Draft Noise Abatement Protocol

United Water Conservation District MSHCP

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UNITED WATER CONSERVATION DISTRICT

"Conserving Water Since 1927"

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1. INTRODUCTION

United Water Conservation District (United) was established in accordance with California Water Code §§74000 et seq. United's mission is to manage, protect, conserve, and enhance the water resources of the Santa Clara River, its tributaries, and associated aquifers in the most cost-effective and environmentally balanced manner. United operates multiple facilities, including the Santa Felicia Dam, the Freeman Diversion, and water recharge and delivery infrastructure in the Santa Clara River Watershed and on the Oxnard Plain (Figure G-1). These facilities allow United to store winter runoff for release at other times, divert water from the Santa Clara River, recharge underground aquifers through recharge basins, and deliver water to cities and agricultural growers so that groundwater pumping is reduced in critically over-drafted aquifers. United's operations, maintenance, and improvements/enhancements of certain existing facilities (e.g., Freeman Diversion and associated recharge basins) require environmental permitting.

1.1 PROJECT LOCATION AND DESCRIPTION

The Freeman Diversion is located on the Santa Clara River near Saticoy (Figure G-1). The diversion contains a passage facility for the federally endangered southern California steelhead (*Oncorhynchus mykiss*) that is planned for reconstruction to address concerns related to potential effects to this species. The fish passage facility is located mostly within the Santa Clara River, on the southeastern bank, adjacent to native riparian and coastal sage scrub habitat. The federal Endangered Species Act allows take of federally listed animal species "if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity" [16 United States Code. §1539(a)(1)(B)] through issuance of incidental take permits by the United States Fish and Wildlife Service and National Marine Fisheries Service (Services) for approved habitat conservation plans. United is preparing an MSHCP to proceed with the modification of the Freeman Diversion. As a part of an approved MSHCP and project specific permit conditions, avoidance and minimization measures and mitigation are required to avoid effects to covered species. Covered species are those species listed as threatened or endangered under the Endangered Species Act, and potentially subject to adverse effects as a result of project activities analyzed and covered un the MSHCP. This Noise Abatement Protocol evaluates the existing sensitive resources, operations, maintenance, and proposed construction activities, including methods for avoiding or minimizing noise-related effects to covered fish and wildlife species in the permit area (Figure G-2).

Figure G-1 District Overview

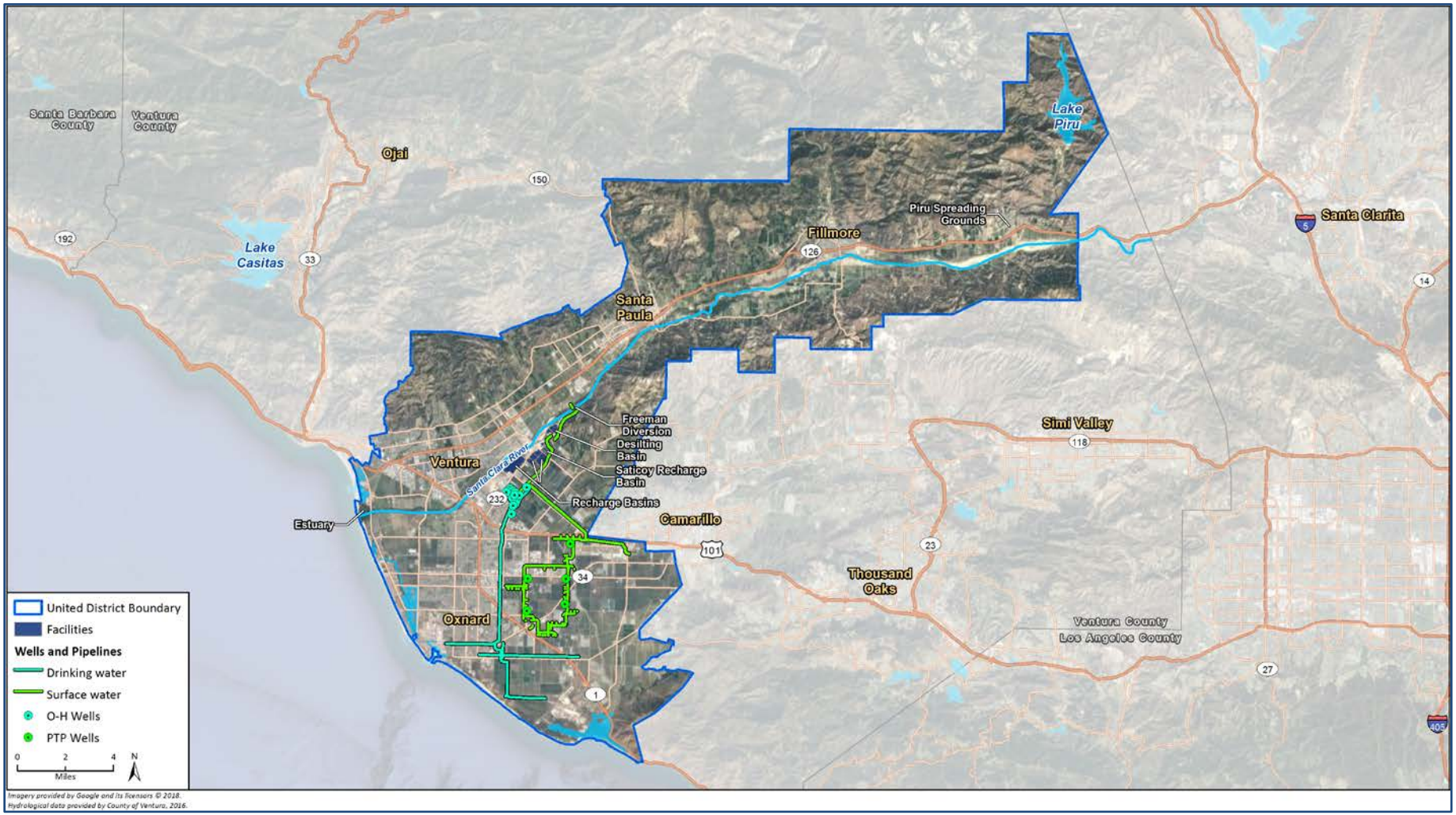
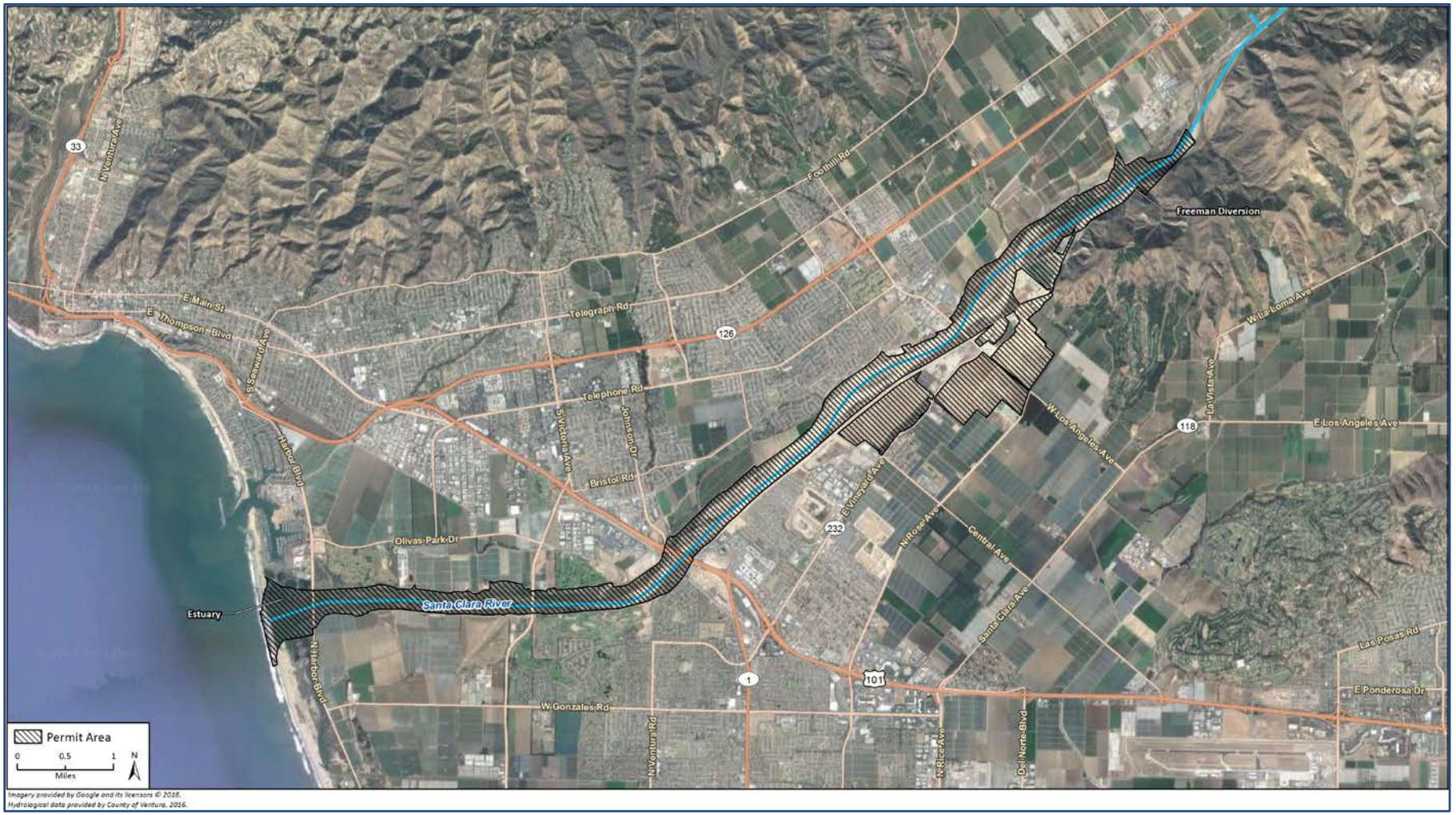


