science Panel to examine potential underwater noise impacts to the marbled murrelet. The panel discussed a range of potential underwater thresholds and recommended auditory and non-auditory injury thresholds of 202 dB (cumulative SEL) and 208 dB (cumulative SEL), respectively. Although noise impacts to birds would vary by species, these thresholds would be generally applicable to similarly sized seabirds.

## F3.3 SOUND-GENERATING ACTIVITIES

### F3.3.1 Boat Operations

Three noise-generating vessel types are required for the disposition of the shoreline and offshore facilities: a tugboat, workboat, and crew boat. These vessels are likely to be less than 80 feet in length and are likely to include inboard diesel engines. Noise from crew boats and tug boats during the Proposed Project would be limited to short durations, typically while transporting crews and equipment. It is likely that the total duration of both types of vessels operating on a daily basis would be less than 2 hours per day. Vessel noise is a combination of narrowband tones at specific frequencies and broadband noise, which are roughly related to a vessel's size and speed. For vessels the approximate size of crew and supply boats, tones dominate up to about 50 Hz. Broadband components may extend up to 100 kHz, but they peak much lower, at between 50 and 150 Hz. Richardson et al. (1995) summarized noise from various vessels, providing estimated underwater source levels of 156 dBrms for a 53-foot-long crew boat (with a 90-Hz dominant tone) measured at 52 feet (16 meters) and 159 dBrms for a 112-foot-long twin diesel boat (630 Hz, 1/3 octave) measured at 112 feet (34 meters). These vessels were used as proxies in the following analysis, which used the NMFS spreadsheets (NMFS 2016) to calculate the distances to the cumulative SELs for injury and peak SPL for behavioral disruption for marine mammals.

For a 53-foot-long crew boat, the distance to cumulative SEL for non-impulsive noise sources would be less than 10 meters (33 feet) for all marine mammal hearing groups except high-frequency cetaceans (Table F3-1), where potentially injurious noise levels may occur up to 40 feet (12 meters) from the vessel. The distance to the non-impulsive behavioral harassment threshold (120 $dB_{rms}$) would extend to 9,840 feet (3,000 meters) from the 53-foot-long crew boat for all marine mammal hearing groups. For a 112-foot-long twin diesel boat, the distance to the cumulative SEL for non-impulsive noise sources would be less than 10 meters (33 feet) for all marine mammal hearing groups except high- and low-frequency cetaceans and phocid pinnipeds (Table F3-1), where potentially injurious noise levels may occur up to 54 feet (16.5 meters) for phocid pinnipeds, 88 feet (27 meters) for low-frequency cetaceans, and 131 feet (49 meters) for high-frequency cetaceans. The distance to the non-impulsive behavioral harassment threshold (120 $dB_{rms}$) would extend to 9,940 feet (3,030 meters) from the 112-foot-long twin diesel boat for all marine mammal hearing groups.

### F3.3.2 Concrete Sawing

Limited hydroacoustic data exist for concrete sawing; as a result, the following projects and sources were reviewed for the Proposed Project's noise analysis:

- Philadelphia Naval Shipyard Project, September 30, 2014 through October 2, 2014 (Illingworth & Rodkin, Inc. 2014) – this project measured noise from cutting a concrete dock above water
- Naval Base Point Loma, San Diego Fuel Pier Replacement Project, October 8, 2014 to April 30, 2015 (Naval Facilities Engineering Command [NAVFAC] SW 2015) – this project collected noise measurements at distances between 330 and 2,600 feet [100 to 800 meters] from the saw cutting source
- A recent study reported underwater sound measurement data during diamond wire cutting of 2.5-foot-diameter (0.76-meter-diameter) conductors at an oil and gas platform in the North Sea (Pangerc et al. 2017)

The Naval Base Point Loma project was determined to be most similar to the Proposed Project and is used to inform the current analysis. For the Point Loma project, a diamond wire saw was used to cut 72-inch-diameter caissons underwater near the mud line at a duration of about 4 hours per cut. The caissons were composed of a rusted steel outer layer with a concrete, wood, and steel cable interior. Underwater sound measurements were made at half of the water depth and about 50 feet (15 meters) from the activity. Acoustic data were collected intermittently as the diamond wire saw passed through different layers of the caisson. Two metrics were analyzed: peak and 90% RMS SPLs.