Figure G-2 Plan and Permit Areas



2. BACKGROUND AND APPROACH

United's ongoing operations, maintenance, and proposed improvements, including the modification of the Freeman Diversion fish passage, incorporate activities that may have effects to natural resources resulting from noise associated with the type, location, time (daily and seasonal), intensity, and duration of the various activities. To facilitate the comprehensiveness of this Noise Abatement Protocol, covered activities are segregated into applicable components to evaluate the various noise (sound) sources, levels, locations, and periods, based on the ongoing and proposed activities, methods, and schedules. The noise sources are then categorized and listed based on the best available data. The location of ongoing or proposed activities and their resulting sound sources are compared to delineated extents of covered species and other sensitive resources using GIS mapping software to identify overlaps and determine potential activity constraints.

The spatial extent of covered species, critical habitat, and other sensitive biological resources in United's permit area are known generally from biological surveys conducted for the MSHCP or from prior project efforts. The mapped locations defining the distribution of covered species and their habitats serve as the initial resource constraints layer for assessing potential noise-related effects. For each covered species or sensitive biological resource susceptible to noise disturbance, thresholds for behavioral modification and injury-inducing noise (i.e., decibel levels) were identified based on the best available data and are presented in the biological resources section, for review and concurrence by applicable regulatory agencies.

For the purpose of this protocol, covered activities in the permit area are categorized into four phases: 1) planning, 2) access and operations, 3) maintenance and earth movement, and 4) demolition and renovation. The activity phases are further partitioned into specific activities (pumping, grading, chipping, pile driving, etc.) to effectively estimate noise levels and assess appropriate noise abatement measures commensurate with each activity and potential resource constraints. Documented or estimated noise levels are assigned to proposed activities and will be monitored and assessed to account for site-specific attenuation, proximity of sensitive biological resources, and potential noise abatement measures to reduce noise levels and/or related effects.

2.1 NOISE

Noise is characterized typically as undesirable sound and is measured in terms of sound pressure levels. Sound in air and underwater form pressure waves that move through different media and are reported in different metrics. Air sound is measured in decibels (dB) using the A-weighted sound pressure level (dBA). The A-weighting scale is an adjustment to the actual sound pressure levels to be consistent with that of human hearing response. The A-weighted sound pressure level is measured on a logarithmic scale, with the 0 dB level based on the lowest sound pressure level that humans can perceive. The reference intensity is the difference between sound measured in air and underwater. Scientists have arbitrarily agreed to measure air sound relative to 20 microPascals (μPa), to correspond with human hearing; underwater sound is measured relative to 1 μPa. Therefore noise (sound pressure levels) should be reported based on their reference level and the distance from the source (e.g., concrete trucks generate 80 dB re 20 μPa at 33 feet). Under this protocol all sound pressure levels are reported as dB (dB re 20 uPa or dBA) since referenced information for both construction activity sound sources and resource sensitivity levels for wildlife (excluding fish) are most consistently reported in the dBA metric. For underwater sound related to fish or reptile noise sensitivity, sound pressure levels are presented in dB equal to 1 uPa and are annotated where appropriate.

Noise is characterized as continuous, intermittent, impulsive, or low frequency, terms that further categorize sound sources in terms of duration and/or intensity. Identifying various types of noise is important for understanding how recordation and documentation of individual sound sources are conducted, potential effects to resources evaluated, and effective noise abatement strategies developed. The measurement and characterization of noise, its duration, and propagation are important in determining if specific noise

thresholds maybe exceeded for certain ongoing or proposed activities adjacent to sensitive resources. It should be noted that noise occurring over a long period is more likely to cause physical injury and environmental stress. The equivalent noise level (L_{eq}) is the preferred method to describe sound levels that vary over time, resulting in a single decibel value that accounts for the total sound energy over a particular period of time. As a measure of equivalent continuous sound level, L_{eq} measures the average noise level, typically over a one-hour period, but any time scale can be applied. L_{eq} is a common metric applied during quantification and monitoring of noise sources both in air and underwater.

2.1.1 Attenuation

Noise (sound) decreases in intensity (loudness) from its source location to some point in the distance through a process of scattering and absorption called attenuation. Scattering is the reflection of the sound in directions other than that of its original propagation. Absorption is the conversion of the sound energy to other forms of energy. Many factors affect the scattering of noise including wind, temperature, humidity, terrain profile, and obstacles. Without specific boundary conditions or obstacles, sound loses energy through wave propagation as it expands from the source. Cylindrical or spherical wave propagation is used most commonly to model how spreading loss occurs in the absence of barriers or obstructions. Based on spherical spreading loss (sound radiates evenly in all directions), noise levels attenuate at a rate of 6 dBA per doubling of distance from sources such as industrial machinery or pile driving, without accounting for atmospheric or site-specific conditions. However sound propagation deviates from spherical due to a number of factors, including absorption of sound in air, non-uniformity of the propagation medium due to meteorological conditions (refraction and turbulence), and interaction with an absorbing ground and solid obstacles (such as hills and vegetation). Increased attenuation boundaries or barriers can be used to shield, deflect, or absorb sound. For the purpose of this protocol, noise attenuation estimates will be based on spherical spreading loss plus attenuation attributed to typical atmospheric and outdoor conditions known to exist in the permit area. Based on limited site-specific data obtained for moderate sound sources (60-75 dB) and the results of noise measurement from similar project areas and activities, noise attenuation is estimated conservatively at 10 dB per doubling distance.