Peak SPLs ranged from 150.1 $dB_{peak}$ to 159.2 $dB_{peak}$; overall RMS SPLs ranged from 145.6 $dB_{rms}$ to 155.4 $dB_{rms}$. (Note that RMS levels from this continuous sound were analyzed as impulse levels using the 90% RMS metric that measures only over the loudest portions of the sound.) Based on these data and NMFS (2016) spreadsheets, the cumulative SEL would be less than or equal to 33 feet (10 meters) for all marine mammal hearing groups, and the distance to the non-impulsive behavioral harassment threshold (120 $dB_{rms}$) would extend to 1,560 feet (475 meters) from the concrete cutting source.

### F3.3.3 Offshore Pile Driving

The construction of a temporary trestle for the complete removal of the intake and discharge conduits under the Full Removal of Offshore Conduits Alternative (see Section 5.5.2) would involve the driving of round steel guide piles to support the temporary trestle. The piles would be installed with either an impact hammer, vibratory hammer, or a combination of these hammers. Although pile sizes have not been determined for the Alternative, 24- to 36-inch-diameter piles are typically used for this type of activity.

Impact pile driving produces impulsive sounds, while vibratory pile driving produces continuous, non-impulsive sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing. Impulsive sounds, such as those produced during impact pile driving, are brief, distinct acoustic events that occur either as an isolated event or repeated in some succession. Impulsive sounds are all characterized by discrete acoustic events that include a relatively rapid rise in pressure from ambient conditions to a maximum pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures. Pulsed sounds are typically high amplitude events that have the potential to cause hearing injury. Continuous or non-impulsive sounds, such as those produced during vibratory pile driving, can be tonal or broadband. The total energy imparted by vibratory pile driving can be comparable to impact pile driving as the vibratory hammer operates continuously and pile installation requires more time (Washington State Department of Transportation 2010); however, since vibratory pile drivers generally produce less sound than impact pile drivers, they are often employed as a mitigation measure to reduce the potential for adverse effects on marine species that can result from impact pile driving (Buehler et al. 2015).

If an impact hammer is necessary for the Alternative, a Delmag D30/32 diesel impact hammer or equivalent hammer would be used to drive the piles into the sediment, which would require approximately 60 feet (18 meters) of embedment. If a vibratory hammer is used, an APE 200 or equivalent size hammer would be used to install the piles. On days when piles are installed to their final depth with the impact hammer, pile driving would occur for up to 2 hours per day—two piles per day, with driving time taking about 30 to 60 minutes for each steel shell pile, plus time between to set up the next pile—thus generating up to 148 hours of underwater noise (for 148 piles) over a 74-day period. Pile driving periods (two piles per day) would not likely occur continuously on any given day and downtime between pile drives would depend on the contractor and scheduling.

For this analysis, acoustic data were reviewed from two projects where impact pile driving was completed: Humboldt Bay Bridge (HBB) seismic upgrade project in Eureka, California was used for the 36-inch steel shell piles; and U.S. Coast Guard Tongue Point Pier (TPP) repairs project near Astoria, Oregon was used for the 24-inch steel shell piles. Acoustic data collected for the TPP project are most representative of the noise levels expected during pile driving for the Alternative due to similar water depths and pile sizes. The purpose of the TPP project was to repair the existing Tongue Point Pier, which included the installation of 24-inch-diameter steel pipe piles via impact pile driving to replace existing wood piles, along with reconstruction of a concrete deck. Average sound levels measured underwater included peak SPLs of 189 dBpeak to 205 dBpeak, RMS SPLs of 178 dBrms to 189 dBrms, and SELs of 160 dB to 175 dB per strike at 33 feet (10 meters) from the source. For the HBB project, acoustic data collected during the impact pile driving of 36-inch-diameter steel shell piles included underwater peak SPLs of 210 dBpeak, RMS SPLs of 193 dBrms, and SELs of 184 dB per strike at 33 feet (10 meters).