2.1.2 Covered Activities

Chapter 3 of the MSHCP provides a comprehensive description of individual activities. The covered activities listed below include all of those for which incidental take will be authorized under the ITP:

- Construction, operation, and maintenance of a new fish passage facility
- Modifications to the facility to allow diversion of more turbid water at higher flows
- Water diversion/in-stream flow operations
- Habitat restoration and enhancement
- Monitoring
- Implementation of potential adaptive management measures

United will construct a new fish passage facility and upgrade the diversion facility at the existing Freeman Diversion. United will operate and maintain the facility for its lifetime. Covered activities for the construction of the fish passage facility include all pre-construction and construction activities with the potential to result in take of covered species. United will conduct diversion operations at the Freeman Diversion in a manner that attempts to balance mimicking the natural flow recession of the river while minimizing net yield loss of water resources for United's constituents. Maintenance activities will include the upgrading and repairing existing facilities, periodic equipment testing (e.g., canal gates), vegetation management, and ensuring optimal performance of facilities. Routine maintenance activities are those expected to be required regularly (e.g., annually). Rehabilitation, repair, and upgrade activities are expected to be required less frequently and irregularly.

Routine maintenance activities are listed below with their anticipated frequency:

- Fish passage facility routine maintenance (annually)
- Vegetation management (quarterly)
- Sediment and debris management (annually)
- Use of permit area roads and access points (daily/weekly)

Infrequent rehabilitation, repair, and upgrades are listed below:

- Rehabilitation, repair, and upgrade of existing structures
    - Facility repair, buildings, canals, roads, rip rap, bank stabilization structures, culverts, access areas, drainages
- Recontouring of riverbed

Covered activities including construction and maintenance incorporate the use of a broad range of equipment that can produce both impulse and continuous noise at varying levels of intensity (loudness). Noise sources are categorized by activity and noise type to facilitate grouping of similar noise intensities and optimize application of mitigating strategies described in the noise abatement section.

Key components of each activity are evaluated to assess potential noise related resource effects and determine the suitability of potential noise abatement measures. Covered activities are partitioned into separate stages and categories and include:

1. Planning
    a. Scheduling
    b. Sequencing
    c. Layout
    d. Education
2. Access and Operations
    a. Access road use
    b. Machinery and equipment
    c. Heavy equipment movement and grading
3. Maintenance and Earth Movement
    a. Facility and structure maintenance activities or processes
    b. Earthwork and placement of sediment stock piles
    c. High noise level activities and alternatives
        i. Rock movements
        ii. Dredging
4. Demolition and Repairs
    a. Structural improvement and repairs
        i. Concrete cutting and chipping
        ii. Sand blasting
        iii. Blasting or rock crushing
    b. Pile Driving
        i. Vibratory
        ii. Impact
        iii. Coring/Drilling
    c. Concrete Work
        i. Forming
        ii. Concrete plant operations
        iii. Hardware Placement

2.2 NOISE LEVELS OF COVERED ACTIVITIES

Table G-1 shows land-based activity noise sources as L_{max}, the root mean square (RMS) maximum level of a noise source or environment where peak is the maximum level of the raw noise source. L_{max} provides a realistic application of the maximum noise likely to be measured over a period for a specific noise-producing activity. L_{10} is the noise level exceeded for 10 percent of the measurements (top 10 percent). In most cases the monitoring and reporting metric will be the $L_{eq,}$ L_{max}, and L_{10}. For documenting air sound pressure levels (dBA) the noise source is measured at 50 feet from the activity and for underwater sound sources measurements are typically recorded at 10 meters (33.3 feet). Table G-2 presents underwater sound pressure levels for various pile driving methods and pile sizes.

Table G-1 Construction Activity Noise Levels[1]

Equipment Description	Lmax Noise Limit at 50 feet, dB, slow	Equipment Description	Lmax Noise Limit at 50 feet, dB, slow
Auger Drill Rig	85	Grader	85
Backhoe	80	Horizontal Boring Hydraulic Jack	80
Bar Bender	80	Hydra Break Ram	90
Blasting	94	Impact Pile Driver(diesel or drop)	95
Boring Jack Power Unit	80	Insitu Soil Sampling Rig	84
Chain Saw	85	Jackhammer	85
Clam Shovel	93	Mounted Impact Hammer (hoe ram)	90
Compactor (Ground)	80	Paver	85
Compressor (Air)	80	Pickup Truck	55
Concrete Batch Plant	83	Pneumatic Tools	85
Concrete Mixer Truck	85	Pumps	77
Concrete Pump	82	Rock Drill	85
Concrete Saw	90	Scraper	85
Crane (mobile or stationary)	85	Slurry Plant	78
Dozer	85	Slurry Trenching Machine	82
Dump Truck	84	Soil Mix Drill Rig	80
Excavator	85	Tractor	84
Flat Bed Truck	84	Vacuum Street Sweeper	80
Front End Loader	80	Vibratory Concrete Mixer	80
Generator (25 KVA or less)	70	Vibratory Pile Driver	95
Generator (more than 25 KVA)	82	Welder	73

Note: All dB referenced in Table G-1 are dB re 20 µPa or dBA at 50 feet from source.

[1] Adapted from Federal Highway Administration (FHWA) *Construction Noise Handbook* (FHWA 2006)

Table G-2 In-Water Single-Strike Sound Levels Associated With Impact And Vibratory Pile Driving Of Different Piles (Measured At 10 Meters From Pile)[2]			
Pile Type and Size	Peak Pressure (decibels)	Sound Pressure Level (dB RMS)	Sound Exposure Level (decibels)
AZ Steel Sheet (24-inch) Vibratory	177	163	163
CISS (12-inch) impact	190	180	165
CISS (13-inch) Vibratory	171	156	N/A
CISS (30-inch) Impact	208	190	180
CISS (72-inch) Vibratory	195	180	180
CISS (96-inch) impact*@ 25 m	212	197	188
Concrete (24-inch) Impact	193/183	175/171	160
Steel H-type Impact	190	180	165
Note: All dB referenced in Table G-2 are dB re 1 µPa measured at 10 meters unless noted. `CISS – Cast in Steel Shell			

[2] (California Department of Transportation [Caltrans] 2015).

3. BIOLOGICAL RESOURCES AND NOISE SENSITIVITY

Covered species and other sensitive biological resources potentially affected by noise from covered activities include fish, reptiles, birds and their associated habitat. Wildlife relies upon meaningful reception of sound for communication, navigation, avoiding danger, and finding food against a background of environmental noise. The occurrence and distribution of individual covered species and their habitat have been identified, in part through focused surveys conducted as part of the MSHCP and are presented as resource layers in individual figures of the permit area and for the Freeman Diversion (Chapter 4). The MSHCP addressed the covered species evaluated for potential effects from covered activities (Chapter 7); the Noise Abatement Protocol examines these further to identify and inform noise abatement measures. The area of potential effects from impacts related to noise is roughly limited to the renovation work area and close proximity in the river channel. In this section, species are grouped and general information on noise sensitivity is presented and described for each group. Details are provided for each MSHCP-covered species under subsections for the group, including brief discussions of their habitat associations.

3.1 FISH

Several studies have made recommendations for physical and behavioral effects thresholds for salmon and other fishes. The Fisheries Hydroacoustic Working Group (FHWG) included representatives from Caltrans, the Federal Highways Administration, Washington State Department of Transportation, Oregon Department of Transportation, Regions 1 and 8 of the USFWS, and the NMFS. The working group reached agreement on the interim fish sound exposure thresholds. In terms of injury related to impulse sounds from impact pile driving 206 dB re 1 µPa peak is considered the threshold for the onset of injury or 187 dB cumulative sound exposure levels (SEL) for fish weighing less than 2 grams, and 183 dB cumulative SEL for fish weighing more than 2 grams. Generally, noise sensitivity for fish ranges in frequency from 50-2,000 Hz to below 2-3 kHz, with sensitivity from 50-70 dB.

Fish are capable of receiving sound in the water. Several species have reportedly been affected adversely by sound levels greater than 180 dB re 1 µPa, present for two hours or less (Hawkins et al 2008). For a given sound to result in hearing loss, it must be of a certain intensity above the threshold of the fish for that sound. This model has been called the linear threshold shift (LINTS) hypothesis (Smith et al. 2004b). The LINTS hypothesis is only related to temporary hearing loss potentially causing behavioral responses and does not predict permanent hearing loss.