Due to the lack of adequate vibratory pile driving data for projects similar to the conditions at the SONGS site, acoustic data from Buehler et al. (2015) were reviewed. Table I.2-2 in Buehler et al. (2015) shows a summary of near source, unattenuated sound levels for various sized piles installed with a vibratory driver. For a 36-inch-diameter steel shell pile, a SEL of 170 dB per strike was measured at 33 feet (10 meters). For a 24-inch-diameter steel shell pile, measured for project in Norfolk Virginia,[5] the 1-second SEL ranged from 135 dB to 170 dB per strike at 33 feet (10 meters).

## F3.4 UNDERWATER NOISE ANALYSIS FOR PILE DRIVING ACTIVITIES

For impact and vibratory pile driving, the following source levels[6] (measured 10 meters from the pile) were used in this analysis (based on pile type):

- 36-inch-diameter piles
  - Impact: SPLs of 210 $dB_{peak}$ and 193 $dB_{rms}$; SEL (single strike) of 184 dB
  - Vibratory: SPL of 170 $dB_{rms}$
- 24-inch-diameter piles
  - Impact: SPLs of 205 $dB_{peak}$ and 188 $dB_{rms}$; SEL (single strike) of 173 dB
  - Vibratory: SPL of 153 $dB_{rms}$

[5] Underwater and Airborne Acoustic Monitoring for the U.S. Navy Elevated Causeway (ELCAS) Removal at the JEB Little Creek Naval Station: September 10-11, 2015.

[6] These levels represent unattenuated conditions (i.e., no air bubble curtain or other means of reducing underwater sounds).

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

In addition to calculating the distances to these thresholds for unattenuated piles, distances were also calculated using common attenuation methods, including a vibratory hammer, proofing the piles, and air bubble curtains. The following pile driving scenarios were modeled for this alternative:

- Unattenuated: piles driven to their final depth with a diesel impact hammer or vibratory hammer
- Attenuated: piles driven to their final depth with a diesel impact hammer or vibratory hammer, and the application of an air bubble curtain
- Unattenuated (50%): piles driven 50% of the way with a vibratory hammer and to their final depth with a diesel impact hammer
- Attenuated (50%): piles driven 50% of the way with a vibratory hammer and to their final depth with a diesel impact hammer, and the application of an air bubble curtain
- Unattenuated (proofed): piles driven to near their final depth with a vibratory hammer and proofed with a diesel impact hammer

The difference between the unattenuated and attenuated scenarios presented above is the use of a bubble curtain, which is commonly used to reduce noise from impact pile driving. Air bubble curtains are commonly used to reduce noise from impact pile driving. Buehler et al. (2015) reports a large range in sound reduction, from almost no reduction to 30 dB when air bubble curtains are used during impact pile driving activities. During the TPP project, the sound reductions ranged from 8 dB and 14 dB for all metrics including peak and RMS SPLs and SEL. Therefore, this analysis assumes that underwater sounds could be reduced by at least 10 dB with the use of a properly designed and deployed air bubble curtain. Based on the topography of the seafloor at the SONGS site, it would be relatively easy to obtain a good seal between the seafloor and the bubble ring.

For the unattenuated scenario, it was assumed that the piles were each hit 1,000 blows to install; for the unattenuated (50%) and attenuated (50%) scenarios, it was assumed that a vibratory hammer was used for 0.5 hour per pile, then the piles were struck 500 times with a diesel impact hammer; and for the unattenuated (proofed) scenario, it was assumed that a maximum of 30 blows per pile would be needed to proof a pile installed with a vibratory hammer.

### F3.4.1 Impact Pile Driving

*Marine Mammals*

Table F3-5 and Table F3-6 show the estimated distances to the PTS onset acoustic thresholds for marine mammals based on hearing group, and Table F3-7 shows the estimated distances to the behavioral harassment acoustic threshold for all marine mammals. The levels and distances in Table F3-5, Table F3-6, and F3-7 are based on unattenuated and attenuated pile driving for up to two piles per day. These distances were calculated using the NMFS Marine Mammal Spreadsheet (NMFS 2016).