The spatial extent of fish habitat of covered species in the permit area fluctuates seasonally, both in terms of total area and location as the river flows in levees that delineate the maximum extent of the river basin. Figure G-3 shows the general fish passage and Freeman Diversion renovation site where noise effects to fish are most like to occur. Fish habitat is temporally variable and occurs where water is present sufficient to support fish species. Noise sources from covered activities with the potential to affect fish are limited to high intensity (>180 dB re 1 µPa) impulse sound sources, resulting typically from in-water construction demolition and/or pile driving. Aside from specific in-water construction activities proposed for construction modifications to the Freeman Diversion, other covered activities are not expected to have noise effects on covered fish species in the permit area.

3.1.1 Pacific Lamprey

Several studies have led to the hypothesis that the effects of high-intensity sound on the hearing of teleost fish are related to the level of the stimulus sound above the hearing threshold of the fish (Hastings et al. 1996; Smith et al. 2004a, b). There is no hearing data on lamprey as their ear is relatively simple and there is nothing within the structure of the ear or associated structures to suggest any specializations that make them more than a hearing generalist. Their maximum capacity is no more than several hundred Hz (Popper 2005).

In the absence of a species-specific noise threshold, the general FHWG thresholds should be considered valid and should be applied to Pacific lamprey.

3.1.2 Santa Ana Sucker

A population of Santa Ana sucker is known from the Santa Clara River watershed, information available at the time lead USFWS to conclude that the Santa Clara River population was of introduced origin (USFWS 1999; USFWS 2000). No specific noise-related disturbance or injury thresholds are documented for the Santa Ana sucker, and general FHWG thresholds should be considered valid.

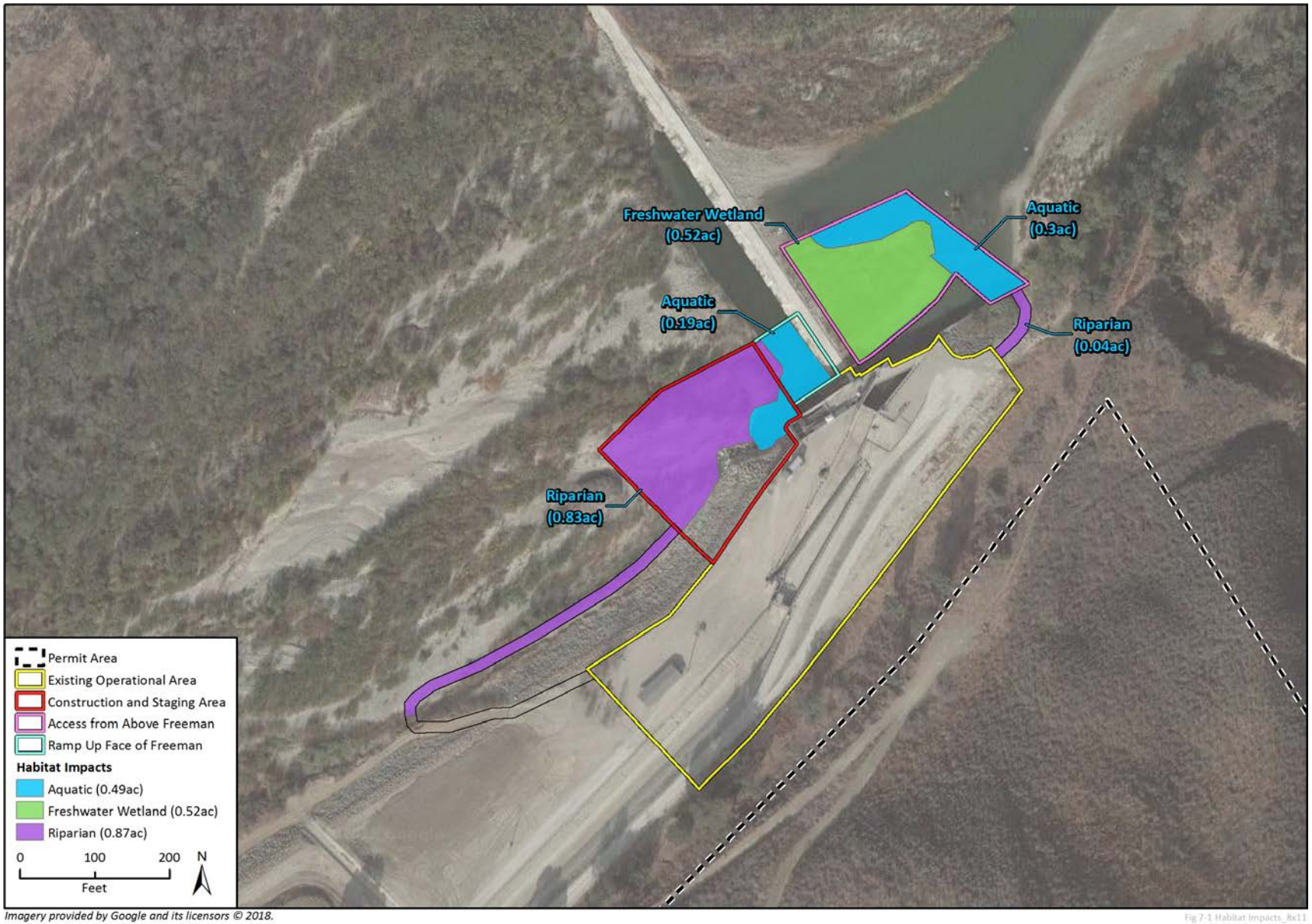
3.1.3 Southern California Steelhead

Studies conducted during pile driving activities in Arcata, California exposed steelhead to underwater peak sound pressure levels (SPL) ranging from 163 to 188 dB re 1 uPa. Cumulative SEL ranged from 179 to 194 dB and exceeded the 187 dB cumulative SEL criterion established by NMFS as a threshold for fish injury on four occasions. Necropsy and histopathology of exposed fish revealed no physical trauma related to exposure to underwater noise from pile driving (Caltrans 2015). To minimize potential behavioral noise-related disturbance or injury effects to southern California steelhead FHWG thresholds should be applied with respect to impulse noise sources.

3.1.4 Tidewater Goby

The tidewater goby migration range is a maximum of 3-5 miles, with a minimum water depth of 3 feet required for adequate migration from the Santa Clara River estuary. No specific noise-related disturbance or injury thresholds have been documented for the tidewater goby; thus general FHWG thresholds should be applied with respect to impulse noise sources.

Figure G-3 Covered Species Suitable Habitat Present in the Renovation Site



3.2 REPTILES

Few studies have been conducted on the response of reptiles and amphibians to noise. The most applicable study reported an adverse effect on reptiles related to road noise. Brattstrom and Bondello (1983) found Mojave fringe-toed lizards (*Uma scoparia*) can experience hearing damage when exposed to relatively short, single bursts (500 seconds) of loud sounds (95 dBA at 16 feet). It is likely that repeated or continued exposure to damaging noises will cause a great reduction in auditory response of these lizards. An additional study was conducted on amphibian spadefoot toads (*Scaphiopus couchi*) undergoing estivation that showed they respond to motorcycle sounds (up to 95 dB at 0.4-4.4 KHz) by leaving burrows, which could have a detrimental effect at the wrong time of year. Surface activity of western spadefoot toads decline during the unbroken hot, dry periods of late spring, summer, and fall. By late summer, adults and juveniles are quiescent, usually in earth-filled burrows they construct themselves. During dry periods, western spadefoot toads are similar to other toad species that burrow ≤ 1 m (Ruibal et al., 1969) and survive periods of osmotic stress. Dune buggy noise had adverse effect on hearing in the fringe-toed lizard (*Uma scoparia*) at durations of 500 seconds or longer at 95 dBA (FHWA 2006).

It is not unreasonable to expect loud noises to similarly impact the auditory performance or estivation of other reptiles. Short-duration, high-intensity sounds and associated vibration from construction activities may have effects to reptiles. Generally, the noise-sensitive range for reptiles is 50 Hz to 2 kHz with sensitivity at 0-10 dB. No specific noise thresholds have been established for reptiles, but considering the similarity of the hearing structures and habitat of covered species to reptiles and amphibians shown to display adverse behavior to high-intensity noise sources, noise levels in occupied habitat should be restricted to less than 95 dBA for a duration of no greater than two hours during breeding or estivation periods, unless abatement measures are implemented.

The distribution of covered reptilian species and the spatial extent of their habitat depends on seasonal changes in total suitable habitat area and location based on where the river flows within the levees that delineate the maximum extent of the river basin.

3.2.1 Western Pond Turtle

Terrestrial habitat may be just as important as aquatic habitat in some populations. Males may be found on land for some portion of ten months annually; while females can be found on land during all months of the year due to nesting and overwintering. Mating typically occurs in late April or early May, but may occur year-round. Overwintering and estivation in which the turtles enter states of dormancy during hot and cold periods to preserve energy are both important activities and may occur from early summer until most hatchlings emerge in the early fall, while some overwinter in the nest (Lovich 1998). Turtles are most sensitive to sound underwater, and their sensitivity depends on the large middle ear. Their threshold to sounds in water is approximately 20 - 30dB lower than in air (Christensen-Dalsgaard et al 2012). In the absence of an applicable noise disturbance threshold for western pond turtles and the fact that similar reptiles have been documented to display avoidance or adverse behavior to high-intensity noise sources, noise levels in western pond turtle occupied habitat should be restricted to less than 95 dB(A) for a duration of no greater than two hours during the breeding or estivation periods, unless abatement measures are implemented.

3.2.2 Two-Striped Garter Snake

This species is aquatic-dependent and is rarely found far from water. Habitat in the permit area consists of suitable breeding and foraging habitat and overlaps considerably with western pond turtle in terms of shoreline areas adjacent to existing water courses. Mating normally occurs soon after spring emergence and young are born alive in the late summer, usually in dense vegetation near pond or stream margins (Cunningham 1959, Rossman et al. 1996). Snakes feel vibrations and are most sensitive to low frequencies between 80 to 160 Hz; their sensitivity decreased at higher frequencies, falling from 78 dB at 160 Hz to 96 dB at 800 Hz (Christensen et al 2012). Snakes respond to vibrations transmitted directly from the air to the skeleton rather than sound pressure. In the absence of an applicable noise disturbance threshold for the two-

striped garter snake and the fact that similar reptiles have been documented to display avoidance or adverse behavior to high intensity noise sources and associated vibrations, noise levels in two-striped garter snake occupied habitat should be restricted to less than 95 dB(A), unless abatement measures are implemented.

3.3 BIRDS

Noise produced by human activities range in intensity and duration; considered a type of pollution, much of human-generated noise can be physically harmful or distracting avian species (Francis et al. 2009). The global scale of noise pollution rose rapidly in the last century and presents an evolutionarily novel source of interference for many species, with potentially significant influence on the ecology of many animals (Slabbekoom and Ripmeester 2008). In their environment, birds must be able to discriminate their own songs and those of other species apart from any background noise (Dooling 1982). Calls are important in the isolation of species, pair bond formation, pre-copulatory display, territorial defense, danger, advertisement of food sources, and flock cohesion (Knight 1974). Birdsong from several species has been measured to peaks of 90-95 dB and can be greater for larger birds. Ideally, bird sound production needs to exceed background noise by 18-20 dB for detection. Generally, the noise sensitive range in birds is 100 Hz to 8-10 kHz with sensitivity at 0-10 dB. Birds tend to be most sensitive to sound during breeding and nesting periods; very limited information is available on noise-related disturbance thresholds for birds in general and for the covered species outside of nesting periods. Noise disturbance thresholds have been set at 60 dB for avian species relative to maintenance and construction-related projects in California, including raptors and listed species of concern. It is recommended to apply the 60 dB noise level conservatively as the disturbance threshold relative to potential effects for covered species.

3.3.1 Least Bell's Vireo

Focused surveys have identified the federally and state-endangered least Bell's vireo in the permit area. Potential adverse noise effects on the behavior and reproduction of least Bell's vireo has provided an ongoing concern to wildlife agencies. Excessive noise levels might depress breeding success by acoustical masking or otherwise interfering with intra-specific communication or detection of predators. A study conducted by OGDEN Environmental and Energy Services Company in San Diego monitored the noise effects on least Bell's vireo during military helicopter activity and found that noise intensity did influence vocalization rates for the species, where they were significantly depressed when noise levels exceeded 60 dBA L_{eq} (32-35 percent versus 46-53 percent). The amount of time the species had available to vocalize without noise interference declined from 95 percent when noise levels were less than 50 dBA L_{eq} to 65 percent when noise levels exceeded 60 dBA L_{eq} (OGDEN 1997). For least Bell's vireo, noise levels in occupied habitat should be restricted to less than 60 dB(A) $L_{eq}(1)$, or the ambient noise level plus three decibels (perceptible change threshold), whichever is greater.

3.3.2 Southwestern Willow Flycatcher

The project site includes designated critical habitat for southwestern willow flycatcher, a species confined generally to dense areas of riparian vegetation. Its nesting habitat tends to be uncommon, isolated, and widely dispersed. The southwestern willow flycatcher spends more time in migration and on the wintering grounds each year than it does on its North American breeding grounds (Sedgwick 2000). The least Bell's vireo and yellow-billed cuckoo habitat requirements overlap with that of the flycatcher. Activities that involve mechanized equipment in occupied habitat may adversely affect listed birds and may produce, directly or indirectly, an additional level of physical disturbance as they involve the presence of humans and/or associated equipment, vehicles, or machinery. No specific noise disturbance threshold is in place for flycatcher disturbance, but considering their habitat overlaps with that of least Bell's vireo, noise levels in occupied habitat should be restricted to less than 60 dB(A) during the breeding season, unless abatement measures are implemented.

3.3.3 Yellow-Billed Cuckoo

Noise has the potential to mask vocal signals (e.g. mating songs, begging calls of young, alarm calls), potentially affecting communication and ultimately reproduction (Bowles 1995). Goodwin found noise to be the single best predictor of yellow-billed cuckoo occupancy in otherwise suitable habitat, with 35 to 55 percent lower occupancy rates in noisy areas compared to quiet ones (Goodwin 2009). Yellow-billed cuckoos have both low and narrow ranges of vocalization frequencies, with the average below 3 KHz and are not likely able to increase their amplitude nor vary their frequency. Declines have been noted for other species in response to traffic noises (Reijnen and Foppen 1995, Reijnen et al. 1995, Reijnen et al. 1997). No specific noise disturbance threshold is in place for yellow-billed cuckoo. In the absence of an applicable threshold and considering the similarity of the yellow-billed cuckoo to other protected species and their habitat requirements, noise levels in occupied habitat should be less than 60 dBA during the breeding season, unless abatement measures are implemented.

3.3.4 Yellow Warbler

Annual surveys have been conducted in the permit area that document the presence of yellow warbler in riparian habitat. Currently no specific noise disturbance threshold is in place for the species. In the absence of an applicable threshold and the similarity of the yellow warbler to other protected species and their habitat requirements, noise levels in occupied habitat should be restricted to less than 60 dBA during the breeding season, unless abatement measures are implemented.

3.3.5 Yellow-Breasted Chat

Annual surveys have been conducted in the permit area that documents the presence of yellow breasted chat in riparian habitat. Currently no specific noise disturbance threshold is in place for the species. In the absence of an applicable threshold and the similarity of the yellow-breasted chat to other protected species and their habitat requirements, noise levels in occupied habitat should be restricted to less than 60 dBA during the breeding season, unless abatement measures are implemented.