**Table F3-5. Distances to the PTS Onset Acoustic Thresholds (Peak SPL) for Marine Mammals During Impact Pile Driving: Attenuated and Unattenuated[1, 2]**

| Pile Size/Modeling Scenario | Low-Frequency Cetaceans (219 dB) | Mid-Frequency Cetaceans (230 dB) | High-Frequency Cetaceans (202 dB) | Phocid Pinnipeds (218 dB) | Otariid Pinnipeds (232 dB) |
|---|---|---|---|---|---|
| 36 inches (unattenuated) | <10 m <33 ft | <10 m <33 ft | 34 m 112 ft | <10 m <33 ft | <10 m <33 ft |
| 36 inches (attenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 24 inches (unattenuated) | <10 m <33 ft | <10 m <33 ft | 16 m 52 ft | <10 m <33 ft | <10 m <33 ft |
| 24 inches (attenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 50%, 36 inches (unattenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 50%, 36 inches (attenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 50%, 24 inches (unattenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 50%, 24 inches (attenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 36 inches (proofed) (unattenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |
| 24 inches (proofed) (unattenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |

Acronyms: dB = decibel; ft = feet; m = meter; PTS = permanent threshold shift; SPL = sound pressure level.
Notes: [1] Peak SPL has a reference value of 1 μPa. [2] Based on the driving of two piles in 1 day.

**Table F3-6. Distances to the PTS Onset Acoustic Thresholds (Cumulative SEL) for Marine Mammals During Impact Pile Driving: Unattenuated and Attenuated[1,2]**

| Pile Size/Modeling Scenario | Low-Frequency Cetaceans (183 dB) | Mid-Frequency Cetaceans (185 dB) | High-Frequency Cetaceans (155 dB) | Phocid Pinnipeds (185 dB) | Otariid Pinnipeds (203 dB) |
|---|---|---|---|---|---|
| 36 inches (unattenuated) | 999 m<br>3,276 ft | 36 m<br>1,216 ft | 1,190 m<br>3,903 ft | 534 m<br>1,753 ft | 39 m<br>128 ft |
| 36 inches (attenuated) | 215 m<br>706 ft | <10 m<br><33 ft | 256 m<br>841 ft | 115 m<br>378 ft | <10 m<br><33 ft |
| 24 inches (unattenuated) | 464 m<br>1,521 ft | 17 m<br>54 ft | 552 m<br>1,811 ft | 248 m<br>814 ft | 18 m<br>59 ft |
| 24 inches (attenuated) | 100 m<br>328 ft | <10 m<br><33 ft | 119 m<br>390 ft | 52 m<br>172 ft | <10 m<br><33 ft |
| 50%, 36 inches (unattenuated) | 629 m<br>2,064 ft | 22 m<br>73 ft | 794 m<br>2,606 ft | 337 m<br>1,105 ft | 25 m<br>80 ft |
| 50%, 36 inches (attenuated) | 136 m<br>445 ft | <10 m<br><33 ft | 161 m<br>530 ft | 73 m<br>238 ft | <10 m<br><33 ft |
| 50%, 24 inches (unattenuated) | 292 m<br>958 ft | 10 m<br>34 ft | 348 m<br>1,141 ft | 156 m<br>513 ft | 11 m<br>37 ft |
| 50%, 24 inches (attenuated) | 63 m<br>206 ft | <10 m<br><33 ft | 75 m<br>246 ft | 34 m<br>111 ft | <10 m<br><33 ft |
| 36 inches (proofed) (unattenuated) | 96 m<br>316 ft | <10 m<br><33 ft | 115 m<br>377 ft | 52 m<br>169 ft | <10 m<br><33 ft |
| 24 inches (proofed) (unattenuated) | 45 m<br>147 ft | <10 m<br><33 ft | 53 m<br>175 ft | 24 m<br>78 ft | <10 m<br><33 ft |
| 36 inches (proofing) (attenuated) | 21 m<br>69 ft | <10 m<br><33 ft | 25 m<br>82 ft | 11 m<br>36 ft | <10 m<br><33 ft |
| 24 inches (proofing) (attenuated) | <10 m<br><33 ft | <10 m<br><33 ft | 12 m<br>39 ft | <10 m<br><33 ft | <10 m<br><33 ft |

Acronyms: dB = decibel; ft = feet; m = meter; PTS = permanent threshold shift; SEL = sound exposure level.
Notes: [1] SEL has a reference value of 1 $\mu Pa^2 s$. [2] Based on the driving of two piles. SEL criteria apply to impact pile driving events that occur during 1 day.

**Table F3-7. Distances to Behavioral Harassment Acoustic Threshold (RMS SPL) for Marine Mammals During Impact Pile Driving: Attenuated and Unattenuated[1, 2]**

| Pile Size/Modeling Scenario | **All Marine Mammals** (160 $dB_{rms}$) |
|---|---|
| 36 inches (unattenuated) | 1,585 m (5,200 ft) |
| 36 inches (attenuated) | 341 m (1,119 ft) |
| 24 inches (unattenuated) | 736 m (2,415 ft) |
| 24 inches (attenuated) | 158 m (518 ft) |
| 50%, 36 inches (unattenuated) | 1,585 m (5,200 ft) |
| 50%, 36 inches (attenuated) | 341 m (1,119 ft) |
| 50%, 24 inches (unattenuated) | 736 m (2,415 ft) |
| 50%, 24 inches (attenuated) | 158 m (518 ft) |
| 36 inches (proofed) (unattenuated) | 1,585 m (5,200 ft) |
| 24 inches (proofed) (unattenuated) | 736 m (2,415 ft) |

Acronyms: dB = decibel; ft = feet; m = meter; SEL = sound pressure level.
Notes: [1] RMS SPL has a reference value of 1 μPa. [2] Based on the driving of two piles in 1 day.

As shown in Table F3-5, for impact pile driving, peak SPL thresholds would not be exceeded more than 33 feet (10 meters) from the source for all marine mammal hearing groups except for high-frequency cetaceans, where injurious noise levels may occur up to 112 feet (34 meters) for 36-inch-diameter unattenuated piles and 52 feet (16 meters) for 24-inch-diameter unattenuated piles.

As shown in Table F3-6, for impact pile driving, cumulative SEL thresholds would be exceeded for a number of pile size/modeling scenarios presented, with the largest area of impact for high-frequency cetaceans, where injurious noise levels may occur up to 3,903 feet (1,190 meters) for 36-inch-diameter unattenuated piles. If an air bubble curtain was deployed (attenuated scenarios), these distances could be reduced by over 75 percent.

As shown in Table F3-7, for impact pile driving, the behavioral harassment RMS SPL threshold would be exceeded for all pile driving scenarios, with the largest area of impact (5,200 feet [1,585 meters]) for 36-inch-diameter piles, whether the piles are unattenuated, 50% (unattenuated), or proofed (unattenuated). The smallest area of impact (518 feet [158 m]) would occur for 24-inch-diameter piles, either attenuated or 50% (attenuated).

*Sea Turtles*

Distances to the injury thresholds for sea turtles (210 dB [cumulative SEL] and 207 $dB_{peak}$) were calculated using the NMFS pile driving spreadsheet (NMFS 2012). For the 36-inch-diameter unattenuated piles, the distance to the 210 dB (cumulative SEL) threshold would be 82 feet (25 meters) and the distance to the 207 $dB_{peak}$ threshold would be 52 feet (16 meters). Distances to both the peak SPL and cumulative SEL thresholds would be less than 32 feet (10 meters) for all other scenarios.

In the absence of behavioral impact thresholds for sea turtles, NMFS's Level B harassment threshold for impulsive sound (160 $dB_{rms}$) was used. As shown in Table F3-7, for impact pile driving, the behavioral harassment RMS SPL threshold would be exceeded for all pile driving scenarios, with the largest area of impact (5,200 feet [1,585 meters]) for 36-inch-diameter piles, whether the piles are unattenuated, 50% (unattenuated), or proofed (unattenuated). The smallest area of impact (518 feet [158 meters]) would occur for 24-inch-diameter piles, either attenuated or 50% (attenuated).

*Fish*

Table F3-8 shows the estimated distances to the acoustic thresholds for the onset of physical injury and adverse behavioral effects for fish. The levels and distances in Table F3-8 are based on unattenuated and attenuated pile driving for up to two piles per day.