Table G-3 Summary of Noise Limit Thresholds and Breeding Seasons for Covered Species

Covered Species	Noise limit threshold (dB) (recommended)	Breeding Season/ Migration season	Documented in project area (Yes/ No)
Fish			
Pacific lamprey	180 dB re 1µPa for > 2 hours	Nov 1 to May 31 (migrant)	Yes
Santa Ana sucker	180 dB re 1µPa for > 2 hours	Mid-March to early July (non-migrant)	Yes
southern California steelhead	180 dB re 1µPa for > 2 hours	Late winter to early spring (migrant)	Yes
Tidewater goby	180 dB re 1µPa for > 2 hours	Can migrate 3-5 miles from estuary Year around with adequate water depth (1 meter)	Not expected in project area
Reptiles			
Two-striped garter snake	95 for periods up to 2 hours	March to early April	No, but expected
Western pond turtle	95 for periods up to 2 hours	May to August	Yes
Birds			
Least Bell's vireo	60 at nest	April 10 to July 31	Yes
Southwestern willow flycatcher	60 at nest	Mid-May to Mid-July	Yes
Yellow-billed cuckoo	60 at nest	Mid-May to September	No
Yellow-breasted chat	60 at nest	Mid-April to August	Yes
Yellow warbler	60 at nest	May to June	Yes

4. PROTOCOL IMPLEMENTATION

4.1 PERMIT AREA NOISE

Covered activities, including construction, can involve the use of equipment that can produce noise of varied intensity and duration. The permit area spans a variety of locations and includes several service roads, access corridors, settling ponds, facilities, and proposed repair projects (Figure G-6). Vehicle and heavy equipment movement in support of maintenance activities along approved corridors and roads may generate noise-related effects to covered species occupying adjacent habitat. Pickup trucks used to transport construction crew personnel are not evaluated as their estimated maximum sound level is less than that determined to effect covered species (< 60 dB). Movement and use of heavy equipment, such as graders, backhoes, concrete mixer trucks, dump trucks, compactors, crane, dozer, and water trucks, cause noise in the 80-85 dB range. Noise arising from earthwork, road maintenance, and transit of heavy equipment would take place in the permit area, including in the river basin, during levee repairs and activities associated with the Freeman Diversion reconstruction. Additionally, some earthwork and rock rip-rap work would be required routinely along either side of the dam to address problems related to high river flows and channel meandering. Based on an attenuation rate of 10 dB per doubling distance, covered activity noise sources of 85 dB should be reduced to approximately 60 dB at 300 feet, below the disturbance threshold for avian wildlife during breeding season. To effectively evaluate potential noise effects on covered species a 300-foot buffer was used to define each of the construction areas associated with the Freeman Diversion (Figure G-7).

High-intensity noise sources associated with demolition, and construction activities noise during the Freeman Diversion reconstruction are anticipated to produce noise ranging from 85-95 dB. Activities may include jack hammering, clam shell work, concrete cutting, concrete crushing, and hydra ram breaking. River diversion and new construction would involve activities with noise sources ranging from 75 to 95 dB that could include vibratory and impact pile driving, concrete plant operations, and heavy equipment use at the Freeman Diversion and adjacent work areas, including in the riverbed and along the dam wall.

Figure G-4 Fish Passage and Freeman Diversion Renovation Area

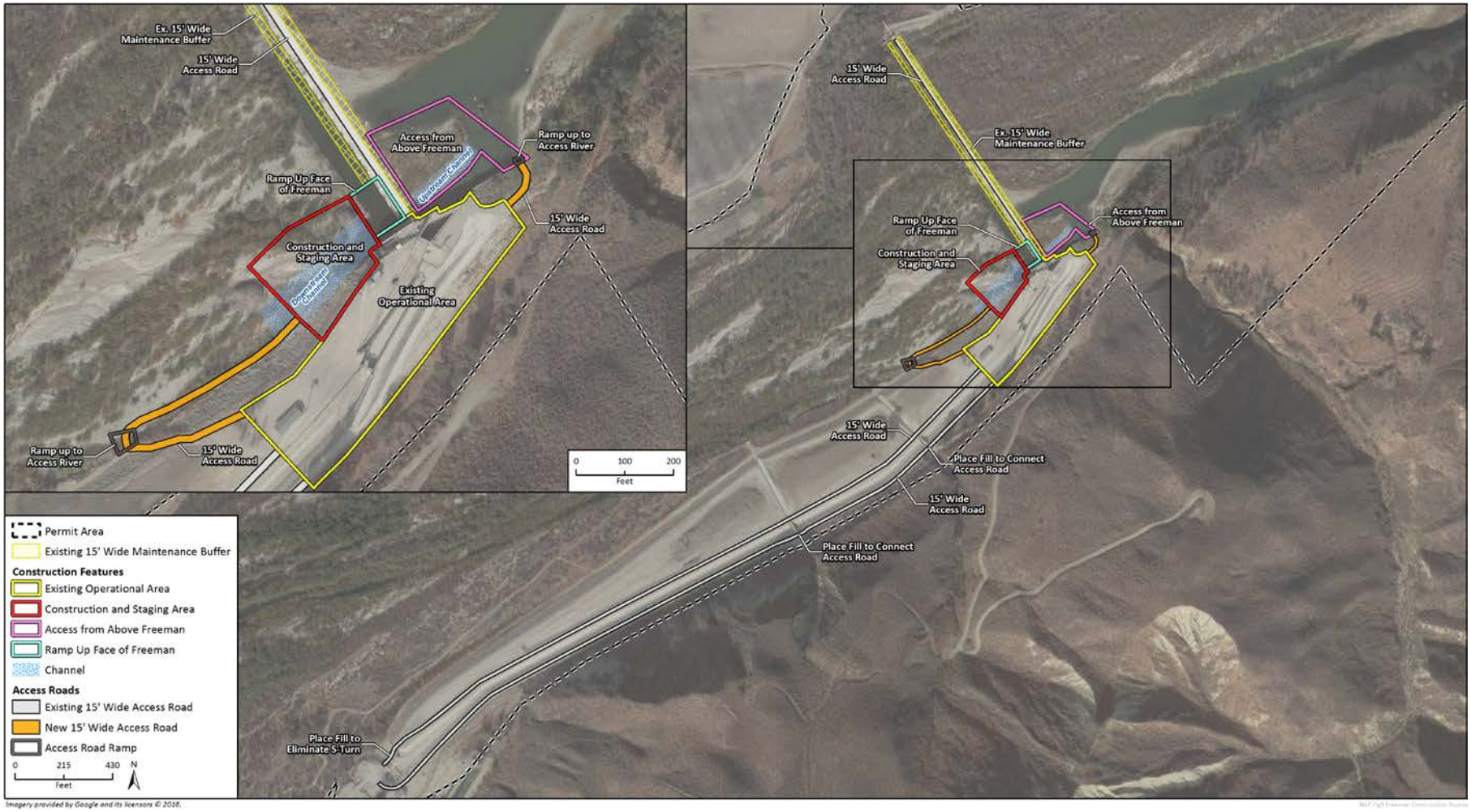


Figure G-5 Construction Area with Integrated 300-foot Resource Buffer

4.2 AVOIDANCE AND MINIMIZATION MEASURES

To mitigate noise effects to sensitive resources, avoidance and minimization measures will be in place for each phase and type of covered activity. Limiting work to seasonal periods or times of day is the most effective approach to avoid potential effects to wildlife migration, nesting, or breeding. Installing hardscape structures (earthen berm or sound wall) to abate persistent or continuous sound sources is also effective. Considering the complex nature of the covered activities, careful planning should integrate the temporal and spatial distribution of those activities relative to sensitive receptors. Each covered activity with the potential to generate noise levels above 60 dB should be evaluated relative to the noise abatement measures listed below. The mitigation strategies listed below should be assessed during the planning phase for appropriate integration into activities conducted by United personnel and contractors.