**Table F3-8. Distances to the Acoustic Thresholds for Fish During Impact Pile Driving: Unattenuated and Attenuated[1,2]**

| Pile Size/ Modeling Scenario | Injury | | | Behavior |
|---|---|---|---|---|
| | Peak SPL (dB re 1 μPa) | Cumulative SEL (dB re 1 $\mu Pa^2 s$) | | RMS SPL (dB re 1 μPa) |
| | 206 dB | 187 dB | 183 dB | 150 dB |
| 36 inches (unattenuated) | 18 m<br>59 ft | 863 m<br>2,831 ft | 1,595 m<br>5,233 ft | 7,356 m<br>24,134 ft |
| 36 inches (attenuated) | <10 m<br><33 ft | 186 m<br>610 ft | 344 m<br>1,129 ft | 1,585 m<br>5,200 ft |
| 24 inches (unattenuated) | <10 m<br><33 ft | 159 m<br>522 ft | 295 m<br>968 ft | 3,415 m<br>11,204 ft |
| 24 inches (attenuated) | <10 m<br><33 ft | 34 m<br>112 ft | 63 m<br>207 ft | 736 m<br>2,415 ft |
| 50%, 36 inches (unattenuated) | 18 m<br>59 ft | 544 m<br>1,785 ft | 1,005 m<br>3,297 ft | 7,356 m<br>24,134 ft |
| 50%, 36 inches (attenuated) | <10 m<br><33 ft | 117 m<br>384 ft | 216 m<br>709 ft | 1,585 m<br>5,200 ft |
| 50%, 24 inches (unattenuated) | <10 m<br><33 ft | 100 m<br>328 ft | 186 m<br>610 ft | 3,415 m<br>11,204 ft |
| 50%, 24 inches (attenuated) | <10 m<br><33 ft | 22 m<br>73 ft | 40 m<br>131 ft | 736 m<br>2,415 ft |
| 36 inches (proofed) (unattenuated) | 18 m<br>59 ft | 74 m<br>243 ft | 136 m<br>116 ft | 7,356 m<br>24,134 ft |
| 24 inches (proofed) (unattenuated) | <10 m<br><33 ft | 14 m<br>46 ft | 25 m<br>82 ft | 3,415 m<br>11,204 ft |

Acronyms: dB = decibel; ft = feet; m = meter; RMS = root-mean-square; SEL = sound exposure level; SPL = sound pressure level.
Notes: [1] Based on the driving of two piles. [2] SEL criteria apply to impact pile driving events that occur during 1 day.

As shown in Table F3-8, for impact pile driving, the peak SPL injury threshold would not be exceeded more than 59 feet (18 meters) from the source for all pile size/modeling scenarios. The cumulative SEL injury threshold for fish ≥ 2 grams (187 dB) would be exceeded for all pile size/modeling scenarios, with the largest area of impact (2,831 feet [863 meters]) for 36-inch-diameter unattenuated piles and the smallest are of impact (46 feet [14 meters]) for 24-inch-diameter proofed (unattenuated) piles. The cumulative SEL injury threshold for fish < 2 grams (183 dB) would be exceeded for all pile size/modeling scenarios, with the largest area of impact (5,223 feet [1,595 meters]) for 36-inch-diameter unattenuated piles and the smallest are of impact (82 feet [25 meters]) for 24-inch-diameter proofed (unattenuated) piles. The RMS SPL behavioral harassment threshold would be exceeded for all pile size/modeling scenarios, with the largest are of impact (24,134 feet [7,356 meters]) for 36-inch-diameter unattenuated piles and the smallest area of impact (2,415 feet [736 meters]) for 24-inch-diameter piles, either attenuated or 50% (attenuated).

*Seabirds*

Distances calculated to the injury threshold for seabirds (202 dB [cumulative SEL]) were calculated using the NMFS (2012) pile driving spreadsheet. For the 36-inch-diameter steel shell piles, the distances to the cumulative SEL threshold are: 207 feet (63 meters) for the full installation/unattenuated scenario; 131 feet (40 meters) for the 50% (unattenuated) scenario; and less than 33 feet (10 meters) for the attenuated (proofed) and attenuated scenarios. For the 24-inch-diameter steel shell piles, the distances to the cumulative SEL threshold are: 39 feet (12 meters) for the full installation/unattenuated scenario; and less than 33 feet (10 meters) for all other scenarios.

### F3.4.2 Vibratory Pile Driving

*Marine Mammals*

Table F3-9 shows the estimated distances to the PTS onset acoustic thresholds for marine mammals based on hearing group. The calculations in Table F3-9 are based on a pile driving duration of 1 hour per pile and two piles per day. The NMFS Marine Mammal Spreadsheet was used to calculate the distances shown in Table F3-9 (NMFS 2016).

**Table F3-9. Distances to the PTS Onset Acoustic Thresholds (Cumulative SEL) for Marine Mammals During Vibratory Pile Driving: Unattenuated**

| Pile Size/Modeling Scenario | Low-Frequency Cetaceans (199 dB) | Mid-Frequency Cetaceans (198 dB) | High-Frequency Cetaceans (173 dB) | Phocid Pinnipeds (201 dB) | Otariid Pinnipeds (219 dB) |
|---|---|---|---|---|---|
| 36 inches (unattenuated) | 43 m 141 ft | <10 m <33 ft | 63 m 207 ft | 26 m 85 ft | <10 m <33 ft |
| 24 inches (unattenuated) | <10 m <33 ft | <10 m <33 ft | 16 m 52 ft | <10 m <33 ft | <10 m <33 ft |
| 36 inches (attenuated) | <10 m <33 ft | <10 m <33 ft | 14 m 46 ft | <10 m <33 ft | <10 m <33 ft |
| 24 inches (attenuated) | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft | <10 m <33 ft |

Acronyms: dB = decibel; ft = feet; m = meter; SEL = sound exposure level.
Notes: [1] SEL has a reference value of 1 $\mu Pa^2 s$. [2] Based on the driving of two piles. SEL criteria apply to impact pile driving events that occur during 1 day.

The calculated distance to the RMS SPL behavioral harassment acoustic threshold (120 $dB_{rms}$) for an unattenuated 36-inch-diameter steel shell pile would extend out to approximately 70,680 feet (21,544 meters), and with an attenuated pile (use of bubble curtain), the distance would be approximately 15,230 feet (4,642 meters). For an unattenuated 24-inch-diameter steel shell pile, the distance to the 120 $dB_{rms}$ threshold would be 5,200 feet (1,585 meters), and an attenuated pile (use of bubble curtain) would extend out to approximately 1,120 feet (341 meters).

*Sea Turtles*

There are no formal criteria for non-impulsive, continuous noise impacts for sea turtles. The impulsive noise thresholds, described under Section F3.2.2, *Sea Turtles*, are used for this analysis.

In the absence of behavioral impact thresholds for sea turtles, NMFS's Level B harassment threshold for non-impulsive (120 $dB_{rms}$) sound was used. The calculated distance to the RMS SPL behavioral harassment acoustic threshold (120 $dB_{rms}$) for an unattenuated 36-inch-diameter steel shell pile would extend out to approximately 70,680 feet (21,544 meters), and with an attenuated pile (use of bubble curtain), the distance would be approximately 15,230 feet (4,642 meters). For an unattenuated 24-inch-diameter steel shell pile, the distance to the 120 $dB_{rms}$ threshold would be 5,200 feet (1,585 meters), and an attenuated pile (use of bubble curtain) would extend out to approximately 1,120 feet (341 meters).

*Fish*

There are no formal criteria for non-impulsive, continuous noise impacts for fish.

*Seabirds*

There are no formal criteria for non-impulsive, continuous noise impacts for seabirds.

## F3.5 AIRBORNE NOISE ANALYSIS

Pile driving generates airborne sound that could potentially result in disturbance to pinnipeds hauled out or at the water's surface. As described above under Section F3.2, *Acoustic Thresholds for Marine Wildlife*, the in-air behavioral thresholds for harbor seals and all other pinnipeds are 90 $dB_{rms}$ and 100 $dB_{rms}$, respectively. There are no established thresholds for PTS onset.

Similar to underwater sounds, airborne sounds generated during pile driving activities are considered over the frequency range of 75 Hz to 20 kHz and are assumed to be similar to C-weighted[7] sound levels, which are broadband sound levels that are weighted at very low frequencies (below 100 Hz). The thresholds are interpreted to apply to average RMS SPL during a pile driving event. There are relatively few data for un-weighted sound levels of impact driving or vibratory pile driving. Table F3-10 shows the $L_{max}$ and $L_{eq}$ levels[8] measured while driving relatively small diameter steel shell piles (24 to 36 inches) at the

[7] C-weighting is based on a curve defined by IEC 61672:2003 relating to the measurement of SPL. The weighting is employed by arithmetically adding a table of values for one third-octave bands, to the measured levels. There is generally no weighting applied to sounds between about 80 and 8,000 Hz.