4.2.1 Proposed General Mitigation Strategies

- Outfit equipment with engineering and administrative controls (mufflers, shielding, etc.)
- Establish project design and project layout cognizant of noise criteria and buffers
- Sequence operations to avoid sensitive migratory or nesting periods
- Consider alternative activity methods
- Create temporal and spatial operational constraints
- Include noise information/training into environmental education provided to workers and contractors
- Integrate noise mitigation at the source including both stationary and mobile equipment
- Select equipment for appropriate noise level recommendations
- Implement inspection and maintenance programs
- Utilize natural shielding
- Establish temporary shielding
- Build permanent shielding
- Implement noise mitigation at receptor sites
- Use masking
- Relocate covered species

4.2.2 Resource-Specific Mitigation Strategies to be Considered

- Conduct activities outside of nesting bird season
- Install block nets for fish up and downstream at an adequate distance for less than 180 dB re 1µPa
- Perform pre-construction surveys to document presence/absence of species of concern and develop buffers around active nests or other resources
- Conduct noise monitoring to document sound sources and establish boundaries around nests so noise levels do not exceed to 60 dBA
- Implement additional measures if a nest is located within the area of the 60 dBA boundary, including the use of a sound walls or sound reducing curtains to reduce noise levels around construction activities, or to stop the offending construction activity until juveniles have fledged
- Fence around work areas adjacent to the river to exclude wildlife (turtles) from construction areas prior to hibernation periods

5. NOISE ABATEMENT MEASURES

5.1 PLANNING

To effectively avoid potential noise effects to covered species from covered activities, managers, supervisors, and contractors should be informed of potential noise constraints and required to implement noise abatement measures. This includes individuals understanding that noise levels associated with the use of vehicles, heavy equipment, and machinery needed for conducting covered activities may constrain scheduled operational, maintenance and repair activities. Covered activities planning including maintenance operations, equipment and machinery movements, equipment placement, and their associated sound levels should be considered and weighted relative to the extent of covered species habitat. Alternative methods, locations, and sequencing of covered activities should be considered based on anticipated seasonal constraints. High sound source activities such as demolition, pile driving, rock movements, and riverbed grading should be scheduled outside of sensitive periods, nesting periods, and limited in duration to the maximum extent possible. During the planning stages of covered activities, natural or artificial barriers (earthen berms or sound walls) should be discussed to reduce sound propagation while they minimize temporal constraints on work periods or seasons. For all covered activities and particularly recurring maintenance and operational activities, the following noise abatement measures should be evaluated and implemented progressively, as pertinent.

- Integrate noise abatement information into environmental training for workers and contractors
- Outfit or maintain equipment with engineering and administrative controls (e.g., mufflers, shielding)
- Delineate the covered activity footprint and review in context with the extent of covered species habitat and recommended buffer distances
- Review work schedules to work around sensitive resource breeding, nesting, or migratory periods, to the maximum extent possible
- Implement temporary or permanent noise shielding
- Implement diversions or relocate covered species

5.2 ACCESS AND OPERATIONS

Heavy equipment uses existing roads or corridors continuously or semi-consistently to access the river bed or other facilities. Temporal and spatial avoidance measures cannot be implemented adequately to address all activities; thus engineered noise control measures should be evaluated and implemented to reduce noise levels at or near the source. Machinery that generates continuous or semi-continuous operational sound, such as pumps, fans, or generators, should include permanent or temporary noise abatement structures or shields, where applicable. Considering the comparative coincidence of sensitive breeding or nesting periods of covered species (Table G-3) some access or road grading could be conducted during the late summer, if avian nesting has concluded or associated noise threshold buffers are sufficient for the covered activities. Grading and other similar noise-producing activities to be conducted in access corridors for the riverbed should proceed outside the avian breeding season due to the proximity of covered species habitat documented throughout the permit area, as practicable.

Improvements to access corridors or roadwork activities are not expected to cause noise effects to sensitive resources for the majority of covered activities. Based upon estimated sound sources of heavy equipment operations (approximately 80 dB), the proximity of known habitat for covered species, and anticipated noise attenuation rates (spherical spreading loss plus wind, etc.), sound levels are anticipated to range from 63 to 68 dB at 200 feet from access points and roads throughout the permit area. Based on atmospheric and site conditions (topography), 10-30 percent of additional noise attenuation can be expected near the boundaries of

covered species habitat. Other than engineering controls and temporal avoidance, no additional noise abatement measures are suggested for activities limited to mobilization to the construction and staging areas or proposed activities associated with the access roads along the south bank of the river (Figure G-2). For covered activities, including access and operations in permit areas, the following noise abatement measures should be evaluated and implemented progressively, as pertinent.

- Maintain operational and heavy equipment through regular servicing and outfit with engineering and administrative controls (e.g., mufflers, shielding)
- Evaluate alternative locations for placement of machinery or develop sound control structures
- Delineate the covered activity footprint and review in context with the extent of covered species habitat and recommended buffer distances
- Review work schedules and work around sensitive resource breeding, nesting or migratory periods to the maximum extent possible

5.3 MAINTENANCE AND EARTH MOVEMENT

Avoidance is the simplest and most cost-effective method of circumventing noise effects to sensitive receptors; thus temporal and spatial noise abatement measures are preferred. Maintenance and earth movement covered activities should be timed to avoid the breeding or nesting season for riparian and avian species (March 15 to September 15), unless covered activities occur in areas where covered species do not occur. Noise production should be kept below prescribed threshold limits, or adequate buffer distances should be applied for covered activities. Some noise disturbance to adjacent habitat is anticipated as a result of repair activities that involve heavy equipment work, grading, earth movement and rock movements in the river bed. For planning purposes covered activities should occur outside of the avian breeding and nesting season, if feasible. For proposed earth movement activities, Ramp up Face of Freeman (RUFF), and Access from Above Freeman (AAF) earthen sound barriers 12 to 15 feet tall could be established around the perimeter of the work areas to reduce noise levels (Figure G-8). Covered activities should be planned carefully both temporally and spatially relative to sensitive receptors considering the need to construct the earthen noise barriers as part of site preparation. Staged materials, excavated soil, and equipment should be evaluated to either minimize noise sources or to locate them so they act as sound barriers. Simple earthen or temporary (plywood) noise barriers can reduce noise levels if appropriately placed and maintained around work areas. For covered activities, including maintenance and land movement in permit areas and specifically in the Freeman Diversion project area, the following noise abatements measures should be evaluated and implemented progressively, as pertinent.

- Integrate noise abatement information and environmental training to contractors
- Delineate the covered activity footprint and review in context with the extent of covered species habitat and recommended buffer distances
- Review work schedules and work around sensitive resource breeding, nesting or migratory periods to the maximum extent possible
- Implement temporary or permanent noise shielding
- Implement diversions or relocate covered species

Figure G-6 Freeman Diversion Construction Area with Proposed Earthen Berm Locations

5.4 DEMOLITION AND REPAIRS

Demolition and construction repairs required for facilities, and specifically the Freeman Diversion, involve construction activities including rock/concrete crushing or demolition, rock rip rap movement, drilling, impact and vibratory pile driving, concrete plant operations, carpentry form construction, concrete finishing, and hardware installation. Covered activities including demolition activities, surface preparation, repairs, and rock rip rap placement will likely require implementation of seasonal avoidance measures specific to noise abatement, considering the proximity of sensitive habitat and anticipated noise levels from reconstruction activities. Covered activities in the CSA, RUFF, and AAF will likely have the benefit of earthen or structural sound barriers installed during the demolition phase of construction and sound attenuation rates ascertained during monitoring of other covered activities, to adaptively manage noise abatement measures. Planning and positioning of demolition and reconstruction activities and machinery should use project noise and resource information gathered during the earlier phases of the project to make adaptive decisions on sequencing, scheduling, and implementation of noise abatement measures.