[8] $L_{max}$ level is the typical maximum RMS SPL measured with a Sound Level Meter set to the "fast" response (or 1/8th second response time). The $L_{eq}$ is the energy average sound level measured over a driving event.

Navy Test Pile Program project in Bangor, Washington (Illingworth & Rodkin, Inc. 2012). These $L_{max}$ levels (measured at 50 feet [15 meters]) were used for the following analysis.

**Table F3-10. Airborne Sound Levels at 50 feet (15 meters) from Steel Pile Installation**

| | Vibratory Driver[1, 2] | Impact Hammer[2] |
|---|---|---|
| $L_{max}$ | 101 dBA | 112 dBA |
| $L_{eq}$ | 96 dBA | 103 dBA |

Sources: [1] Schexnayder and Ernzen 1999; [2] Illingworth & Rodkin, Inc. 2012.
Acronyms: dBA = A-weighted decibel; $L_{eq}$ = equivalent continuous sound level; $L_{max}$ = maximum sound level.

### F3.5.1 Offshore Impact Pile Driving

*Marine Mammals*

Table F3-11 shows the estimated distances to the in-air behavioral harassment acoustic threshold for pinnipeds using a spreading loss calculation of $20*\log_{10}$. It should be noted that these distances likely overestimate impact areas since they are based on the $L_{max}$ levels.

**Table F3-11. Distances to the In-Air Behavioral Harassment Acoustic Thresholds for Pinnipeds During Impact Pile Driving**

| All Other Pinnipeds (100 $dB_{rms}$) | Harbor Seals (90 $dB_{rms}$) |
|---|---|
| 200 ft (60 m) | 630 ft (190 m) |

Acronyms: dB = decibel; ft = feet; m = meter.
Notes: In-air sound pressure has a reference value of 20 μPa.

*Seabirds*

Table F3-12 shows the estimated distances to the in-air acoustic threshold for seabirds using a spreading loss calculation of $20*\log_{10}$.

**Table F3-12. Distances to the In-Air Acoustic Thresholds for Pinnipeds During Impact Pile Driving**

| Type of Pile Driving | Hearing Damage (125 dBA) | TTS (93 dBA) |
|---|---|---|
| Impact | < 50 ft (15 m) | 426 ft (130 m) |

Acronyms: dB = decibel; ft = feet; m = meter.
Notes: In-air sound pressure has a reference value of 20 μPa.

### F3.5.2 Offshore Vibratory Pile Driving

*Marine Mammals*

Table F3-13 shows the estimated distances to the in-air behavioral harassment acoustic threshold for pinnipeds using a spreading loss calculation of $20*\log_{10}$. It should be noted that these distances likely overestimate impact areas since they are based on the $L_{max}$ levels.

**Table F3-13. Distances to the In-Air Behavioral Harassment Acoustic Thresholds for Pinnipeds During Vibratory Pile Driving**

| All Other Pinnipeds (100 $dB_{rms}$) | Harbor Seals (90 $dB_{rms}$) |
|---|---|
| 56 ft (17 m) | 180 ft (55 m) |

Acronyms: dB = decibel; ft = feet; m = meter.
Notes: In-air sound pressure has a reference value of 20 µPa.

*Seabirds*

Per Dooling and Popper (2007), noise levels from continuous sources do not reach levels capable of causing auditory damage and/or permanent threshold shifts based on empirical data on hearing loss in birds from the laboratory. Therefore, only the distance to the TTS threshold (93 dBA) was calculated for vibratory pile driving. The distance to the TTS threshold is approximately 118 feet (36 meters).

## F3.6 SUMMARY

The underwater noise impacts from the Proposed Project would be localized and temporary in nature. With implementation of sound reducing measures for impact pile driving, noise impacts to marine mammals, sea turtles, fish, and seabirds, could be reduced substantially.

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