Quiet machinery designed specifically to produce less noise should be considered to the greatest extent possible. Mufflers can be fitted to rock breakers, diesel generators, and compressors, reducing noise levels by up to 15 dB in some cases. Concrete saw cutting should be conducted using ample water, blades with the greatest number and smallest teeth, and shielding considered where applicable.

The CSA, RUFF, and AAF are mostly located in the river at the same elevation as the majority of sensitive habitat concentrated along the northern portion of the river. Use of earthen or structural sound barriers along the river side of the three areas may provide a significant reduction to noise levels potentially affecting adjacent habitat, allowing construction to proceed in part, around seasonal date restrictions. Additionally, rock or concrete crushing equipment or machinery should be located at the southernmost part of CSA as possible, and earthen or structural sound barriers should be implemented as part of site mobilization and organization, wherever possible. Considerable earth movement may be required in the river as part of the construction and water diversion effort, providing large quantities of river sediment to use for earthen berms to help control noise sources.

Consistent with all of the previous covered activities, engineering noise reduction measures should be integrated to the greatest extent possible including the use of mufflers and shielding at the sound sources. During concrete pouring, the placement of the concrete plant, pumps, and generators should be considered prior to scheduling and commencing work. The high traffic area for the concrete plant or heavy equipment should be placed as far away from sensitive sound receptors as feasible. Locating the concrete plant near the southeast boundary of the Freeman Diversion construction area in the existing operational area would be appropriate. During high noise source (> 85 dB) activities, additional or temporary noise shields should be considered, especially with respect to drilling and pile driving activities. If possible, vibratory pile driving should be used instead of impact pile driving, and in-water pile driving activity should be conducted outside southern California steelhead migration periods and with a water diversion in place. If in-water impact pile driving is required during the rivers high water flow times then fish exclusions should be installed and additional noise abatement measures including bubble curtains, pile within a pile, and dewatering evaluated based on documented SPLs and implemented if effect level thresholds are reached.

If noise levels reach 90 percent of species disturbance thresholds for a specific activity, the duration of that activity should be minimized to no greater than two hours every four hours and additional noise abatement measures should be implemented or considered to extend working periods. Installation of hardware requiring drilling, grinding, or use of other hand tools should not be subject temporal restrictions, but should be evaluated in terms of noise source levels on an individual basis, particularly considering the proximity of sensitive noise receptors.

In-water resources, primarily fish, are not expected to be exposed to noise levels above established thresholds (183 dB re 1µPa) during of the Freeman Diversion reconstruction. Pre-demolition water diversions will route

flow around the main construction areas and noise levels associated with concrete or rock demolition (hydraulics, jackhammers, crushers) will take place out of the water and propagation into adjacent waters is not expected to reach established noise threshold limits. To account for potential vibration effects to reptiles, surveys for western pond turtles and two-striped garter snakes documenting presence/absence should be conducted in proposed work areas adjacent to aquatic or riparian habitat. Work periods should avoid areas and times of year that estivating turtles or nests may occur. Construction activity sequencing should consider seasonal resource constraints, and construction contractors should incorporate environmental information into production schedules to avoid resource conflicts and delays. For covered activities, including demolition and reconstruction in the permit area and specifically at the Freeman Diversion, the following noise abatements measures should be evaluated and implemented progressively, as pertinent.

- Integrate noise abatement information and environmental training to contractors
- Delineate the covered activity footprint and review in context with covered species habitat and integrate recommended buffer distances
- Review work schedules and work around sensitive resource breeding, nesting, or migratory periods to the maximum extent possible
- Implement earthen berms as temporary noise shielding around work areas in the river for the Freeman Diversion reconstruction
- Implement fish diversions and relocate covered species potentially impacted during earth movements

6. MONITORING

To consistently determine potential effects to covered species for individual activities and locations existing data will be assessed prior to conducting covered activities and monitoring implemented when insufficient information is available to determine habitat extent, noise source levels, and noise attenuation rates. covered species and noise monitoring will be conducted prior to the start of construction and clearance surveys performed by a qualified biologist for the covered species, consistent with the MSHCP Conservation Measures. In addition, covered species habitat will be delineated and applicable buffers established for the proposed covered activities based on covered species disturbance thresholds, estimated or documented noise source levels (Table G-1), and estimated or documented attenuation rates. For each type of covered activity, facility, or repair project, resource and noise level monitoring should be conducted to document existing resource and activity noise levels, and to determine suitable buffer distances. For the Freeman Diversion, noise level monitoring should be conducted during initial mobilization of heavy equipment to the CSA. Noise monitoring should be conducted at two locations on either side of the main access road (total of four locations). Noise measurements should be collected at a distance of 50 feet and 100 feet, simultaneously, at each location to document sound source levels and localized attenuation rates along existing roads and river access roads. Noise measurements should be recorded during the highest use periods and the corresponding L_{10}, L_{max}, and L_{eq} determined.

Each of the sound metrics should be recorded for each type of activity with similar activities lumped for efficiency (water trucks, dump trucks, cranes, etc.). Acoustic data collection should also document site conditions (topography), weather, instrument type, and calibration dates and times. If no resource constraints exist for a specific area or period then noise monitoring is optional and the estimated sound sources (Table G-1) applied with conservative attenuation rates (10 dBA per doubling distance) applied.

The same approach to noise source monitoring should be applied to each covered activity and location with no need to record noise source levels at 50 feet (source) for the same construction activity at different locations. At least one type of construction activity should be monitored for noise source levels at each site consistent with the stated approach to develop appropriate attenuation rates.

Hydroacoustic sound level monitoring is only necessary if demolition or construction activities occur in the water to a sufficient degree to propagate sound pressure levels throughout the water body. If needed, hydroacoustic monitoring should be conducted at 10 meters from the source and sound pressure levels reported consistent with the FHWG thresholds.

For covered species and associated habitat, noise levels should be monitored at the sensitive receptor location or habitat boundary, with noise levels and distance documented during specific covered activities. Noise source levels, including ambient sound levels, should be collected using a standard noise meter, calibrated daily using a pistonphone. Collected data should be recorded on monitoring log datasheets. Data should be collected for a minimum of three times during high activity periods and document if noise abatement measures were in use at the time of the monitoring. A description of the topography and any natural or non-natural obstructions between the noise source and recording location should be noted, photographed, and evaluated for efficacy.

7. REPORTING

An annual report shall summarize noise information for covered activities, including recurring maintenance and operations activities conducted in the permit area. This will document specifically the covered activities associated with the Freeman Diversion reconstruction during the first year, and will include an update to the summary table in future years to sufficiently document noise source levels and attenuation rates. The report will provide general information about the MSHCP and integrated Noise Abatement Protocol including an introduction, methods, results, and discussion sections. It will be organized to provide noise source level information for each covered activity, presenting the documented noise source level measured for each activity, greater than 60 dB, compared to the estimated noise source levels reported by the U.S. Department of Transportation (Table G-1 and Table G-2). The report will provide an account of the localized conditions and factors that contributed to sound source levels, including a description of the noise source type (continuous or impulse), intensity (loudness), range of intensity, and duration.

The report will outline the attenuation rates measured for the various covered activities and locations providing the applicable attenuation rates to be applied for a range of conditions (wind) or locations (road or river) to establish guidance for ongoing and future covered activities conducted in the permit area. A summary of attenuation rates for each location should be compared to spherical spreading loss and contributing factors outlined and discussed.

The report shall present the various noise abatement measures considered and implemented for each covered activity and a brief discussion outlining how the measure was implemented and its effectiveness at reducing noise source levels and potential effects to covered species. For implemented noise abatement measures the overall reduction in noise (dB) should be presented in terms how much noise was mitigated (dB). For temporal avoidance measures the report shall describe the seasonal time frames, rationale, and lessons learned. Finally, the report will provide recommendations pertaining to the ongoing implementation of the noise abatement measures for the various covered activities and identify, if any, additional measures to be considered or tested.

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